Excess mortality in the Glasgow conurbation: exploring the existence of a *Glasgow effect*

James Martin Reid *MSci*

Submitted in fulfilment of the requirements for the Degree of PhD

University of Glasgow
Faculty of Medicine, Section of Public Health and Health Policy

September 2008

Abstract

Introduction

There exists a 'Scottish effect', a residue of excess mortality that remains for Scotland relative to England and Wales after standardising for age, sex and local area deprivation status. This residue is largest for the most deprived segments of the Scottish population. Most Scottish areas that can be classified as deprived are located in West Central Scotland and, in particular, the City of Glasgow. Therefore the central aim of this thesis is to establish the existence of a similar 'Glasgow effect' and identify if the relationship between deprivation and all cause mortality is different in Glasgow to what is in other, comparable cities in the UK.

Methods

A method to compare the deprivation status of several UK cities was devised using the deprivation score first calculated by Carstairs and Morris. The population of mainland UK was broken into deciles according to the Carstairs score of Scottish postcode sectors and English wards. Deprivation profiles for particular cities were drawn according to the percentage of the local population that lived in each Carstairs decile. Using data from the three censuses since 1981, longitudinal trends in relative deprivation status for each city could be observed.

Analysis of death rates in cities was also undertaken. Two methods were used to compare death rates in cities. Indirect standardisation was used to compare death rates adjusting for the categorical variables of age group, sex and Carstairs decile of postcode sector or ward of residence. Negative binomial models of death counts in small areas using local population as the exposure variable were also created; such models allow the calculation of SMRs with adjustment for continuous variables. Covariates used in these models included city of residence, age group, sex, Carstairs z-score and also the z-scores for each of the four variables from which the Carstairs score is comprised (lack of car ownership, low social class, household overcrowding and unemployment).

Results

The deprivation profiles confirmed that all UK cities have a high proportion of deprived residents, although some cities have far higher proportions than others. Some cities appeared to show relative improvement in deprivation status over time whilst others seemed resistant to change. Glasgow was the most deprived city at all census time points and the Clydeside conurbation was also more deprived than all other conurbations.

SMRs calculated by indirect standardisation indicated that many cities have excess mortality compared to the whole of the UK when adjusting for age group and sex only. Three cities, Glasgow, Liverpool and Manchester, had SMRs that were significantly higher than all other cities at every census time point. Adjusting SMRs for Carstairs deprivation decile diminished the magnitude of this excess mortality in most cities. However, adjusting for Carstairs decile did not diminish the excess mortality in Glasgow sufficiently and there remained a significant, unexplained residue of excess mortality in Glasgow.

SMRs generated by regression models adjusting for continuous variables were able to reduce the size of the excess mortality in most cities, though the model producing the lowest SMR varied from place to place and from time to time. In Glasgow, a regression model including age group, sex and lack of car ownership as covariates explained most of the excess mortality at all three time points.

Discussion and Conclusion

The relationship between deprivation (as measured by the Carstairs index) and death rates in Glasgow did appear to be different to other cities, and there seems to be evidence of a Glasgow effect. There are several reasons why this might be the case, including; the Glasgow effect may be apparent rather than real – an artefact of the Carstairs measure of deprivation failing to capture the complex nature of multiple deprivation; The effect may be the result of migration patterns to and from the city; the effect may be the result of historical levels of deprivation; or the effect may result from different behavioural patterns among Glasgow residents compared to residents of other UK cities.

In conclusion, the results show that continued efforts by public health professionals, politicians and residents have failed to produce a step change in the city's relative health status and Glasgow continues to lag some way behind other cities in the UK. The ability of the Carstairs measure to describe multiple deprivation is called into question. Future research should focus on identifying specific causes of mortality that contribute to the Glasgow effect; on qualitative work to identify if there is a distinct set of social norms in deprived neighbourhoods of Glasgow that contribute to unhealthy patterns of behaviour; and on creating a deprivation index that can be used on equivalent units of geographical area in both Scotland and England.

Acknowledgements

Although this thesis is fundamentally my own work, I would have certainly have failed to accomplish the task without the encouragement, advice and technical help (often all three on the same occasion) of certain individuals.

My main supervisor during this project was Professor Phil Hanlon. In my career to date, I have been managed by a broad array of personality types. I am happy to say that Prof Hanlon, by some distance, has been the most inspiring, invigorating and innovative boss that I have had. I have learned many academic, professional and personal lessons through meeting with him and observing him going about his business within the Department of Public Health and at the GCPH. I am proud to have become his friend and I shall greatly miss our weekly updates when this PhD is complete.

I have been lucky enough to have had Professor Carol Tannahill as my second supervisor. She is a quite brilliant woman and I consider it a great privilege to have enjoyed her tutelage. I met with Prof Tannahill less frequently than with Prof Hanlon but our meetings were no less valuable. She took a strategic role in managing the project and identified gaps in my literature and research. Later on, her devastating critical faculties were instrumental in turning amateurish and often turgid early drafts into comparatively well polished scientific writing.

Harper Gilmour of the Department of Public Health offered statistical advice in an admirably calm and patient manner. Richard Lawder of NHS Scotland's Information Services Division helped with initial mortality analyses and familiarisation with the datasets. Dr Karen Lorimer became an important friend and ally. She offered advice and strong opinions about the writing process, research training courses, interesting journal articles and life in general. David Walsh of the GCPH offered advice on fine tuning the analyses and responded with good humour to my increasingly random information requests.

The following people graciously volunteered to proof read the final drafts of the chapters: Frances Downie, Karen Lorimer, Ruth Reid, Donald Reid and Gabrielle Reid. I am grateful for the lessons in grammar and spelling and for the final bits of advice that they provided. Any remaining errors in the text are, of course, entirely my own.

I wish to thank my wife, Gabrielle, who was a continual source of support and optimism even on those rare occasions when I felt like I could not continue. Last, I wish to thank my mother, who threatened to kill me if I did not complete the project. I believed her.

Declaration

The work in this thesis was undertaken full time at the Department of Public Health and Health Policy within the University of Glasgow from February 2005 to September 2008, under the joint supervision of of Professor Phil Hanlon (Section of Public Health and Health Policy, University of Glasgow) and Professor Carol Tannahill (Director, Glasgow Centre for Population Health).

This thesis comprises original work carried out solely by the author. It contains no material previously published or written by another person except where referenced. This thesis has not been submitted in part or whole to any other university for any other degree.

1 Introduction

Glasgow is the largest city in Scotland, with a population in excess of 570,000. It is situated in the West of the country, approximately 15 miles from the coast. The River Clyde flows through the centre of the city and is also central to the city's social history. Glasgow is an old settlement – references to a *Glas chu* (translated as 'dear green place') can be found as far back as the 6th century[1] when St Kentigern established a church in the vicinity. Today, Glasgow is part of a larger continuous urban area or conurbation that encompasses a large portion of West Central Scotland and nearly 1.5 million people.

Glasgow rose to prominence during the industrial revolution. From the middle of the 18th century onwards its population swelled to a peak of slightly more than 1 million in the early 1950's when it was the second most populous city in the UK. In the latter half of the 20th century, Glasgow was subject to deindustrialisation. Heavy industries such as metal forgery, shipbuilding and locomotive manufacturing that had been the focus of the local economy and major sources of employment were gradually dismantled and the city became associated with poor social cohesion, high crime rates, social and material deprivation and very poor population health. In recent times, catalysed by the city being awarded the title of European Capital of Culture in 1990, Glasgow has sought to reinvent itself as a tourist destination[2], a major retail centre and as the location of a vibrant arts and cultural scene. Employment in the city is now dominated by the service sector with manufacturing playing a secondary role. Structures associated with the city's manufacturing past continue to be demolished or replaced and housing policy in the city has seen whole scale changes in the last 50 years that have contributed to great changes in the urban form.

Even in the face of these improvements to the city's physical fabric, Glasgow retains a reputation for severe deprivation and very poor population health. In the mainstream press, Glasgow is depicted as the 'sick man of Europe'[3] and one columnist made the observation that life expectancy figures in parts of Glasgow are similar to those found in Belarus or even Iraq[4]; the comparison was somewhat facetious but the point was stark. The shock value of these comparisons comes from the fact that Glasgow is located in one of the world's most affluent countries, where there is free health care that is of high quality and where national life expectancy places Scotland in a group of nations that is the best in the world. Why then should the health of Glasgow's population be so bad in comparison to the rest of the UK? A recently published report has highlighted that on several measures of health, the West of Scotland region fares worse than many comparably deindustrialised areas in Western Europe and as badly as several deindustrialised regions in Eastern Europe[5].

Part of Scotland's response to the continued concerns about Glasgow's poor health status, was to establish the Glasgow Centre for Population Health (GCPH) in 2004. The GCPH[1] has the central purpose of investigating the causes of Glasgow's poor population health and suggesting evidence-based policies to ameliorate or solve the problem. The Centre has three research themes. The first seeks to strengthen understanding of health and its determinants through programmes that have assembled comprehensive public health datasets at several levels of geography, facilitating comparisons that provide insights to inform interventions and further research. The second theme aims to provide evidence that will influence health policy, such as researching best practice in healthy urban planning, through experimental studies such as the GoWell study of regenerated communities in Glasgow and through employability projects. Finally, the third theme provides new insights and fresh thinking regarding health, particularly in Glasgow. To this end the GCPH funds studies taking a less mainstream approach to understanding the determinants of health such as evaluating an intervention based on Sen's capability approach and publishing reflective papers on topics such as consumer society and spirituality and health. The current project is part of the first of these three research themes as it aims to compare health in Glasgow with other UK cities in order to gain a better understanding of why Glasgow suffers excess mortality.

This thesis was prompted by the results of a project published in The Journal of Public Health in 2005[6]. Hanlon and colleagues made a number of noteworthy

[1] The Centre is a partnership between Glasgow City Council, Greater Glasgow and Clyde NHS Board and The University of Glasgow, supported by the Scottish Government. This arrangement means that the Centre enjoys a wide range of support and a substantial level of independence.

findings concerning standardised mortality ratios in Scotland relative to England and Wales. A summary of their main findings is shown in Table 1 below.

Table 1: Summary of Standardised Mortality Ratio findings of Hanlon et al, Journal of Public Health, 2005.

	1981	**1991**	**2001**
SMR in Scotland, adjusted for age and sex	112	114	118
SMR in Scotland, adjusted for age, sex and deprivation decile	104	109	112
% Excess mortality in Scotland 'explained' by deprivation	66%	36%	33%

First, they found that Scotland's age and sex adjusted standardised mortality ratios (SMRs) grew relative to those of England and Wales between 1981 and 2001. They found that in 1981, Scotland's SMR was 112, equating to a 12% excess mortality relative to England and Wales. In 1991, Scotland's SMR was 114 (a 14% excess mortality) and in 2001, it was 118 (an 18% excess mortality). Even though absolute death rates in Scotland fell during the period 1981-2001, the absolute fall in deaths in England and Wales was larger, thereby creating increasing relative excess mortality in Scotland.

Second, the authors used the Carstairs Index of Deprivation to quantify the relative deprivation status of Scotland to England and Wales at each of the three Census time points. Using the Carstairs measure, they broke the population of the UK into ten equally sized deciles. Decile 1 areas were the most affluent while decile 10 areas were the most deprived. They created histograms to show the percentage of each country's population in each Carstairs decile. This allowed the relative deprivation status of the two countries to be compared. However, material and social conditions improved in Scotland until the time of the 2001 Census such that the deprivation status of Scotland became more similar to that of England and Wales. It should be noted that the absolute levels of deprivation improved in both Scotland and England and Wales between 1981 and 2001. The key point, however, was that Scotland's position relative to England and Wales became less unfavourable.

Third, the researchers found that when death rates in Scotland were adjusted for age, sex *and* Carstairs deprivation decile, the relative excess mortality in Scotland compared to England and Wales was diminished. In 1981, the age, sex and deprivation decile adjusted SMR was 104, equating to an excess mortality in Scotland of 4% (relative to England and Wales). In 1991, this excess was 9% and in 2001 it was 12%. In the light of these results, the researchers concluded that deprivation played a key role in contributing to the mortality gap between Scotland and England and Wales and adjusting for deprivation status resulted in a narrower mortality gap between Scotland and the rest of the UK. However, the researchers pointed out that the percentage of excess mortality in Scotland that was 'explained' by adjusting for deprivation diminished at each successive Census time point. In 1981, more than two-thirds of the excess mortality in Scotland could be attributed to deprivation, but by 2001 less than half of the excess was explained in this manner, as the final row of Table 1 shows. This was a less than intuitive finding – Scotland's relative deprivation status had improved between 1981 and 2001. Accordingly, it might be expected that Scotland's population health would have improved relative to that of England and Wales between 1981 and 2001 but the reverse happened. Furthermore, even though Scotland remained somewhat more deprived than England and Wales, deprivation (as measured by the Carstairs score) explained less of Scotland's excess mortality as time progressed. The researchers asserted that this finding supported the notion that there was some, as yet undefined, 'Scottish effect', in operation whereby the residents of Scotland suffered adverse health outcomes above and beyond what might be predicted from the conventionally measured deprivation status of the population.

The researchers looked at various sub-groups of the Scottish population to identify if there was a particular group in society that was particularly responsible for the excess mortality apparent at the national level. They compared age and sex specific groups of the Scottish population with their counterparts south of the border and they also compared the mortality rates of Scots residents in each Carstairs decile with equally deprived residents in England and Wales. From this part of the investigation, two trends in mortality rates were apparent. Compared to their counterparts South of the border, mortality rates among men in Scotland of working age (15-64 years old) were significantly higher in 1981 and rose even further by 2001. Women in Scotland of the same age groups also had significantly elevated mortality rates compared to their English counterparts and while these rates were not so high as those for working-aged men in Scotland, it was clear that they contributed to the national level picture. Age specific mortality rates amongst other Scottish groups (infants, children and the elderly) were either similar to those in England or slightly higher. Perhaps the most striking finding that the researchers made was when they looked at age and sex standardised rates within each Carstairs decile. In this regard, residents of Carstairs deciles 8, 9 and 10 areas (the three most deprived categories) in Scotland had mortality rates greatly in excess of equally deprived areas in England and Wales and this excess grew between 1981 and 2001.

It was this last finding in particular that led to the inception of the current project. Not only do Scots generally fare poorly in terms of all cause mortality compared with their neighbours in England and Wales but when comparing *similarly deprived* population deciles at the most deprived end of the spectrum of the Scottish and English populations, the Scots fared particularly poorly. This suggested two things. First, it raised the possibility that in Scotland there is some other mechanism influencing population health in addition to the well described interactions between social and material factors and morbidity such as those postulated by Evans and Stoddart[7]. Second, it raised the question of who these most deprived citizens in Scotland were since they seemed to be particularly affected by the mechanism that was termed the 'Scottish effect'. It is well established that West Central Scotland region, centred on the Clydeside conurbation and the City of Glasgow, is the location of the majority of Scotland's most deprived areas. The majority of areas that were in the most deprived deciles and were contributing most to the Scottish effect are to be found in Glasgow and its wider conurbation. Following on from the findings of the *Scottish effect* project, researchers within the GCPH concluded that if the

Scottish effect is to be more fully investigated then it is necessary to examine Glasgow and its hinterland in more detail.

There are then, three central aims to this thesis. First, it is necessary to compare cities and conurbations in terms of their deprivation status. Second, the population health of these entities needs to be compared to establish if Glasgow really is different from other cities. Finally, a further set of health comparisons needs to be made with allowance for cities' deprivation status.

There are three sections to this thesis. In the first section (which comprises three chapters) I will review a broad range of literature that is pertinent to the issues of health and deprivation in cities in the UK and concludes with a section presenting three specific research questions that will address the aims listed above. The second section contains two chapters. The first chapter of that section describes the methods I used to answer these research questions while the results chapter contains the results of these investigations. The final section contains the discussion chapter where I discuss the implications of my findings, how they fit with current knowledge and the research of the GCPH and the strengths and limitations of this study.

2 Literature Review

2.1 Introduction to the literature review

A very wide range of literature was reviewed for this thesis, covering the philosophical concepts of health, poverty and deprivation through to practical issues such as the measurement of deprivation, population health in Scotland and the uses of mortality data. For several of these topics, I conducted a broad narrative review as this material was being used to establish relevant background material. In these cases I did not attempt to rehearse some of the intricate and nuanced debates that are to be found in these literatures. I did, however, attempt to gain an overview of the key ideas and concepts, particularly where they applied to population health in Glasgow. For the more focused areas I did conduct more conventional search strategies and these are indicated below. Most of the writing for the three chapters of literature review is, therefore, of a critical narrative style.

I identified three broad areas of literature that were pertinent to this thesis. These three areas are dealt with in three separate chapters of literature review. In the first chapter I will deal with the concepts of poverty, deprivation, health and how these are measured. In the second chapter, I will consider the literature pertaining to cities, urban environments and also the social history of Glasgow itself. In addition, I will consider how the concepts and discourses that have arisen from the new academic discipline of urban health can be applied to the case of Glasgow. The third and final chapter of literature review concerns population health in Scotland, Greater Glasgow and Glasgow itself.

In the current chapter I will discuss the literature concerning the concept of health itself. To gain an overview of the topic I conducted a library search and an electronic database search for recent review articles. I looked for general titles on the subjects of health, concepts of health, models of health, and the determinants of health. Such searches yielded a number of key books and major review articles from which I was able to hand search references to find important publications in the published books, grey literature and in academic journals. From the reference lists in these sources I found yet further informative texts.

The second section of this chapter deals with the related concepts of poverty, deprivation and social exclusion. Again, a search for books and review articles was conducted looking for titles containing the terms: poverty, deprivation, relative deprivation, concepts of poverty and social exclusion. From these texts I was introduced to the works of key authors and publications in both the academic and the grey literature. There is also a lengthy subsection on the subject of measures of deprivation. For this section I interrogated the online database SCOPUS, which draws its entries primarily from social science journals but also from some biomedical journals. I entered the search terms 'measures of deprivation', 'relative deprivation', 'area based measures of deprivation' into SCOPUS. Such searches yielded a large number of publications which I limited initially by searching only for review articles published in English after 1990. From reading texts on the concepts of poverty, I was introduced to the work of several authors who had created measures of relative deprivation and I interrogated both the SCOPUS and MEDLINE databases to find all the published academic articles by such authors.

The second literature review chapter concerns cities, the concept and process of urbanisation and the social history of the city of Glasgow. To research the concept of urbanisation, I searched the university library for titles containing the following key words: cities, history of cities, social history of cities, urbanism, history of urbanism, urbanisation, history of urbanisation, concepts of urbanisation. I found several texts that matched these search terms and I selected those that seemed most likely to give an overview of the key ideas and concepts. I did not conduct a comprehensive literature review of this subject as it was not necessary to become familiar with all of the related issues but it was important to be aware of how, when and why cities form, grow and develop. When reviewing the social history of Glasgow, my aim was to write a narrative of the city's history with an emphasis on its economic and industrial development. I conducted a library search for books on the subjects of: cities in Scotland, the history of Glasgow; social history of Scotland; urban life in Scotland; Glasgow industry; shipbuilding in Scotland; the economy of Scotland.

There exists a relatively new academic discipline which has come to be known as *urban health*. I considered that it was important to this thesis to understand the ways in which the urban environment could itself be a determinant of population health as well as being a setting where particular health issues are presented. I was particularly interested to read about any models of urban health that might exist and consider the ways in which any general principles of urban health that have been described might apply to Glasgow and other cities in the UK. I searched the library for books on the subjects of: urban health; health in cities; and healthy cities. I also searched MEDLINE for review articles written by key authors that I had identified in these books.

The final literature review chapter has a different style to the preceding chapters. The central subject of this chapter is population health in Scotland, the Greater Glasgow region and Glasgow itself. My aims were to gain a clear picture of what is known about all aspects of health (including determinants of health) in these entities relative to other parts of the UK and Europe. I was particularly interested to discover what role deprivation played in contributing to the existence of any health gap between Scotland, Greater Glasgow or Glasgow itself and the rest of the UK. I also wanted to discover any published work that offered any explanations or tested hypotheses as to why mortality in Glasgow and/or Scotland should be so high. Colleagues at the Glasgow Centre for Population Health introduced me to certain publications from the grey literature that they considered important. I also interogatted the MEDLINE database using the following search terms: mortality in Scotland; health in Scotland; Scottish effect; health inequalities in Britain; CHD mortality in Scotland; north south divide; homicide in Scotland; murder in Scotland; suicide in Scotland; health in UK cities. Where appropriate, I repeated these searches replacing ‘Scotland’ with ‘Glasgow’.

2.2 What is health?

In this section, I will consider the literature on the subject of health itself: the various models and concepts of health that exist and how they have developed; the ways in which health can be accumulated and depleted and the ways in which these determinants of health have been modelled; and how the health of populations changes (usually for the better) over the course of history.

2.2.1 Models and concepts of health

In this sub-section, different models and concepts of health will be discussed. The largest portion of writing will be on the subject of the WHO definition of health. This is the most commonly cited definition and though it has several theoretical and practical drawbacks it does serve as a useful starting point for discussion of the idea of health.

2.2.1.1 The World Health Organisation's model of health

Modern thinking about the definition of health can be traced back to the inception of the World Health Organisation (WHO) in 1948. The WHO constitution states that:

> "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."[8]

This definition provided the vision for all of WHO's initiatives and is still in place today. It is an aspirational definition that emphasises the positive dimensions of well-being ahead of a state of being non-diseased.

The strength of the WHO definition is that it is aspirational. It implies that health should be available to all citizens, irrespective of location, age or gender. Well being should be a major policy target for governments and citizens should only be described as healthy once all the dimensions of well-being have been obtained. It has a broad scope: most spheres of human activity would appear to influence health as it is defined by the WHO. Thus, health is not simply a concern of health policy makers and health professionals but an ingredient of all aspects of human existence.

The main weakness of the WHO definition is that it is utopian at the expense of being practical[9;10]. It begs the question of whether a person with complete physical, mental and social well-being could exist. Furthermore, it does not offer any indication of what complete well-being might look like. A definition of well-being from the same era as the original WHO definition of health was offered by American public health specialist, Halbert Dunn:

> "Well-being is a state of complete physical, mental and social health."[11]

A more useful definition of well-being was offered by Huppert, Baylis and Keverne in 2005:

> "*well-being is a positive and sustainable condition that allows individuals, groups or nations to thrive and flourish. Well-being....requires an integrated approach, one that embraces mind, body, society, and the environment. Understanding how individuals and communities can be helped to thrive and flourish could be of great benefit to our citizens, our educators and our leaders*"[12]

Another limitation of the original WHO definition is that it appears to offer only polar alternatives: one can suffer well-being or disease and makes no allowance for everyday variations in subjective feelings of well-being.

The WHO definition was influential[13] but is now just one of many different models of health. It does not make any statement about the ways in which better well-being can be accumulated nor the things that lead to its depletion. However, several thinkers developed their own definitions and models of the determinants of health which did consider the ways in which health could be influenced in the latter half of the 20th Century. Some of these models will be described and criticised in the paragraphs that follow.

2.2.1.2 The negative model of health

The negative model of health is most closely, but perhaps unfairly, associated with the health care systems in the Western World[14]

Health is defined more by what it is not rather than what it is. It focuses on the absence of disease, illness or disability– those 'healthy' individuals who do not suffer disease or ill-health are not the focus of attention. The distinction between illness and disease is not straightforward – one can suffer disease without necessarily feeling ill and one can feel ill without suffering[9]

The great advantage of adopting such a negative model of health is that it facilitates a focus on illnesses or diseases which are remediable. As such, it is useful in certain circumstances. Problems arise when clinicians who are used to employing this model extend its use into circumstances where a broader definition of health is needed. The focus on the elimination of symptoms and underlying disease through medical, surgical or some other intervention is a reasonable approach and the path to achieving 'healthy' status is clear. There are a great many conditions where the adoption of such a view of health is highly practical and leads to the swiftest possible return to a non-diseased state.

2.2.1.3 Health as a resource

Partially in response to criticisms of its earlier statement on the nature of health, the WHO published a further definition of health in 1984. Health was no longer seen as an end in itself but as a resource for living:

> "Health is the extent to which an individual or group is able, on the one hand, to realise aspirations and satisfy needs; and, on the other hand, to change or cope with the environment. Health is, therefore, seen as a resource for everyday life, not an object of living; it is a positive concept emphasising social and personal resources, as well as physical capacities."[15]

This description of health was influential in developing the discipline of health promotion in that it conceived health as being a resource for life rather than an end in itself[16]. By breaking the link between health and well-being, it offered a more practical basis for achieving the utopian vision in the original 1948 WHO definition: health was not the *raison d'être* implied by the earlier definition; instead health was just one factor required to achieve overall well-being. This second WHO definition also began to describe the dynamic between a person's health and the things that influence it.

According to this definition, health is a form of currency that allows access to everyday behaviours and relationships. However, it seems to imply that those who are unable to 'change or cope with the environment' are somewhat lacking in the resource known as 'health'. Accordingly, it is debatable whether people with long term disabilities or impairing chronic disease such as blindness or diabetes mellitus are able to maximise their health.

2.2.1.4 Health, autonomy and empowerment

Tengland[17] explored the link between well-being (i.e. the positive aspect of health) and personal empowerment. He suggested that rather than power and powerlessness being determinants of health (as indicated by studies such as the Whitehall Study of civil servants[18]) that health should be seen as a determinant of empowerment and that the state of being healthy should be more or less synonymous with being empowered. According to this view of health, the physical, mental and social health (or lack thereof) of an individual is a natural, inevitable consequence of the degree to which the individual has autonomy or power over the issues that determine the nature of his or her life. When this model is adopted, measures to improve health become markedly different. For example, the persistently depressed, unemployed patient would be 'treated' not by the prescription of anti-depressant medication (which enhances subjective feelings of well-being but does not address the fundamental reasons for the individual's depression and unemployment) but by encouraging the patient to meet with others in a similar situation (i.e. 'self-help' groups) and facilitate the patient's access to financial, educational and social resources that will in turn enhance the individual's life skills. The aim of this 'therapy' is not to eliminate symptoms but to provide conditions where the individual has greater control or empowerment over his life. At the population level, this model leads to policies that reduce inequalities and address the structural determinants of health.

2.2.2 The determinants of health

In 1974, Marc Lalonde, the Canadian Minister of National Health and Welfare, published his report into the causes of health and ill-health in Canada[19]. This report was the first time that the government of a major industrialised country had explicitly stated that biomedical interventions (such as physician services, hospital services, pharmaceuticals and so on) were not primarily responsible for individual health[20].

Lalonde identified four 'fields' that contributed to an indvidual's health status:

Environment

This includes all matters related to health external to the human body and over which the individual has little or no control such as the physical and social environments.

Human Biology

All aspects of health, physical and mental, developed within the human body as a result of organic make-up.

Lifestyle

The aggregation of personal decisions over which the individual has control. Self-imposed risks created by unhealthy lifestyle choices can be said to contribute to, or cause illness or death.

Health Care Organisation

The quantity, quality, arrangement, nature and relationships of people and resources in the provision of health care.

The Lalonde report concluded that major improvements in health in Canada would come mainly from improvements in lifestyle, the environment and from a better understanding of human biology. Lalonde did not discount the role of health care organisation in improving the health of Canadians, but it is notable that he looked beyond the delivery of health care and commented on 'fields' that had hitherto not formed a dominant part of health policy makers in the West[21].

Lalonde's report received very positive reaction at the time of its publication and similar reports were soon published in Britain[22] and the USA[23]. However, Hancock asserts that the report made no significant impact on health policy in Canada and that no real gains in health were made as a direct result of the report's publication[24]. Other writers such as Terris acknowledged that while the Lalonde report failed to bring about much change in Canadian governmental policy it did provide the stimulus for a change in thinking among health policy makers and that it heralded a new era in public health[25].

Lalonde's report was criticised on the grounds that it concentrated too much on lifestyle matters and somewhat neglected the Environment. Critics pointed out that the 'Environment' health field was described as being beyond an individual's control with the implication that poor social circumstances or residing in a poor area is a virtually immutable feature of life for some. Buck[26] argued that it was not inevitable that an element of misery should be part of the human condition and that it was defeatist, perhaps even *laissez-faire,* to suggest that there will always be some unfortunate individuals who lack necessities, amenities, rewarding jobs and who suffer social alienation.

Lalonde certainly facilitated a change in approach to thinking about health and brought attention to the wider influences on health beyond a simple vector-host-disease paradigm. Subsequent writers refined his model and as new evidence came to light more complex interactions between health influences were modelled. Since his report was published, the most common method of describing health and how it is influenced is through the use of *ecological* models. These borrow from the field of ecology and place the human being at the centre of a hierarchy of social and environmental systems. Each element in the system, whether it is proximal (such as behavioural factors) or distal (such as the culture in which the human resides) has an influence on the human's health. Moreover, elements at the same level of the hierarchy can influence each other and also elements at higher and lower levels. Van Leeuwen suggests that ecological models have become popular as a conceptual construct because they can be summarised in graphical form (thereby allowing the public to understand them better), because they do describe the complexity of the influences on the health of individuals and because they allow the writers to assign weightings to those domains that influence health.[16].

2.2.3 Ecological models of the determinants of health

The simplest ecological model of health is shown in Figure 1, below. It describes the interaction between the host (i.e. a human being), the environment and a disease (typcially a germ). According to Van Leeuwen[16] and Dever[27], this model captures the understanding of health that was prevalent in the late 19th Century. There is a dynamic equilibrium between the three elements. A change in the condition of any one of these three may tip the balance towards either the host or the disease.

Although this model is very simple, it does demonstrate that health is a dynamic equilibrium and it also crudely captures all of the influences on health. More nuanced ecological models do not add further dimensions but instead break down each of the three dimensions here into ever smaller categories. However, this simple model does not come close to describing the relationship between health, disease and environment as it is currently understood. For example, certain agents can cause more than one disease, many diseases have multiple causes, many diseases or health conditions are non-infectious and exposure to a disease vector does not necessarily lead to disease.

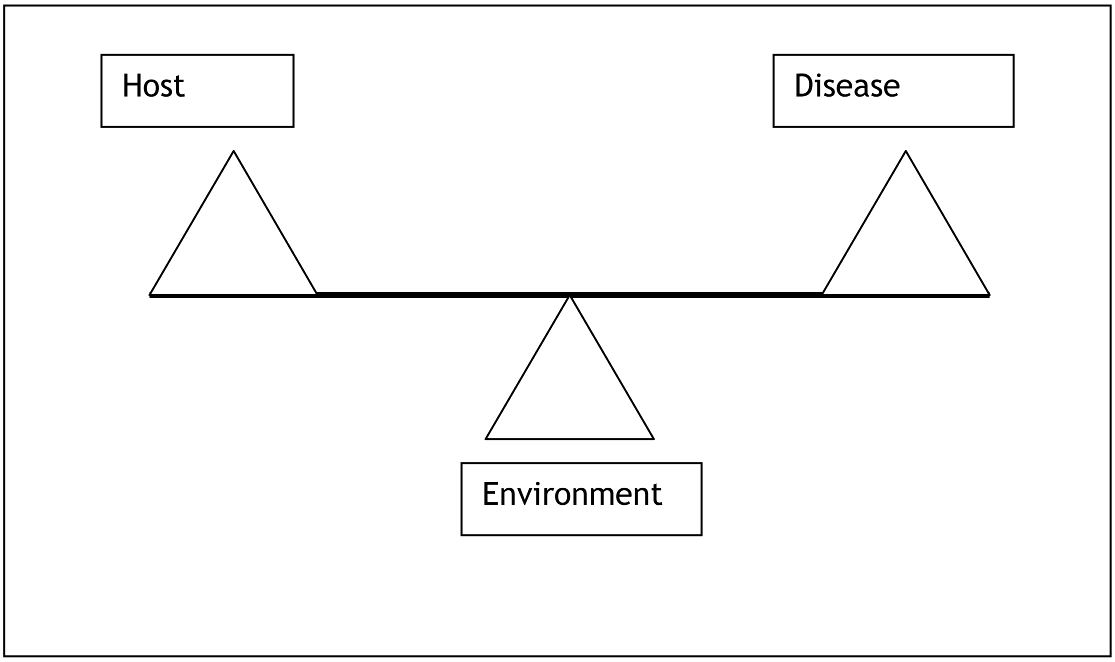


Figure 1: A basic ecological model of health

The Ecological Model described above was refined by Morris in 1975[28]. Morris's version is displayed in Figure 2, below.

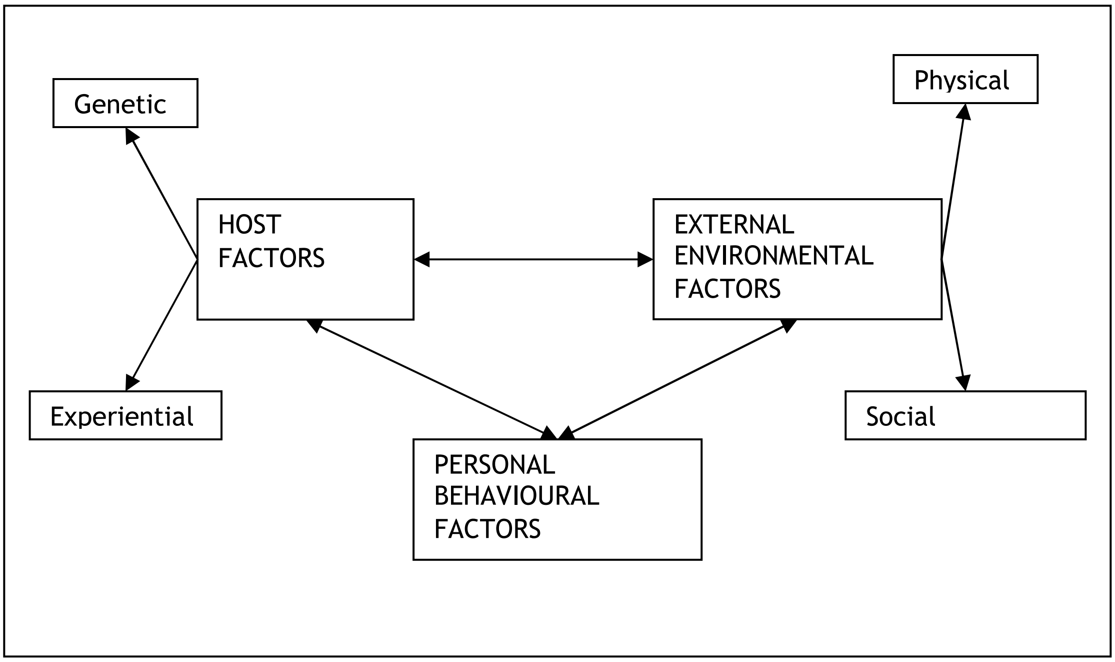


Figure 2: Morris's socioecological model of health

Morris addressed some of the shortcomings of the original ecological model. He notes that there are two distinct types of environmental factors and replaces the 'agent' of disease from the original model with 'personal behavioural factors'. The model assumes that behavioural factors have a bigger impact on disease than the physical environment as disease is dependent on where one chooses to live (the *choice* of residence being the key behavioural factor). It is questionable, however, how much choice people can exercise over where they live. Many groups in society have no say in where they live: children, the elderly, those living in institutions and those living in social housing. This model dispenses with the implication that one agent causes one disease to a multifactorial model for both infectious and non-infectious disease. The model places importance on environmental and behavioural influences on disease although it still has disease (and its absence) as its core concept rather than health.

Shortly after the release of the Ottawa Charter, Hancock published his *Mandala of health*[29].

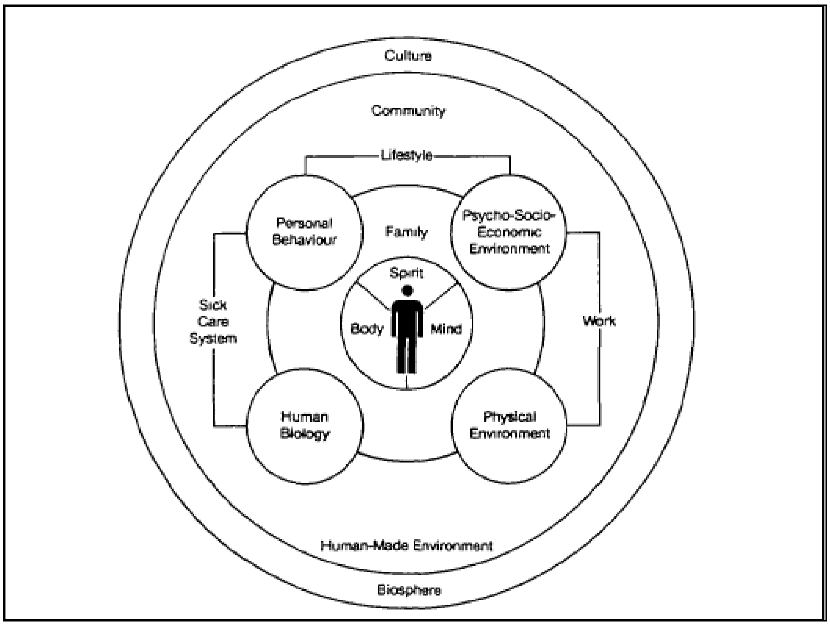


Figure 3: Hancock's mandala of health

Hancock gave this *Mandala* the subtitle "a health model of the human ecosystem". An ecosystem is the collection of components and processes that comprise, and govern the behaviour of, some defined subset of the biosphere. In this case the subset of the biosphere is human health and Hancock's *Mandala* is his attempt to model the systems and processes that govern health. It is a development of Lalonde's health fields concept and all four fields can be seen in various guises in this model. The influences on health are represented by three concentric circles of nested systems centred on the individual: the family, the community and human-made environment, and finally the culture or biosphere. Hancock made it clear that the three rings should be interpreted as three dimensional and dynamic; that their relationships with each other would be multi-faceted and would change according to the spatial and temporal context of the individual at the centre. In addition, the author specifies four subgroups of health influences spanning the family and community circles: personal behaviour, the psycho-socio-economic environment, the physical environment and human biology. Again, the authors intended that these four subgroups should not be viewed as rigid or independent of each other and that their relative importance would vary with place and time.

Hancock's model was the first to describe a hierarchy of influences on human health[16]. It also served as the foundation of practice for health policy makers by showing that no single determinant of health should be the exclusive focus of effort. Instead it encourages multi-level and multi-disciplinary approaches to improving health.

However, Hancock has himself admitted to some weaknesses in this model[30]. The model fails to address what he views as two key determinants of health. Firstly the mandala has nothing to say about making the economy or the environment sustainable. Clearly the health of individuals will suffer if the economy is structured in such a way that natural resources such as foodstuffs and fuels are depleted or if the creation of capital pollutes the environment. Secondly, he pointed out that his model did not make specific reference to the concept of equity of income, citing the work of Wilkinson, who argues that there is an association between income inequality and life expectancy[31].

In 1991, Dahlgren and Whitehead[32] introduced their hierarchical ‘rainbow’ model of health.

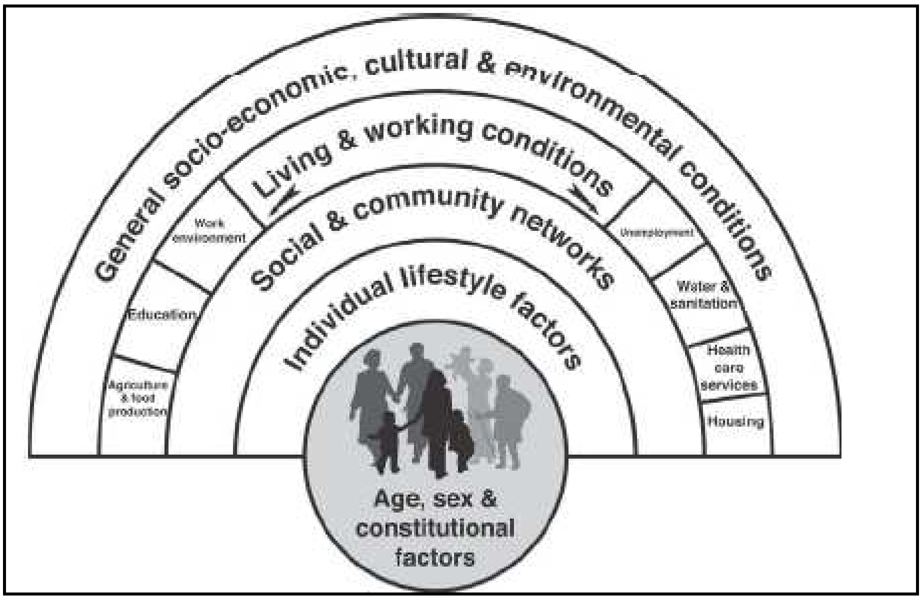


Figure 4: Dahlgren and Whitehead's Model of Health

This model was originally created as a background to a document exploring policies in EU countries that were intended to reduce inequalities in health[33]. In the accompanying text, Whitehead expounded the idea that inequalities in health resulted from social gradients operating at all levels of her model and also that factors conducive to health (at any level of her model) had less positive influences as social status declined.

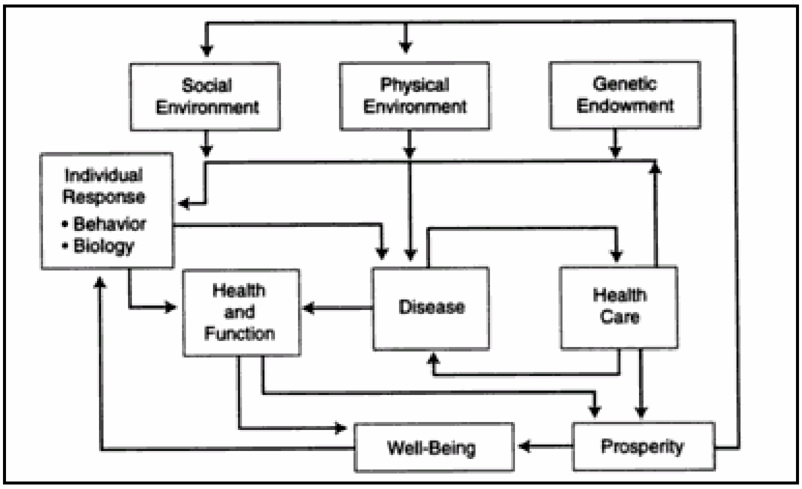


Figure 5: The Health Determinants Model

The model of Evans and Stoddart is the most complex that will be discussed here. This is the first model that includes feedback loops such that health and function is not the 'end product' of the model but another node in a complex loop of inter-related determinants. For example, if an individual suffers a loss of health and function then it is plausible to say that his level of prosperity will be adversely affected. This might entail him moving to a less salubrious location where the physical environment might encourage the development of further disease (e.g. moving to poor quality housing where problems with damp might exacerbate lung function problems). When an individual suffers disease then his health and function is further compromised. Working in the opposite direction, improved individual prosperity allows greater choice over one's physical environment and social environment. Both of these can influence behaviour (for example, diet) and thereby protect and improve the individual's health.

The model was welcomed for providing insight into the social determinants of population health but Evans and Stoddart received criticism for their belief that prosperity from economic development would lead to health improvements across the whole population. They overlooked the link between advanced economic development and health inequalities[34].

These ecological models of the determinants of health are most useful for understanding the different health outcomes in different populations at a given time. They are less good at following outcomes that result from conditions at earlier stages of life and over periods of history.

2.2.4 Life course epidemiology

A life course approach to chronic disease epidemiology is the study of long-term effects on chronic disease, risk of physical and social exposures during gestation, childhood, adolescence, young adulthood and later adult life. It includes studies of the biological, behavioural and psychosocial pathways that operate across and individual's lifecourse and even across generations, to influence the development of chronic diseases[35]. This is a different approach to the conventional way in which the development of chronic adult diseases is understood where the relationships between risk factors such as smoking, physical inactivity, poor diet and high blood pressure and disease outcomes are investigated.

The life course perspective is best established for Coronary Heart Disease (CHD). Barker[36] highlighted a relationship between low birthweight and later CHD. He suggested that poor foetal nutritional status was at least as important a risk factor as conventional 'destructive' risk factors such as cigarette smoking and a high fat diet[37]. The foundation of his hypothesis is based on a series of cohort studies that linked weight and length at birth with health outcomes in later life[38-41]. Barker's hypothesis also receives support from the observation that conventional risk factors can only explain 50% of CHD mortality[42]. While part of the remainder may be explained by a genetic component and although several candidate genes have been identified[43], a genetic explanation is insufficient in accounting for the rich-poor gradient in CHD mortality within individual countries. Barker suggested that poor foetal nutrition (measured by birthweight) leads to permanent physiological changes that have the effect of predisposing towards the development of later coronary heart disease.

While the greatest body of literature exists pertaining to life-long influences and the development of cardiovascular disease, a life course approach has also been adopted for other diseases including stroke, type II diabetes, respiratory and allergic diseases, certain forms of cancer and psychiatric morbidities[44]. It is not relevant to appraise the literature for each of these health outcomes here. However, Figure 6 which is taken from a paper by the pre-eminent lifestyle epidemiologists Kuh and Ben Shlomo shows their model for the ways in which lung function might be influenced by factors that operate at different times in life[45]. This model has been reprinted because it shows some of the general principles that are taken into consideration by epidemiologists taking a life course approach.

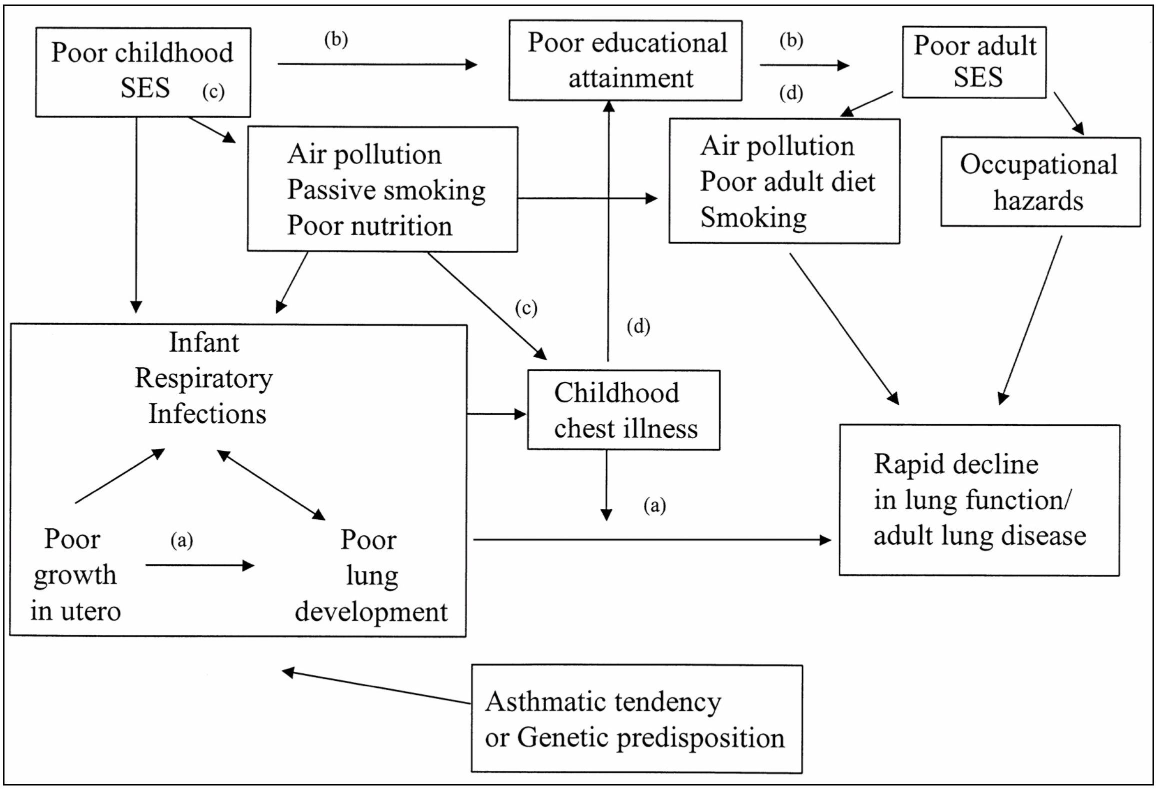


Figure 6: A schematic representation of biological and psychosocial exposures that operate across the life course to influence lung function or the development of respiratory disease.

Kuh and Ben-Shlomo point out that the life course perspective combines biological and social elements. In the figure above, they identify four separate yet related pathways by which lung disease may emerge. The first pathway, labelled (a), is predominantly biological and suggests that poor foetal growth is associated with poor lung development. Poorly developed lungs are associated with future respiratory insults from infectious agents and greater susceptibility to chronically impaired function in later life. The second pathway (b) is predominatly a social pathway whereby adverse childhood socioeconomic status increases the risk of harmful exposures and its influence on adult socioeconomic position. Path (c) is a sociobiological pathway containing a mixture of social and biological elements. Poor maternal socioeconomic circumstance is more likely to result in poor foetal lung development, poor postnatal lung function and subsequent poor adult lung function. Pathway (d) is a biosocial model and suggests that children with poor lung function and a propensity to chest-related maladies will be likely to be absent from school and thereby have low educational attainment. Low educational attainment is associated with health damaging behaviours and employment in hazardous jobs which would further impede lung function.

Kuh and Ben-Shlomo concede that even this model is rather crude and does not capture all the influences on lung function that operate throughout an individual's life course. Although the above model deals specifically with the life course influences on lung function, I think that it does illustrate the general principles of life course epidemiology. It draws attention to the rather arbitrary differentiation between biological and social mechanisms and the necessity of attending to both when attempting to improve health.

2.2.4.1 Critical periods and accumulation models

Some researchers interested in the subject of lifecourse epidemiology have suggested that certain critical periods exist in an individual's development during which times the effect of exposure is magnified compared with exposure to the same threat to health at any other time in the life course[44]. Critical periods include times of social transition such as; school entry,where poverty is suggested to be the threat to longterm health[46]; and the period just prior to puberty, where energy imbalance and obesity may predispose towards later disease and compromised physiological states including type II diabetes[47], hypertension[48;49] and obesity[50;51].

The other main class of life course processes is that represented by accumulation of risk models. These focus on the total amount of exposure or the sequence of exposure to risk. Such models suggest that the effects of exposure accumulate over the life course although they do allow for periods whereby suscepibility may be greater[45]. As such, there exists significant agreement between the critical periods model and the accumulation model and, in any case, empirically separating the two may be difficult[44].

2.2.4.2 Relevance of models to this thesis

The description of models set out above is an important foundation for this thesis for a variety of reasons. First, it establishes that health is complex and cannot be captured by mortality data alone. Second it illustrates that the determinants of health are complex and interactive over the life course. Third, it illustrates that while much is understood about how health is created and destroyed a great deal has yet to be established. So, when we come to examine death rates in Glasgow and other cities, it will be clear that death is a proxy for a more complex entity and that the factors influencing death rates will be complex and interactive and may be separated substantially in time and place.

2.2.5 Historical trends in improving health

Having looked at the determinants of health of populations at a particular time and also at how health can be influenced across the lifecourse, we now need to understand how the health of populations improves or deteriorates over time i.e. a historical perspective.

2.2.5.1 The findings of Thomas McKeown

Thomas McKeown was a historian with an interest in demographic trends. In 1976, he published two books[52;53] that summarised his investigations into population growth in England and Wales from the early 18th Century onwards.

McKeown's central hypothesis in his works was that the population growth observed in England and Wales was primarily due to steady decline in mortality and less attributable to increased fertility. He analysed data form the General Register Office (GRO) which, from 1838 onwards, recorded deaths classified by cause and age.

McKeown calculated that between 1850 and 1971, three-quarters of the overall reduction of mortality in England and Wales could be attributed to reduced mortality from infectious diseases. Forty percent of the reduction in mortality from infectious disease was due to reduced mortality from airborne diseases and from these, reduction in tuberculosis mortality was most important. McKeown proposed four possible mechanisms which might account for this decline in infectious disease mortality which he then evaluated leading to a series of conclusions about what were plausible or implausible mechanisms. First, he suggested that there may have been a spontaneous reduction in the virulence of certain infectious agents over the period that he studied. Second, improved medical care through drug availability, immunisation programmes and management of diseased individuals may have led to reduced prevalence and reduced mortality where infection did occur. Third, he argued that reduced exposure to micro-organisms through measures such as clean water supplies and the proper disposal of sewage might account for the reduction in mortality. The fourth mechanism postulated by McKeown was improved living standards, in particular improved nutrition.

McKeown evaluated each of these possible mechanisms in turn. Despite suggesting that it was an unlikely mechanism, given the evidence available to him, he was unable to dismiss the notion that reduced mortality from infectious disease was due to a spontaneous decrease in the virulence of certain pathogens such as the influenza virus and scarlet fever. Perhaps his most famous conclusion was that the contribution of medical care to reduced mortality was far less significant than had previously been assumed. He demonstrated that declines in mortality from several infectious diseases had occurred prior to the introduction of drug treatment programmes and immunisation. He even suggested that hospital treatment for infectious disease up until the end of the nineteenth century was at best ineffective and perhaps even detrimental to those infected. Next, McKeown discounted the influence of reduced exposure through environmental improvements. He conceded that provision of proper sanitation and clean water supplies in towns and cities accounted for reduced mortality from water-borne infectious disease from the middle of the nineteenth century onwards. However, he argued that such measures would have little impact on the transmission of airborne disease agents and that it was reduced mortality from airborne diseases that was the single biggest reason for the overall mortality reduction in England and Wales.

In addition to this process of elimination which led to the conclusion of reduced infectious disease mortality through improved living standards and nutrition, McKeown asserted that infectious diseases became prevalent at a time when the population of the UK was generally malnourished – an association that could be observed in many contemporary developing countries. The subsequent fall in mortality in England and Wales from infectious diseases was (in McKeown's opinion) due to agricultural improvements of the 18th and 19th centuries which in turn led to increased food supply.

McKeown himself concluded:

> "the decline of mortality from infectious diseases was not due to a change in the character of diseases, and it owed little to the reduction in exposure to the micro-organisms before the second half of the nineteenth century or to immunisation and therapy before the twentieth. The possibility which remains is that the response to infection was modified by an advance in general health brought about by improvement in nutrition."

2.2.5.2 McKeown's legacy

McKeown suggested that, in the light of his findings, future preventative medical care should prioritise the determinants of health ahead of immunization and drug therapy. Health services should be focussed on the personal and non-personal influences on health such as food, the environment and behavioural factors rather than on acute care. On the whole, he was sceptical about the role of traditional, orthodox physician-led medical care in securing better overall population health.

According to one author[54], the influence of McKeown's concept of 'health determinants' can be seen in Lalonde's 'health fields' that featured in his *A new perspective on the health of Canadians*[19], itself a document which was highly influential in the development of preventative public health. Wilkinson, writing about health inequalities within societies[55] cites McKeown to support his own argument that medical care makes only a small contribution to overall population health and that there exist more powerful influences on health. Another writer, Colgrove, goes so far as to say that McKeown's ideas were so important in creating a paradigm shift when considering the health of populations that they have become "the new orthodoxy" in public health circles[56].

The best known critiques of McKeown's works were published by Szreter who was able to show that population growth in the middle of the 19th century was fuelled by increased fertility and not reduced mortality as asserted by McKeown. Szreter also showed that mortality did not fall in anything like a continuous, uninterrupted manner but that it was interspersed with occasional sharp rises.

Szreter[57] went on to challenge McKeown's specific conclusions about why mortality in England and Wales fell. He challenged McKeown's central assertion that reduced mortality from airborne diseases (particularly reduced mortality from tuberculosis) was the biggest contributor to the overall fall and that the main reason for reduced mortality from airborne disease was improved nutrition. While Szreter agreed that mortality from tuberculosis fell in the 19th Century, he suggests that McKeown overstated the role of airborne disease in overall mortality decline as the latter half of the 19th century saw a rise in deaths from bronchitis, pneumonia and influenza – all three are airborne causes of disease, yet McKeown failed to account for rises in mortality from these. This would seem to undermine McKeown's suggestion that improved nutrition was the main reason for the fall in overall mortality. If certain airborne causes of death became more common at time when nutrition was improving then nutrition alone cannot explain the most sizeable part of the reduction in all cause mortality. In addition, Szreter suggested that the fall in tuberculosis mortality occurred decades later than claimed by McKeown. Accordingly, the fall in mortality was not primarily due to reduced airborne infections but due to water and food borne diseases. This would in turn indicate that mortality fell as a result of public health measures such as hygiene and sanitary improvements – a mechanism discounted by McKeown.

In my opinion, Szreter's criticisms of McKeown's hypothesis seem justified. The greater wealth of data available to Szreter, writing at a later date, allowed him to form better founded conclusions about the reasons for the overall fall in mortality from the middle of the 19th century onwards. It would indeed seem that medical care, in the form of vaccinations and drug therapies, did not play the primary role in reducing all cause mortality even in the light of McKeown's data being re-evaluated - the main explanatory factor instead being sanitary improvements. A separate issue is whether the findings of McKeown should continue to have relevance today. We live in a society where infectious diseases are not the major threat to population health. It is unclear whether improving living standards and nutrition beyond a certain point will continue to be the primary driver of reduced mortality when the most important causes of death are cancers and cardiovascular episodes.

More importantly, historical analsysis draws out the fact that levels of mortality in any given population at any defined time has a historical context and so, an investigation of Glasgow's excess mortality requires a similar historical perspective.

2.3 Measuring Health

Once a definition of health is adopted, the next logical step is to consider ways in which the 'amount' of health possessed by individuals or groups of people can be measured. A myriad of health indices now exist and are used not only to measure the numbers of well, sick and disabled members of the population but also to measure the degree of empowerment possessed by individuals and communities, and also the overall level of holistic well-being. Such measures of health are adopted because they move away from a negative view of health dominated by disease and infirmity. Some of these measures will be presented and discussed later in this section.

2.3.1 Usefulness of mortality data

All cause mortality is one of a group of health measures that are based on mortality statistics. The others in this group include life expectancy and infant mortality (although the percentage of low birthweight babies is increasingly used[58] in countries where infant mortality has dropped to such low levels that a few extra deaths in a particular period results in large and artificial fluctuations in the mortality rate). They have all been adopted at various times by governmental and international organisations as a means for comparing health between populations. They provide highly generalised and approximate measures of health.

The main advantage of using measures based upon death rates is that death is universal. Death, conceptually speaking, is inarguable, is the same for everybody and is not subject to the sort of philosophical debates concerning its nature that plague measures of well-being, or health-related quality of life[59]. Of course, conceptual and methodological debates do exist when measuring specific causes of death, but if death itself is viewed as the total absence of health then the total amount of health in a particular population can be inferred from measuring death. In the great majority of nation states, death is recorded and so it is, perhaps, the single measure of health that is available globally[60].

Life expectancy is a statistical measure of the median life span of a specified population. It usually refers to the number of years that a new-born child could expect to live if the death rates in the local population were to remain constant throughout the child's lifetime. However, life expectancies for individuals of any age can also be calculated (for example the life expectancy of people of pensionable age). The calculation of life expectancy relies on knowing the age-specific death rates for the population in question. These values are then entered into a life table from which one can calculate the probability of surviving to each age. A statistical calculation is then performed based on the data in this table to calculate the median age at which death will occur. An important point to note is that measures of life expectancy at birth do not generally account for improved age specific mortality rates in the future. Instead they assume that mortality rates will remain at their present rate throughout the life of the individuals being born presently. It is possible to calculate life expectancies that do account for future variation in death rates[61] but clearly several assumptions have to be made. In any case, life expectancy figures are intended as comparative, easily understood indicators of current population health and not as predictors of future health status.

There are three disadvantages of using life expectancy figures, according to Larson[59]. First, in developed countries, increasing life expectancy may be related to increasing levels of chronic diseases that in previous times would have been fatal. Second, life expectancy (in common with other indicators based on death rates) confers no information about the extent of non-fatal diseases and disabilities and as such is not even a complete measure of the absence of health. Third, there is a phenomenon known as the compression and extension of morbidity[62]: in countries where life expectancy is high, elderly people tend to be most afflicted with chronic diseases and disabilities and though they live longer than citizens of other countries, they do not necessarily enjoy good health into their old age. Life expectancy figures are unable to allow for this phenomenon.

Infant mortality rates are used as indicators of population health and as indicators of economic development. Obviously, they do not provide any explicit information about the general health of the rest of the population in question.

All-cause mortality rates when adjusted for age group and sex are the most widely used measure of health. They emphasise the quantity (rather than quality) of life in the population. Since deaths are recorded by governments, it is usually possible to use mortality data to make comparisons of the health of various groups within particular societies – rates can be compared between various age and sex groups, ethnic groups, socioeconomic groups and geographical areas. Although problems exist with recording the cause of death, particularly in societies where chronic diseases are prevalent, it is also possible to make comparisons between groups according to cause-specific mortality.

In summary, mortality rates are rather a crude indicator of population health. They only describe the extent of the total absence of health and do not give any explicit indication of the health status of those who are not dead although it is reasonable to conclude that in areas where the absence of health is high then the amount of health itself will be low. Unlike more refined measures of health, measures based upon death are less subject to conceptual or methodological dispute and are easily understood by the general public. Most governments have recorded deaths throughout recent history and so it is possible to observe longitudinal trends. Finally, aggregated death data are available for all small areas in the UK. For the investigator considering the geographical distribution of health in the UK, mortality data are, in spite of their considerable limitations, a highly useful resource. For these reasons, they were adopted as the measure of health in this project.

2.3.2 Other measures of health

As I discussed in the previous paragraphs, measures of health based on death rates are fundamentally limited in that they do not describe the health of the population who are alive. According to Murray[63], average life expectancy at birth is becoming increasingly uninformative in many populations where life expectancy is already relatively high and there is a substantial sub-population of elderly people. In other words, significant declines in death rates among older age groups produce only relatively modest increases in life expectancy at birth. At the same time there can be considerable uncertainty as to whether gains in life expectancy (and all cause mortality rates) can be attributed to improvement in the general health status of individuals within the population in question. In addition, it is often necessary to measure how individuals subjectively rate their own health. There exist a large number of subjective measures of health and function that are specific to particular diseases or give a broader indication of an individual's overall health status.

Bowling[64] published a comprehensive review of the many measures of health that have appeared in North America and Europe over the last 30 years. She classified measures of health into five distinct categories: measures of functional ability, broader measures of health, measures of psychological well-being, measures of social networks and social support and measures of life satisfaction and morale.

First, there are measures of functional ability, which seek to test an individual's physical abilities. Usually these are self-reported questionnaires where the respondent answers questions pertaining to basic functions such as mobility or to activities of daily living such as washing and feeding. In Britain, the measure of functional ability that has achieved most widespread use appears in the Government's General Household Survey[65] which contains the following questions:

> "Do you have any longstanding illness, disability or infirmity? By longstanding I mean anything that has troubled you over a period of time or is likely to affect you over a period of time?
>
> If so: a) What is the matter with you? b) Does this illness or disability limit your activities in any way?"

The above series of questions does not add detailed information beyond the knowledge that the respondent does or does not have an illness that limits their activities. It does not allow the respondent to say of they are severely limited or suffer minor inconveniences that might be construed as being limitations (for example, suffering from short-sightedness). The question is very subjective too, what one respondent might regard as a severe limitation might not be considered as such by another respondent suffering the same condition. However, this very subjectivity becomes a strength if a measure of perceived health status is required ahead of objective indicators of morbidity. This is particularly relevant when considering health in Glasgow. There exists a wide body of morbidity and mortality data stratified by age group, gender, area of residence, GP Practice and so on. However, these measures do not say anything about the extent to which Glasgow residents consider their own health to be compromised and questions such as those included in the General Household Survey can help researchers to gain insights into this.

Second, there are broader measures of health status where the focus is on individuals' subjective perceptions of their own health. A simple example of such a measure is in the UK census where one of the questions asks whether respondents rate their own health as 'Good', 'Fairly Good' or 'Not Good'. A more comprehensive measure of broader health status is the Short Form-36 Health Survey Questionnare[66] (and its shorter version, the SF-12 Questionnaire[67]) which provide respondents with a battery of questions across 8 health related dimensions. While both these measurement methods have been found to be acceptably valid and reliable and have been adopted by study groups on both sides of the Atlantic Ocean, they are both too cumbersome to administer to the entire population of a country.

Third, there are measures of psychological well-being. Some have been created with the specific aim of detecting psychiatric disorders such as dementia, depression and anxiety. Many of these are inappropriate as research tools but are useful in the clinical setting. In Britain, the most widely used measure of psychological well-being is the General Health Questionnaire (GHQ) which was developed by Goldberg[68] and colleagues in the 1960s and 1970s. It is used both in the clinical setting and in social surveys and epidemiological research[69]. The GHQ is similar to the SF-36 questionnaire in that it has both extended and concise versions, with 60, 30, 28, 20 and 12 question editions all having been validated. The shortest version, the GHQ-12, is included as an entire section of the Scottish Health Survey[70-72]. The GHQ is designed to assess the respondent's present state of mind relative to his or her 'usual' state of mind. It concentrates on broader components of psychiatric morbidity rather than trying to identify specific mental pathologies. Another benefit to researchers using the GHQ is that aggregated scores from several respondents are a suitable means of comparing the mental well-being of different populations by looking at both the central tendency of a particular group's GHQ scores and also its dispersion of scores. Moreover, a given population can be tested repeatedly to assess changes in psychiatric disturbance over time.

2.3.2.1 Healthy Life Expectancy

Healthy life expectancy is a measure of population health which represents the number of years that an individual can expect to live in good health. This is in contrast to life expectancy where all the years of life are counted, irrespective of whether or not they are lived in good health or with a chronic disease or disability.

In recent years, the UK's Office of National Statistics (ONS) has periodically published healthy life expectancy estimates in its Health Statistics Quarterly[73]. The ONS produces healthy life expectancy tables for the whole of the UK, while other authorities create healthy life expectancy estimates for sub-national regions in England and Wales. In 2004, Clark and colleagues published healthy life expectancy tables for the whole of Scotland and for sub-national regions and population groups[74] for the period 1998-2000. At the time of writing, these tables have not been updated although it is part of the remit of the Scottish Public Health Observatory to publish this information.

In theory, there are as many measures of healthy life expectancy as there are definintions of 'healthy', thus it is feasible that a person might have a high healthy life expectancy according to one measure but a lower expectancy according to another. In Woods' report, three different indices of healthy life expectancy were presented, each combining data from life tables with a different definition of health status. The measures of health status used were: limiting long term illness (LLI); self reported health and Activities of Daily Living (a five question measure of functional ability). Data for these three measures of household status came from the General Household Survey which is conducted on annual basis in the UK. Using data from this source, the authors were able to examine longitudinal trends in healthy life expectancy in the UK. In addition, two further healthy life expectancy measures were created for the whole of the UK population using LLI data and self-reported health data from the 2001 Census.

It is clear that there are several measures of health that can be used to describe and quantify the health of different populations in a more complete way than measures that use mortality statistics alone. However, I am interested in comparing the population health of several different UK cities and to allow for local deprivation status when making these comparisons. I have not come across a routinely collected measure of health that covers every postcode sector or ward that is not based on death rates. As a result, I will proceed with using all cause mortality as the measure of population health in this thesis but at the same time being aware of its limitations.

2.4 Poverty, deprivation and social exclusion

The terms ‘poverty’, ‘deprivation’ and ‘social exclusion’ carry related but distinct meanings. The purpose of this section is to disentangle these concepts and discuss the ways in which they are measured.

2.4.1 Poverty

The adjective *poor* is used to describe any individual characteristic or condition that is below average or could be viewed as socially unacceptable. It signifies a deficiency or deficit. For example, a person can be described as being in poor health, in poor spirits or in receipt of a poor exam result. The adjective can be used to describe a group –*they live in a poor neighbourhood*. Yet in each of these examples, the word *bad* can be substituted easily for *poor*. However, when referring to an individual himself, the words bad and poor have very different meanings – a poor individual deserves pity whereas a bad individual is deserving of disapproval. Thus, the concept of being impoverished, and of poverty itself, carries with it a moral dimension: the suggestion that something ought to be done to alleviate the situation[75].

According to Piachaud, it could be argued that simply writing about poverty or studying poverty is tantamount to prolonging its existence unless it influences individual and social behaviour and attitudes[76]. As Alcock[77] puts it: “poverty is different from inequality…which is simply a state of affairs…poverty is a political or moral concept and thus requires action.” The World Bank, for example, after defining poverty as the circumstance when an individual must subsist on $2 per day or less[78], states that its mission is ‘global poverty reduction’[79] .

Governments, organisations, charities, researchers, the media and the public conceive of poverty in very different ways. Lister, an authoritative British poverty researcher, suggests that poverty has a very different meaning for those who experience it compared to those who write about it[80]. In her eyes, this is a problem since the paradigm by which policies relating to poverty are created is shaped by those who generally have little experience of poverty themselves.

Can any citizen of a developed economy such as the United Kingdom truly be said to be in poverty when there are many millions of people in the world forced to subsist on less than one dollar per day? Nevertheless, the least well off in the United Kingdom can in no way be said to be living in comfort. This issue is addressed by making the distinction between *absolute* poverty and *relative* poverty.

2.4.2 Absolute and relative poverty

Each of these terms has conceptual problems of its own. Concerning absolute poverty, why is it that those who earn less than a dollar per day are said to be in poverty but those who earn a fraction more (yet are probably not materially much better off) are not? And what does *absolute poverty* actually mean. Oppenheim suggests that a reasonable definition of absolute poverty is having insufficient income to cover basic biological needs. Those unfortunate individuals that are unable to meet those needs can be said to be in absolute poverty[75].

Individuals and organisations through time have adopted absolute definitions of poverty. Most of these have attempted to define a *poverty line* - a minimum level of income that allows biological survival. The earliest proponent was

Charles Booth in Victorian era London. He tried to establish a consistent standard of *subsistence poverty*: sufficient food and shelter to make possible the physically efficient functioning of the body. He found that 30% of the population of London at that time lived below the poverty line that he had personally devised[81].

A little later than Booth, Benjamin Seebohm Rowntree examined the conditions of the poor in York in a number of studies that he repeated up until 1951[82]. Rowntree's original study of families in York in 1899[83] attempted to identify the minimum weekly income required to cover the costs of fuel, lighting, rent, food, clothing, household and personal items in accordance with the size of the family. These were the things that he deemed necessary for a healthy life. By the time of his final published report, he had come to the conclusion that poverty as he had defined it at the start of his life was more or less eliminated in Great Britain. By 1955, he could find few people in abject need of income to buy food, pay rent, purchase clothing and so on. Measures such as the introduction of the Welfare State had alleviated the plight of those living on low wages or without employment.

Rowntree's definition of poverty sounds very similar to the definition adopted by the United Nations at the Copenhagen summit in the mid-1990s. They declared that poverty is: "a condition characterised by severe deprivation of human needs, including food, safe drinking water, sanitation facilities, health, shelter, education and information"[84]. So, while poverty had been eliminated in the context that Rowntree understood it during his public life, it remained a serious problem throughout the world almost 100 years later.

Both Rowntree and Booth were influential in turning the attention of the public authorities to the amelioration of poverty. However, in common with all absolute definitions, the definitions of Rowntree and Booth are subject to criticism. At the heart of each absolute definition there lies a judgement about what constitutes a minimum standard of living. At some stage an expert will define a poverty line, whereby a person or a household without the resources to meet these subjectively defined criteria is said to be in poverty. A commonly used approach is to estimate the minimum number of calories a person requires in order to survive, and use this as a yardstick for measuring absolute poverty[85].

Immediately, confusion arises from this method. Various questions of equivalence are raised. The age, sex, area of residence, occupation of the person in question will have a bearing on his or her calorific requirement. Therefore, some sort of subjective judgement needs to be made to account for an individual's particular circumstances and, as a result, an absolute measure of poverty can easily become a relative measure: a food intake that may sustain a person in one environment may not do so in another.

The next question is how 'survival' should be defined. A human being can survive for a long time on fewer calories than is required to maintain body mass. Shortfalls of ingested calories can be offset in the short to medium term by metabolism of body energy stores. Quantifying a minimum daily calorie intake is therefore not straightforward. Moreover, it can be argued that there are other elements beyond those listed by Booth that are necessary for the maintenance of life. These include: health care, transport, education, acceptable clothing and access to information. These elements are also subject to debate about what constitutes a minimum level with the complication that it is even harder to tell what level of each is essential to continued survival. For example, some education is clearly necessary, but at what level of education will a person be equipped with sufficient skills and knowledge to survive in the long term?[86]

Absolute definitions of poverty are associated with other difficulties. What does one do about those who are above a poverty threshold or line but cannot be said to live comfortable lives? The World Bank has a poverty line of those living on U.S. $2 equivalent per day[87] (and another at $1 per day). What measures should be taken for those who have $2.50 per day? What about those who have relative abundance at some times of the year but have livelihoods in jeopardy because of uncontrollable factors such as the climate?

Relative poverty is a less clear cut concept than absolute poverty. Defintions of relative poverty can be traced back to Adam Smith's *Wealth of Nations*[88] where he states that the necessities of life include:

> "not only the commodities which are indispensably necessary for the support of life, but whatever the custom of the country renders it indecent for creditable people, even of the lowest order, to be without."

More recently, Peter Townsend echoed Smith's view that the necessities of life were more than the minimum amount of goods needed to sustain life by concluding that the necessities of life are those goods that allow individuals to

> "play the roles, participate in the relationships, and follow the customary behaviour which is expected of them by virtue of their membership in society"[89].

These two views of *the necessities of life* suggest that what is considered economic deprivation or poverty in one society may not be considered so in another or even in the same society but at a different point in time. Being poor in the UK in the 21st century does not have the same implications as it does to be poor in Ghana or Peru.

In Townsend's eyes, there is more to being poor than simply not having enough to eat. An impoverished person, according to his definition will be lacking in many areas of human functioning, "all of the major spheres of life" will be affected. By explicitly stating that poverty in modern Britain was not a singular concept, Townsend became the first writer to expound the idea of multiple deprivation. By adopting this sort of definition, Townsend has, according to Bradshaw and Sainsbury[90], profoundly influenced the landscape of thinking on poverty in the same way that Rowntree and Booth did at the turn of the 20th Century.

Definitions of relative poverty are not without their own problems as argued by Amartya Sen[91]. It is conceivable that if no other standard was applied that a relative definition would ignore the existence of poverty in a country where everyone was starving. At the other end of the spectrum, this definition allows, in theory at least, an individual to have a comfortable way of life yet still be considered poor in comparison to the opulent standards of those around him. As well as these philosophical criticisms, there are practical difficulties with relative definitions of poverty. What are the normal living standards of a particular society? Who decides what these are? Can they be defined objectively (i.e. a certain portion of the population has access to this item or service) or should they be subjectively defined (i.e. a certain portion of the population agrees that a certain item is a necessity)?

In summary, the use of an absolute definition of poverty reflects the practical problems of reaching agreement on what constitutes poverty across different societies. In developed countries, the greatest advantage of using an absolute definition is that it allows policy makers to assess if they have succeeded in reducing poverty. Relative poverty thresholds on the other hand present a set of moving goal posts and consequently reduce the chances of success for poverty alleviation programmes.

2.4.3 Deprivation

Deprivation is a concept that gained prominence from the work of Townsend. A useful starting point is the following quote from an article published by Townsend in 1987[92]:

> "Deprivation takes many different forms in every known society. People can be said to be deprived if they lack the types of diet, clothing, housing, household facilities and fuel and environmental, educational, working and social conditions, activities and facilities which are customary, or at least widely encouraged and approved, in the societies to which they belong."

There are four elements to this definition. First, it is multi-dimensional, as people can be deprived in different ways - by virtue of their lack of basic necessities of diet or clothing, or by virtue of the poor environment or social conditions in which they live. There is consequently a requirement to measure deprivations across these different dimensions. Each item that a person lacks may be seen as a separate deprivation and people lacking a given item may be termed "deprived" in that respect. It should be stressed, however, that the term is usually used to refer to people who have several deprivations and who are therefore suffering from "multiple deprivation".

Second, Townsend's definition is concerned with both material and social or relational dimensions. The latter refers to the ability of an individual to participate in the normal social life of their community - visiting family, having friends round, or attending social events such as birthdays, weddings or funerals, for example. Townsend and others have noted that most attempts at measurement have focused on material dimensions, as these are easiest to capture. However, he identifies social aspects as essential to our understanding of the nature and impacts of deprivation.

Third, Townsend's definition is a relative one. It is based on socially accepted norms or standards which will differ from one society to the next, and which will change over time. As a result, any measure of deprivation based on this concept will only be valid if it reflects what people perceive to be the minimum acceptable standards of living.

Fourth, Townsend's definition focuses on individuals - it is people who are deprived, not areas. Individuals do not become multiply-deprived simply by moving into an area with a high concentration of deprivation.

Townsend's approach has been refined further, notably in the work on the Breadline Britain surveys[93;94] and the Poverty and Social Exclusion 1999[95] survey These have provided a more systematic method for defining which ‘necessities of life’ people in a given society should expect to have. This is done by consensus; necessities are defined as those items which at least 50 per cent of the population believe an individual needs in order to participate in everyday life. These surveys also attempt to distinguish between people who lack an item through choice or preference, and those who lack it due to inadequate income or resources, with only the latter being identified as deprived.

2.4.4 Social exclusion

In comparison with the concepts of poverty and deprivation, social exclusion is a much more modern idea. It’s origins, according to one author can be traced back to the work of French policy maker, Rene Lenoir[96] who was interested in describing the groups that existed on the margins of French society in the 1970s. Since this time, social exclusion has become a key topic of interest to both policy makers across the European Union and beyond, and also to academics.

Daly[97] writes that there are two factors that underpin the concept of social exclusion, although she concedes that, partly because of its political and therefore contested origins, the concept is often ambiguously defined and has a different usage and application from one agency or institution to another. The first underpinning concept is that there is a normative ideal of each individual being part of a complex set of social networks. Thus, social exclusion occurs when there are failings in the structure of social relations, especially primary ties, a lack of hold of generalised norms or values and reduced integrative power of societal institutions[98]. A second underpinning idea is that social exclusion tends towards a 'horizontal' view of deprivation. According to this idea, those who are excluded are *separated* from the core of society who are integrated into sets of relationships and groups considered 'normal'. This contrasts with the idea of inequality where there is a hierarchical view of society, with access to economic resources being the most critical criterion for avoiding deprivation. Thus, socially excluded people have that status less because of where they are on the social class scale but more because of their remoteness from the core of social life[99].

Daly also writes that there is considerable overlap between the ideas of poverty and social exclusion and that one might be considered a proxy for the other, depending on how poverty is defined. However, there is general acceptance that social exclusion is distinct from poverty because; its self image is social rather than material; it's core interest is in the quality of social relations; it is a multidimensional rather than a unidimensional concept.

In Great Britain, social exclusion is a term that has become prominent in official parlance over the last 20 years[100] and especially since Tony Blair's Labour government came to power in 1997. One of the Blair government's first initiatives was to create the Social Exclusion Unit in 1997. At the Unit's launch, Blair described social exclusion as:

> "...about income but it is about more. It is about prospects and networks and life-chances. It's a very modern problem, and one that is more harmful to the individual, more damaging to self-esteem, more corrosive for society as a whole, more likely to be passed down from generation to generation, than material poverty".[101]

Lister reviewed the literature on social exclusion[80] and concluded that there is a lack of evidence for 'a clearly distinguishable, more generalised phenomenon of social exclusion'. It seems that the term 'social exclusion' refers to those in society who (amongst other things) experience deprivation, unemployment, low education, crime, unfortunate family circumstance and poor health. However, it appears that there is great difficulty in saying when precisely one individual suffers social exclusion. Julian Le Grand [102], director of the Centre for Analysis of Social Exclusion at the London School of Economics suggests that a (British) person can be described as socially excluded if

> "(a) he/she is geographically resident in the United Kingdom but (b) for reasons beyond his or her control, he/she cannot participate in the normal activities of United Kingdom citizens, and (c) he/she would like to so participate."

This definition of social exclusion sounds remarkably similar to those relative definitions of deprivation quoted earlier in this section. Barry[102] stresses that there are often reasons beyond the purely financial where people will find themselves socially excluded, listing race, religion and gender as being prime examples, although financial hardship is usually a feature of life for those who are socially excluded.

The three concepts of poverty, deprivation and social exclusion do have much in common. Deprivation can be seen as one of the outcomes of relative poverty, and social exclusion is a broader term than deprivation because it includes people who are at the margins of society on account of factors such as age, race or disability as well as those living in financially or socially deprived circumstances. The term social exclusion will not be used commonly in this thesis as the Carstairs index was designed to be a measure of material deprivation.

2.4.5 The relationship between social inequalities and health

In the 19th century, Edwin Chadwick completed a series of investigations into public health, the most famous of which is entitled *The Sanitary Conditions of the Labouring Population*[103]. In this report, Chadwick argued that disease was directly related to living conditions and proved that life expectancy was considerably lower in towns than it was in the countryside. He suggested that a series of sanitary improvements such as proper sewerage and clean, reliable water supplies were necessary to boost the life expectancy of the labouring classes. This reduced mortality would in turn lead to economic benefits through increased productivity and fewer poor-house residents. Chadwick was the earliest writer to suggest that social conditions and health outcomes were inextricably linked.

The role of social inequalities in contributing to population health has long been recognised by the WHO. An important milestone in the promotion of this way of thinking about public health was the declaration of Alma Ata in 1978[104]. The third section of the Alma Ata declaration called for economic and social development as a pre-requisite to the attainment of health for all. It also declared positive effects on economic and social development and on world peace through promotion and protection of health of the people.

Participation of people as a group or individually in planning and implementing their health care was declared as a human right and duty. This section also emphasized the role of the State in providing adequate health and social measures. This section enunciated the call for Health for all which became a campaign of the WHO in the coming years. It defined Health for All as the attainment by all peoples of the world by the year 2000 of a level of health that will permit them to lead a socially and economically productive life. The declaration urged governments, international organizations and the whole world community to take this up as a main social target in the spirit of social justice.

In 1980, the British Government's Department of Health and Social Security published the report of its working group tasked with researching inequalities in health. This research group was chaired by Sir Douglas Black and the report he co-authored has universally become known as 'The Black Report'[105]. Initially, the Conservative government of the time tried to surpress the findings of the report, being uncomfortable with the redistributive, socialist implications. However, the authors persisted in trying to communicate their message to the media and some would argue that the government's strategy only served to further publicise the report[106;107]. The report was explicit in linking gradients in health with gradients in social status. The authors discussed four theoretical mechanisms by which they suggested health inequalities may have arisen. These were as follows:

- Artefactual explanations

- Theories of natural or social selection
- Cultural and/or behavioural explanations
- Materialist/structuralis explanations.

The authors first considered that health inequalities between the rich and poor in society might be the result of diminishing numbers of people occupying the lowest social class. However, the authors provided data to dismiss this idea and showed that though numbers in the lowest social classes had diminshed over time, the rate was not so great as to magnify inequalities in health.

The authors next considered that health inequalities might arise from a process of social selection whereby those with poor health status or predisposed towards poor health drift towards the low income end of society. Whilst not completely discounting the existence of such a process and its contribution to health inequalities, the authors concluded that such a process was insufficient on its own to generate the gradients they observed.

The third potential explanation was that there was some sort of culture associated with those living at the lower end of the social order that contributed to their poor health. The authors used the example of birth control and observed that those in lower social classes were less likely (at the time when the report was written) to make use of contraception. The authors stated:

> "Is it lack of knowledge, outmoded ideas, or lack of access to the means of contraception - or is it due to an underdeveloped sense of personal control or self-mastery in the material world? It can certainly be argued that what is often taken for cultural variation in cognition and behaviour is merely a superficial overlay for differing group capacities of self-control or mastery, which are themselves a reflection of material security and advantage." (Black Report, Chapter 6).

Williams, citing the work of Bourdieu, proposed that people make decisions within the boundaries of their social groups, aligning themselves with the group they belong to or aspire to through an acquired and unconscious system of decision-making[108]. This social positioning was described by Bourdieu as "habitus" and is formed directly in relation to people's social locations. Through this process health related decisions are taken to “fit in” rather than to follow specific health beliefs resulting from health education. Groups following what might be described as a healthy lifestyle also take up unhealthy behaviours which would not fit with the positive health behaviour model described by health promotion professionals. A keen advocate of the cultural/behavioural explanatory mechanism is Lynch who has published numerous papers with findings that would appear to confirm this hypothesis[44;109-111].

The final explanation for health inequalities that the authors described was the materialist/structuralist explanation. According to this explanation, health inequalities have arisen because of the way in which society is structured. The authors themselves believed that this mechanism was the most likely candidate of the four they proposed, stating that,

> “it is in some form or forms of the ‘materialist’ approach that the best answer lies”.

Material factors that influence health include the physical environment of the home, neighbourhood and workplace together with the living standards secured through earnings, benefits and other income. Considerable research has been undertaken into the links between unequal material circumstances and health inequalities. For example the series of papers from the Whitehall cohort studies of civil servants[10;18] demonstrate a clear gradient relationship between salary and a variety of adverse health outcomes.

A successor to the Black Report was the ‘Acheson Report’[112]. In this report, Professor Donald Acheson demonstrated the existence of health disparities and their relationship to social class. Among the report’s findings were that despite an overall downward trend in mortality from 1970-1990, the upper social classes experienced a more rapid mortality decline. The report itself contained 39 policy suggestions in an array of areas, from taxation to agriculture, for ameliorating health disparities.

2.5 Measuring Deprivation

This thesis concentrates on deprivation in the UK and so the scope of this section will be limited to those measures of deprivation, poverty and social exclusion that have been used in the UK since 1981. These measures include: The Scottish Deprivation Measure created by Carstairs and Morris[113]; The Townsend Material Deprivation Score devised by Townsend[114], The Breadline Britain Surveys of Mack and Lansley[94]and their successor, The Survey of Poverty and Social Exclusion in Britain[115] and The Underprivileged Area Score devised by Jarman[116]. More recently, these indices of deprivation have been somewhat superseded in government use by the Index of Multiple Deprivation, first compiled and released in 2000[117] and updated in 2004[118]. In Scotland, there exists a similar Scottish Index of Multiple Deprivation[119] which has been adopted for official use by the Scottish Government. It was first published in 2004[119] and was updated in 2006[120].

At this point is worth returning to the previously quoted words of Townsend when he described deprivation:

> "Deprivation takes many different forms in every known society. People can be said to be deprived if they lack the types of diet, clothing, housing, household facilities and fuel and environmental, educational, working and social conditions, activities and facilities which are customary, or at least widely encouraged and approved, in the societies to which they belong."

Townsend lists several ways in which deprivation can make itself manifest: diet, clothing, housing, environment conditions, working conditions, social conditions and facilities. In light of this, one could say that a 'good' measure of deprivation ought to measure the distribution of all these items in a local population or the ability of any individual to gain access to these items. If a particular measure does not capture all of these items then it is reasonable to suggest that its ability to describe the true distribution of deprivation in a particular society is compromised. However agencies seeking to measure deprivation are limited by the data available to them and pragmatic decisions have to be taken about which variables to include in their index. They may have access to a dataset that covers the entire population such as the census.

However, the census is not constructed with the needs of deprivation researchers in mind so researchers have to choose variables that they believe indicate the presence of deprivation but with the advantage that they can model deprivation across an entire country. On the other hand, researchers may create an *ad hoc* index from specific survey data (one such example, the Breadline Britain Index, will be reviewed here). In such cases the variables chosen are likely to have a better ‘fit’ with deprivation itself but only a limited population can be studied. In the sections that follow, several indices of deprivation that have gained prominence in Britain since the 1980s will be discussed. No single index achieves the perfect compromise between practicality (i.e. broadness of population covered) and specficity (i.e. being a precise fit with the lived experience of deprivation) however, the recently developed indices of multiple deprivation mark a significant development in this direction.

2.5.1 Area based deprivation measures

All of the measures of deprivation listed above are area based measures with the exception of the Survey of Poverty and Social Exclusion and The Breadline Britain Surveys (which were discussed in sub-section 2.4.3). Area based measures use data gathered from routine sources such as the Census or governmental agencies. The authors of a particular index choose variables that they consider to be indicators of deprivation according to the definition or definitions of poverty that they hold, or take a more pragmatic approach by choosing indicators where data are readily available.

There is an inherent problem in using area based measures of deprivation that is termed *ecological fallacy*[121;122]. This is when inferences are made about individuals from aggregated area measures. The individuals will not share the same ‘average’ characteristics. Of course, depending on the resolution of the measured geography, there is a risk of ‘missing’ isolated pockets of deprivation, or even one or two desperately poor households within an area that has low levels of measurable deprivation. On the other hand, area based measures of deprivation are generally intended as tools to direct funds and resources. There is a risk, as Kearns[123] points out, that too fine a scale of analysis will result in a "patchwork quilt of deprived and not so deprived areas which might not be so helpful to policy makers wishing to target resources."

It is important to distinguish between an indicator of deprivation and deprivation itself[124]. An analogy might be to distinguish between a positive test for a disease (the indicator) and the presence of that disease itself (that which is being measured). The indicator says little about the nature of the disease and does not necessarily have to be specific to one disease. Likewise, indicators of deprivation only point to where deprivation may be present and should not be confused as being the cause of deprivation or as the essence of deprivation itself. However, Spicker[125](page 20) notes that indicators of deprivation should follow the pattern of deprivation such that they will be rarer where poverty is reduced and observed more frequently where poverty is commonplace.

Researchers creating area based measures of deprivation break the country into small geographical units such as Parliamentary Constituencies, Local Council Wards, Postcode Sectors or some other unit used by governmental agencies. In each geographical unit they count the frequency with which an indicator variable occurs. If several indicators are used to comprise an index of deprivation then some way of adding together indicator variables is used. The way in which indicator data are manipulated to create a deprivation score varies from measure to measure. Most area based measures of deprivation create a set of continuous scores ranging from affluent to deprived. As such, these measures are incapable of saying how many people are in poverty but they do show how separate geographical areas of the same country compare to each other, and allow policy makers to direct resources.

Some of these measures have common features. The measures devised by Carstairs[113], Jarman[116] and Townsend[126] all used Census variables as their basis. The variables that they used are summarised in Table 1 below:

Table 1: Three Census based measures of deprivation.

Name	Authors	First	Purpose	Census

		published		Variables Used
Scottish Deprivation Score/ Carstairs Index of Deprivation	Carstairs and Morris	1989	To explain mortality differentials between Scotland and England	Overcrowding Lack of car ownership Low social class Unemployment
Underprivileged Area Score	Jarman	1983	To assess demand on primary care practitioners	Elderly people living alone Children aged under 5 Lone parent households Unskilled head of households Unemployed Overcrowding Changed Address Ethnic minorities
Material Deprivation Score	Townsend et al	1988	To explain mortality differentials between the North and South of England	Lack of car ownership Unemployment Overcrowding Non-owner occupation

2.5.1.1 Jarman's Underprivileged Area Score

The Underprivileged Area Score devised by Jarman had a somewhat different purpose to the Townsend and Carstairs measures. Jarman was interested in measuring the demand placed upon primary care practitioners and thereby directing funds towards those practitioners with the heaviest workload. Although Jarman did not intend for his index to become a measure of deprivation it was, on occasion, used as such[127]. In addition, the indicators from which this index was comprised have all been used in other measures of deprivation including the Scottish and English Indices of Multiple Deprivation.

Jarman's index was accepted as a valid measure of the determinants of GP workload[128] although it has received some criticism since areas that scored highly on the Jarman index already had the highest saturation of General Practitioners[129]. The Jarman index has not been updated in the 20 years since it was first published and it is questionable whether it still captures those social factors that are associated with demand on General Practitioners since the role of the General Practitioner has changed substantially since 1983. Furthermore, the original index used variables from the 1981 UK census and it seems that other more up to date deprivation measures have replaced the Jarman index in common usage[130].

2.5.1.2 Townsend's Material Deprivation Score

Townsend's index was originally devised in 1988[126] using variables derived from the 1981 census and was later repeated using data from the 1991 census[114]. It was originally intended for use in explaining mortality differentials in the Northern region of England. However, because it uses data from the Census, the index can be easily adapted to cover the whole of the UK. Townsend's emphasis was slightly different to that of Jarman in that he was interested in material deprivation and the influence that this would have on the health of individuals. This measure does not include the entire spectrum of deprivation that can be experienced by an individual but, according to Townsend's own results, this measure of material deprivation was able to explain the high rates of mortality observed in Northern England compared with Southern England in 1981 and 1991.

Townsend's index was constructed by means of standardising the scores of the four variables that he had selected from the census. Standardisation of variables, resulting in 'z-scores' for individual observations is discussed in detail in the Concepts and Definitions chapter. In essence, a z-score indicates how many standard deviations a particular observation is above or below the population mean. The standardisation method also allows comparison of several observations from different normal distributions. The four z-scores from each of Townsend's Census variables were then summed to give an overall score. The z-scores were unweighted: each variable contributed equally to the overall score. Using unweighted z-scores is a method that has attracted criticism from some quarters. Writers in favour of weighted variables adopt such a method because a group of individuals described by a particular variable will be more likely to suffer multiple deprivation. Gordon[131] found that people who did not own a car were far more likely to suffer multiple deprivation as defined by his own Breadline Britain survey than, say, people who were unemployed. In accordance with this finding, Gordon suggested that it would be much more "accurate" to weight these variables when constructing a census-based deprivation index. Townsend's four variables were: car ownership, unemployment, household overcrowding and non-owner occupation. In Gordon's findings, each of these provided different risk for multiple deprivation and he argued that it was inappropriate to weight them equally in an overall deprivation score.

2.5.1.3 Carstairs' Scottish Deprivation Score

Carstairs created her index of deprivation with a very similar aim in mind to that of Townsend. She wished to find some way of explaining Scotland's excess mortality relative to the rest of the UK. Prior to the publication of her index there had been no study which had attempted to quantify the relationship between deprivation and poor health outcome in Scotland[132], although there had been some work examining the relationship between social class and health outcome.

The Carstairs Index is subject to many of the same criticisms as Townsend's index. By weighting each component variable equally, this index runs the risk of disguising the differential risks of multiple deprivation provided by each variable. On the other hand, the authors indicate that the purpose of their index was not to direct resources (unlike Jarman's Underprivileged Area Score) but to explore the relationship between measurable material deprivation and health outcome. To this end, they were very successful in focussing attention on adverse socio-economic conditions in Scotland being related to the poor health outcomes in that region.

The three indices of deprivation discussed so far have been the subject of a small number of papers testing their correlations with each other in local areas[127;133-135]. These papers show that these indices correlate well with each other in ranking small areas. For example, in Mackenzie's study of deprived wards in the Plymouth area[133], the Jarman and the Townsend index had a Spearman ranking correlation of 0.98. In Morris' paper[127] (Morris was the co-author of the Carstairs index), the Carstairs index and the Townsend index had a correlation of 0.96; and in the same paper Jarman's index was found to have a correlation of 0.826 with Carstairs and 0.801 with Townsend. However, the authors of these three indices jointly wrote a letter to the BMJ suggesting that dissecting out the small differences between the three methods was less productive than using the indices for the purposes for which they were developed[136].

These three methods of measuring deprivation have the common feature of using the census as the basis for their data. This approach has the advantage that the census has nationwide coverage and therefore provides a reliable and representative picture. Furthermore, data are available down to a very small spatial scale. On the other hand, the census contains no direct measure of income so researchers must use proxy measures of income such as car ownership or housing tenure type[131]. The census is decennial so suffers from data becoming out of date well before the next census.

2.5.1.4 Indices of Multiple Deprivation in Scotland and England

In contrast to the previous three measures by Jarman, Townsend and Carstairs, the indices of multiple deprivation were devised with the specific intent of measuring the extent of deprivation itself rather than created for some secondary purpose such as accounting for health differentials. They were created with the intention of directing resources to neighbourhoods where they were most needed. The basic unit of geography used in both the Scottish and English indices was much smaller in terms of population size than the ward unit and postcode sector unit that were used in the indices of Jarman, Carstairs and Townsend. Such a strategy reduced the risk of ecological fallacy and allowed identification of particularly deprived ‘pockets’ within what would previously have been classified as affluent areas.

The first index of multiple deprivation in England (EIMD) was released in 2000[117]. This index comprised six separate domains: Income; Employment; Health and Disability; Education, Skills and Training; Housing and Geographical Access to Services. Within each domain there were several indicator variables which were a mixture of 1991 Census data and data gathered by other government sources. The overall score for a small area’s deprivation status was the weighted sum of its score in each of the six individual domains. Accordingly, it was possible to assess which particular forms of deprivation were contributing to an area’s deprivation status. As such the EIMD not only identified multiply-deprived areas but also gave some indication about the specific types of intervention that might lead to their improvement.

Updates to the EIMD were released in 2004[137] and again in 2007[138]. In response to constructive criticism by Deas[130], both these updates included a seventh domain, Crime, in addition to a change in the basic unit of geography from local government wards to Census 'Super Output Areas'[139].

The Scottish Index of Multiple Deprivation (SIMD) was first published in 2004[119] and was updated in 2006[120]. The SIMD has a similar approach to that of the EIMD where the final multiple deprivation score is derived from a composite of different deprivation domains which are measured independently. The domains in the SIMD are entitled as follows: Current Income; Employment; Housing; Health; Education, Skills and Training and Geographic Access and Telecommunications. The 2006 SIMD also included a Crime domain. The score in each of these deprivation domains is in turn derived from several indicator variables.

Despite their conceptual and methodological similarities, the EIMD and the SIMD are not directly comparable. Certain indicators that are used in the calculation of one domain in the EIMD are used to calculate a completely different domain of the SIMD. The geographical unit used in the SIMD, the 'datazone'[140], is smaller than the output areas used in the English indices. Finally the weighting of the various domains to create the overall deprivation score differs between the Scottish and English indices.

As a result of these factors, neither the SIMD nor the EIMD is practical as a way of measuring deprivation in all localities of the United Kingdom. In addition, data for both the SIMD and the EIMD only exist as far back as 2003. This makes longitudinal study of deprivation patterns based on these measures impossible. In the absence of any other current measure of deprivation that can be used to compare Scotland and England's deprivation status, the Carstairs measure will be used in this thesis. Carstairs data exist for the 1981, 1991 and 2001 Censuses and can easily be calculated for both Scottish Postcode sectors and English wards. More pertinently, Carstairs and Morris deliberately chose a set of indicators with the explicit intention of finding census variables that were associated with geographic variations in health outcome.

3 Literature review – part 2

3.1 Introduction

In this chapter, I will consider the subject of cities. Glasgow is the largest city in Scotland and in the past was one of the most populous cities on the planet. Popular discourse suggests that factors in Glasgow's history have contributed to its current status as one of the most deprived and unhealthy cities in Europe. As a result, I wanted to become familiar with the literature concerning cities in general and also read about the social history of Glasgow to see if the popular perceptions of the city hold true.

In the first section, I will describe urbanisation: the process by which agrarian societies become dominated by towns and then cities. I wanted to understand how and why cities are formed and if any general patterns in the social history of cities had been described by authors. In the second section of this chapter I will describe the social history of Glasgow with particular reference to its economy and industries in order to identify the extent to which Glasgow's own history fits with the general patterns of city history and to see if any factors from Glasgow's history might shape the city's current social and economic context.

The health status of the populations of various cities in the UK will be analysed in this thesis. Cities offer opportunities to improve population health but also provide challenges to population health. The purposes of this chapter are to describe the process of city growth in terms of when, why and where it occurs and to describe its history in the United Kingdom and Scotland. Later, the particular population health problems faced by cities both historically and contemporaneously will be reviewed.

This is a project about health. As a result, I wanted to discover the ways in which the urban setting creates a special environment from the point of view of health. Similarly, modern problems of deprivation and social exclusion are more common and often more profound in cities. Therefore, I wanted to consider the interactions between urbanisation, deprivation and population health. There exists a relatively new academic discipline known as urban health which investigates and describes the unique threats to population health presented by the urban environment. It was not my intention to become an academic expert in urban health but to become sufficiently familiar with the key ideas and concepts that I could write reasonably cogently about how they applied to Glasgow and other UK cities. As with subjects discussed in previous chapters, my strategy was to search the university library for introductory texts and using references within these texts to explore the subject more deeply.

3.2 Urbanisation

Urbanisation is the process by which the rural characteristics of a village, town or area are removed and is associated historically with the development of civilisation and technology[141]. Demographically, the term denotes the redistribution of populations from rural to urban settlements

There are two separate but related concepts pertaining to the phenomenon of urbanity. Davis[142] says that urbanisation is the extent to which the total population of a particular society is concentrated into urban settlements. This is distinct from the process of city growth: cities can grow without the overall proportion of the population in urban areas increasing. Throughout most of a particular society's urban history, the two concepts are highly correlated such that urbanisation usually occurs simultaneously with city growth. However, in many developed countries, urban populations are still growing but their proportion of the total population of the countries in which they are located has reached stability or even begun to diminish. Davis states that urbanisation is a process with a natural history: it has a beginning, a middle, and it would appear that it has an end. In some societies, where urbanisation has been established for the greatest period of time, it appears that there is a saturation point whereby the proportion of the population living in urban areas no longer rises. For example, Great Britain underwent a rapid process of urbanisation during the 19th Century. The proportion of the population living in towns and cities continued to grow into the twentieth century, but at a less rapid rate. Since the middle of the twentieth century, although the absolute numbers of UK residents in towns have grown, the relative numbers have been stable.

In terms of human history, urbanisation is a relatively new phenomenon. There existed individual cities in ancient Mesopotamian, Babylonian, Egyptian, Mayan and Aztec cultures from as long ago as 5,500 BCE. However, these cities had an appearance and function that was very different to modern urban settlements. Most were concerned with religious functions or they were defensive and had fortified boundaries to repel invaders[143]. Davis points out the existence of these early cities appeared to be quite vulnerable and that they were far smaller than the cities of today. They were surrounded overwhelmingly by a rural population and they were prone to relapsing to small town or village status. The societies in which they were located were highly rural in nature and those individuals living in cities were the exception rather than the norm. In contrast, recent estimates suggest that 75% of the population of the most developed countries live in urban settlements and, though the figure is lower in the developing world, most countries are catching up rapidly[141].

At the start of the 19th century, the only city in the UK with a population in excess of 100,000 was London and there were perhaps as few as 65 cities in the rest of the world with a similarly sized population at that time[144]. By 1850, there were 106 cities with a population in excess of 150,000 and by 1900 there were more than 300 such cities although the great majority of these settlements were located in Western Europe and the North East Coast of North America. However, even as late as 1900 only the United Kingdom could be regarded as an urbanised society (where more than 50% of the population resided in an urban area). Other countries certainly had cities which were at least as large as those in the UK but they still had a majority of their population living in rural areas. Even in neighbouring France, Bairoch suggests that 50% urbanisation was not reached until after the Second World War[145].

The first country to undergo urbanisation was the United Kingdom and the pattern of population change in the UK was subsequently followed by other countries. If the rate of urbanisation was to be drawn on a graph it would show an attenuated ‘S’ shape. The proportion of residents in British cities grew slowly before accelerating between 1810 and 1850, slowed down somewhat over the next century and finally stabilised or declined in more recent times[146]. This slowdown in the rate of urbanisation and city population growth will be discussed shortly.

So what factors first caused urbanisation? Cities have existed in one form or another throughout human history but it is only relatively recently that they have become the typical environment in which people choose to live. It is curious that the regions which became urbanised first (Western Europe and North East America) did not give rise to the major cities of the past[147]. The technological development behind the industrial revolution was the key to urban development[148;149]. Mass production industries do not require land to be the primary resource in the way that agriculture does. Accordingly, sites of industrial production could be located where their primary resource (manpower) was plentiful. As technologies improved, so agricultural production became more efficient and less reliant (and less capable of financially supporting) high numbers of labourers. At the same time, new industries were developed that required large numbers of labourers and so migration from the countryside to the cities was facilitated. It was therefore no coincidence that the countries in which the technologies of the industrial revolution first took hold were the same countries where urbanisation became established. The same factors that facilitated early urbanisation in the West still operate in those rapidly urbanising countries today[150].

Initial growth in the population of cities was fed primarily by migration from rural areas. Several writers[143;148;151] point out that early in the process of urbanisation, the death rates in the growing cities outstripped the birth rates. Figure 7, taken from *Let Glasgow Flourish* by Hanlon, Walsh and Whyte[152], shows that in 1855, the difference between the absolute numbers of births and deaths in the city was slight and it seems likely that the birth rate overtook the death rate in Glasgow at some point earlier in the 19th century.

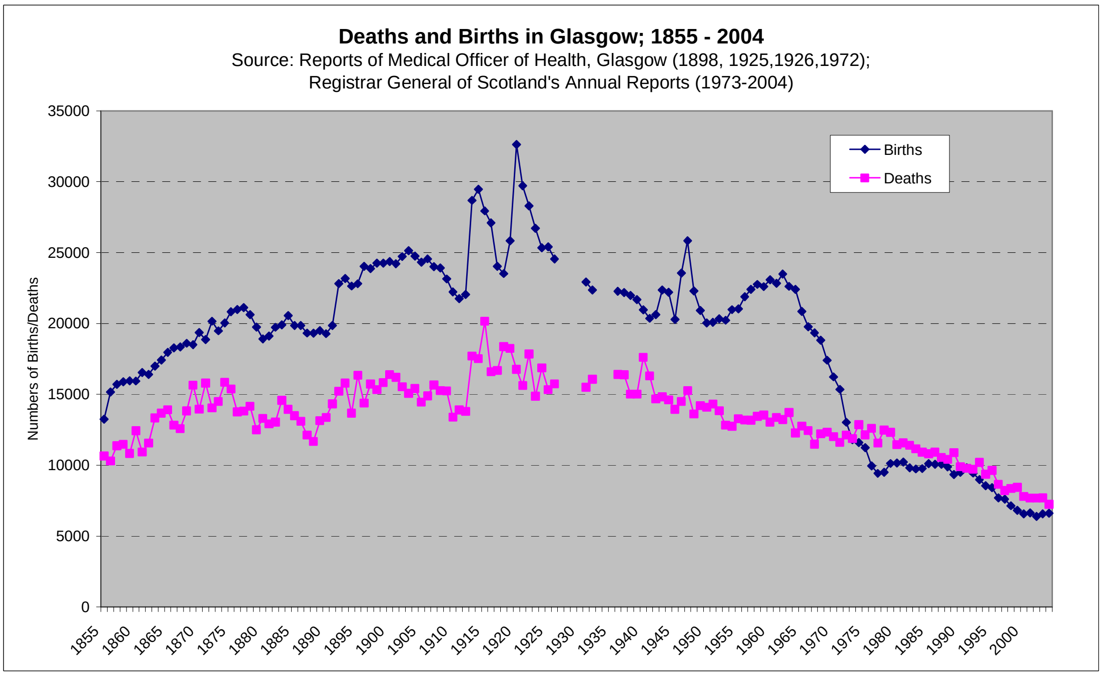


Figure 7: Death and Births in Glasgow; 1855-2004

The population growth of Glasgow was driven not only by a high fertility rate but also by in-migration from the Highlands and Islands and from Ireland[153]. The city's boundary was also extended on several occasions, most notably in 1891 (when the Police Burghs of Maryhill, Hillhead, Crosshill, Govanhill and Pollokshields were incorporated into Glasgow adding 53,000 to the city's population) and in 1911 when Partick and Govan were added, raising the city's population by more than 200,000.

Figure 8, also from *Let Glasgow Flourish*[152], shows how Glasgow's population grew (and then contracted – this will be discussed shortly) from 1801 onwards.

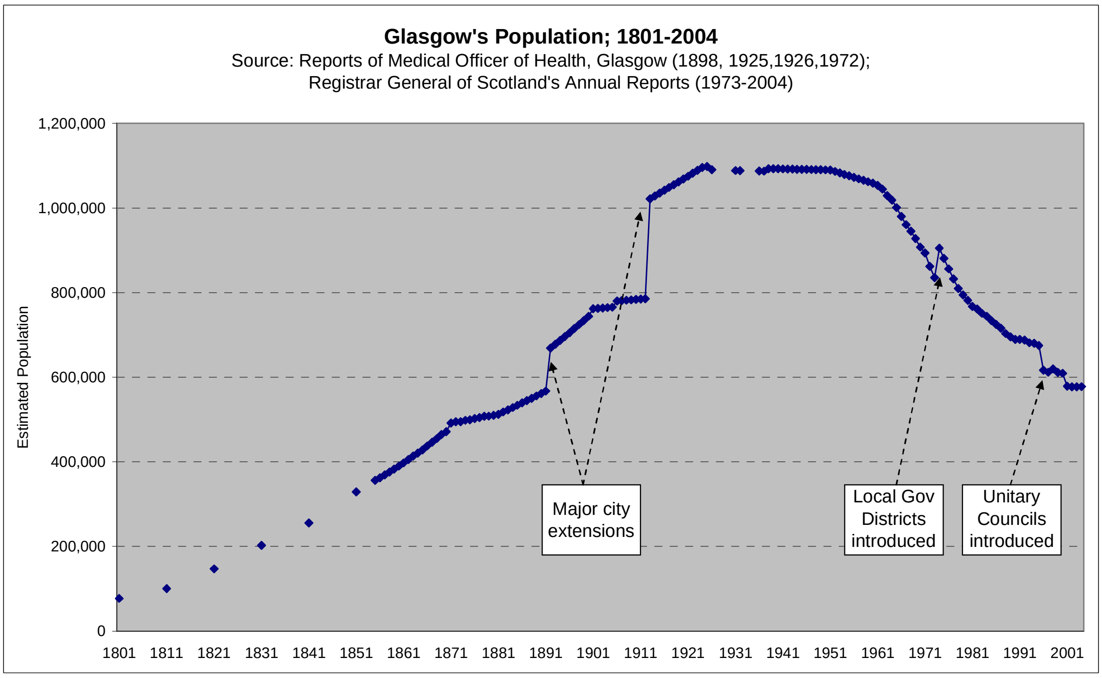


Figure 8: Population trend for Glasgow city; 1801-2004

3.2.1 The end of urbanisation and population decline

Figure 8 shows that the population of Glasgow City reached a peak of 1.1 million in 1925 and then remained stable for a number of years before declining sharply in the early 1960s. This population decline continued such that the population of Glasgow in 2007 was estimated at 581,940[154]. The most recent population estimates indicate that Glasgow's population decline has been arrested (the 2001 Census counted 577,643 individuals residing in the city) and the city's population is predicted to grow slightly over the coming decade. Glasgow's population loss since the middle of the last century exemplifies the concept that urbanisation has a natural history whereby there is initial rapid population gain, a period of slower growth and then a period of equilibrium where the population does not rise or fall significantly.

Flynn[155] observes that cities undergoing population decline are former industrial centres and likely to be formerly busy ports. Examples include Detroit, Cincinnati, Green Bay and Pittsburgh in the North of the USA while European examples are Liverpool, Belfast, Trieste and Bilbao. These cities, where the population size is dwindling are now characterised by growing poverty; inequality and social polarisation; financial crisis and deteriorating environments. Skilled, educated individuals tend to migrate away from such cities in pursuit of employment in those economic sectors that were underrepresented when such cities were experiencing population (and economic) growth. According to Flynn, population loss in these cities is associated with the loss of traditional manufacturing industries and the failure or delayed development of other economic sectors especially those in the service sector which has become the key employment area in those societies that have been urbanised for the longest period of time[156].

A second factor contributing to the population loss of many urban centres is the phenomenon of suburbanisation. The increasing popularity of the automobile allowed workers to live at ever more distant locations from their place of work, starting with the USA in the 1950s and Western Europe in the 1960s[144]. In the USA, the most common pattern of commuting is no longer from suburb to city centre but from suburb to suburb[157]. This has been associated with the rise of so called 'Edge Cities'[158] such as Tysons Corner in Northern Virginia. Such settlements lack a traditional town centre and are considerably less densely populated than traditional towns. They have the appearance of suburban areas but do not owe their existence to a core city. Associated with this phenomenon is *urban sprawl*[159]– residential areas that are low density, car friendly and often hostile to pedestrians.

Critics of urban sprawl suggest that such communities are ecologically unsustainable, are harmful to community relations and social capital and are environments that encourage minimal physical activity[159]. Such factors are detrimental to both physical and mental health.

3.3 Health and Place

This thesis is concerned with variations in health between cities in the UK. Implicit in the term 'Glasgow effect' is the suggestion that there is something distinctive about the physical or social environment in Glasgow that partially accounts for poor population health. In the Scottish effect paper, the authors suggested that one possible mechanism by which the 'unexplained' excess mortality in Scotland might have come into existence is that there may be some cultural or physical characteristic in operation in Scotland that is particularly detrimental to health and that does not appear to operate in England and Wales or at least to the same degree as it does in Scotland. In other words, there is something about the *place* that is Scotland, or certain places within Scotland, that either mediates the determinants of health or provides a direct influence on health, separate from well-established variables such as age, sex and socioeconomic status.

This type of thinking about place is often contrasted with a discussion about people. The Scottish effect could also be the product of differences in the people who make up the Scottish population. A third possibility, of course, is that both are at play.

Epidemiologists have long recognised that people residing in different places have different health outcomes – as far back as the work of Chadwick in the 1840s and even John Graunt in the 17th century[160]. There is recognition that spatial variation in morbidity and mortality is somehow associated with the clustering of genetic predispositions, cultural norms, opportunities for education and employment and environmental conditions. One might define an advantaged area as one that offers a clean, safe and stress-free environment and one would expect that such an area would offer a beneficial effect on the health of those that live there. Conversely, it is logical to assume that an area that was dirty, hazardous and stressful would impact negatively upon the health of those that live there over and above the factors that determine health on an individual basis such as socio-economic status, smoking, exercise and diet. The focus of several investigations has been to determine the size of such 'place' effects on health, how and why they come to exist and how such knowledge might be put to use in improving public health. In this section of the literature review I will consider some of the major issues relating to health and place; the methodological issues that have arisen in dealing with this topic; and the special case of multi-level modelling, which is an advanced method of disentangling neighbourhood effects from individual effects on health.

3.3.1 Theorising identity and area of residence

It is important to consider the relationship between people and place. Too much emphasis on place leads to an imbalance towards determinism: people can be conceptualised as passive victims of their environment. Human agency is important and individual resilience and social capital, to name only a few factors, can impact on neighbourhood. Lack of balance in the other direction can be as dangerous as it leads to victim blaming: people are blamed for the poor health that, in truth, arises from the impact of the physical and social environment over the whole life course. The challenge for empirical science is not just to acknowledge both effects but also to disentangle, measure and quantify each.

A key question for academics in the fields of social and human geography is to come to an understanding of whether people make places or if the reverse relationship is true. The local environment will influence the types of activity, employment, diet and housing of the people that live there. In contrast, people also shape the local environment through creating pollution, using and/or depleting natural resources and creating local social norms that are distinct from those found in nearby areas. Jones and Eyles[161] assert that it is fruitful to look upon space as the outcome of human behaviour while others including Harvey[162] and Soja[163] suggest that the concepts of people and place are so intimately intertwined as to be inseparable[164].

In the case of Glasgow, one can see that several physical environmental factors have had a direct influence on the composition of local society. For example, in a separate section of this thesis, I discuss how Glasgow's geographical position near the west coast of Scotland was important in attracting Irish immigrants and also allowed for efficient trade routes with the Eastern seaboard of the USA to be established. Conversely, the rush of immigrants to the city in the 19th and early 20th centuries resulted in very high population densities which lead to population health issues, social tensions and the development of particular forms of housing stock. The solutions to these problems affected the physical fabric of the city in different ways. In other words, it could be argued that the people of Glasgow made the *place* Glasgow as much as the physical space that Glasgow occupied made the people that live there.

Smith[165] describes three ways of considering the relationship between place and people.

- Space reflects social activity. For example, highly segregated social areas can be viewed as reflecting social inequalities of class, race, age and gender.

- Space constructs social activity. We can also view spaces as having an active role in the creation or maintenance of social inequality. There are many ways in which where one lives reinforces one's social position. For example, some areas have fewer job opportunities than others and their reputations may make it difficult for residents to find work elsewhere. These areas also have poorer services, education and public transport.

- Space is a means of resistance and celebration. Rather than accepting these social constructions of space, they might be challenged through the community's use of space. Spaces can be used to resist oppression and redefine social identity. But disadvantaged communities might use local spaces to contest and redefine their labelling for example as 'living in a bad neighbourhood'.

3.3.2 Methods of investigating area and health

Traditionally, there are two types of investigation into area and health. First, there are studies that have investigated particular aspects of the local environment and specific forms of mortality and morbidity. Such studies usually account for the socioeconomic status of the local residents such that the association between the physical environment and the disease in question can, at least partially, be accounted for by socioeconomic factors. Second, there are studies of the relationship between deprivation and morbidity/mortality which use area level analysis. The original work of Carstairs[132] is typical of this approach as is Townsend's study of health in the North of England[126]. Small areas (be they wards, postcode sectors or local government districts) are classified according to the characteristics of their populations measured at the most recent census. The aggregated measures of deprivation used in such studies are used as surrogates for individual measures of health or deprivation. While such studies have proved useful in identifying areas where health is worse, they have little to say about what features, be they physical or social, of the local area cause poor health. Writing in 1993, Macintyre[166] noted that there had hitherto been little investigation into this area and suggested that the relative paucity of research might be attributable to poorly developed theories about the ways in which the local environment might influence health. Macintyre presented five ways in which the social and physical environment might affect the health of residents

1. Physical features of the environment shared by all residents in a locality. These might include water quality or climate.

2. Availability of healthy/unhealthy environments at home, at work or at play.

3. Provision of support services. Such services might include public transport and education.

4. Socio-cultural features of the neighbourhood. These include the ethnic or religious mixture of the neighbourhood, levels of crime (or fear of crime) and local norms and values.

5. The reputation of the neighbourhood. If a neighbourhood is perceived to be a ‘bad’ area then it is conceivable that the self esteem of the residents will be affected. Reputation might also influence the type of people who migrate to and from the area.

Macintyre then presented the results of an observational study into each of these domains, comparing two areas of Glasgow – one typical working class area in the South of the city and a more middle class area in the North West. Perhaps unsurprisingly, Macintyre concluded that residents living in the more ‘middle class’ area were more likely to have favourable health outcomes even after adjusting for personal circumstances such as income, family size and housing tenure type. Furthermore, the less favourable area was measurably worse across most of the dimensions that Macintyre presented. This was an important paper for two reasons. First, it presented a conceptual framework for the ways in which area of residence might influence health. Second, it used the same framework to show that the factors that might influence health were measurably less favourable in an area with poorer health.

In 1994, Sloggett and Joshi published a paper which reached the opposite conclusion[167], namely, that focussing public health interventions on people rather than places would have a greater impact. The apparent contradiction between the conclusions of these authors and those of Macintyre neatly encapsulates the academic debate concerning geographical inequalities in health that has come to be known by the shorthand ‘context versus composition’. In addition to Sloggett and Joshi, several other notable authors have concluded in favour of the composition of neighbourhoods being more important. These include Diez-Roux[168;169], Davey Smith[170] and Duncan[171;172]. However, there are also a number of prominent studies where the authors concluded that context (i.e. place of residence) played a significant role in influencing health. An early example of such a study was the Alameda County study undertaken by researchers in California[172]. In their conclusions, the authors stated,

> “these results support the hypothesis that properties of the socio-physical environment may be important contributors to the association between low socioeconomic status and excess mortality, and this contribution is independent of individual behaviours”.

Other authors have identified contextual effects on health, mainly through a statistical technique known as multilevel modelling. Pickett and Pearl[173] reviewed 25 papers which investigated a ‘neighbourhood effect’ using the multilevel technique and found that investigators found small, but consistent context effects associated with group-level socioeconomic status.

Writing again in 2002 on the topic of place effects on health, Macintyre et al. questioned the usefulness of the distinction between context and composition. In particular they noted that 9 years after their initial plea for clear theorising about the ways in which neighbourhood might influence health and health behaviours, few writers had done so far less go on to test such hypotheses.

3.3.3 Multilevel modelling

The technique of multilevel modelling is one which offers the potential of shedding light on the issue of the 'Glasgow effect'. Proponents of this method assert that, notwithstanding the criticisms of Macintyre, it is a valid way to separate out compositional effects (such as social class, unemployment levels and so on) from contextual effects. The multilevel technique can be understood when considering the example of school pupil performance. An important question that an educationalist may want to answer is whether pupils in one school perform better than pupils in another school because they are from a social background that facilitates high academic achievement (i.e. individual factors) or whether they are taught by better teachers (i.e. group factors). In essence, multilevel modelling allows the separate effects of individual and group factors to be measured. This is especially important because pupils from a favourable socioeconomic background are likely to attend the same school and so it is difficult to tell if teachers in a school with a class roll drawn from a more disadvantaged background is performing well.

Considering the case of Glasgow and other cities in the UK, multilevel modelling offers potential for separating out a contextual Glasgow effect from the health effects of adverse socioeconomic status in the city. This goes beyond the technique used by the authors of the Scottish effect paper as they described the effect as being the *residue* of excess mortality in Scotland left *after* adjusting for socioeconomic factors. It is possible that deprived postcode sectors in Glasgow are spatially clustered, that is, a deprived postcode sector is likely to be adjacent to several other deprived sectors. If this is the case, it is reasonable to suggest that a similar mechanism might be in operation to that of children from the same socioeconomic background attending a particular school in the example described in the previous paragraph. The operation of such a mechanism would affect the standard error (and therefore robustness) of any model that did not account for clustering of poor neighbourhoods.

The conclusions of Oakes[174], in his discursive paper on the subject of using multilevel modelling to measure neighbourhood effects, would appear to cast doubt on the usefulness of the multilevel approach for quantifying the magnitude of a Glasgow effect. In his paper he listed some fundamental conceptual issues with multilevel modelling methods that are possibly

> "severe enough to undermine the possibility of *ever* making sound policy recommendations from neighborhood effect studies as currently practiced"

and,

> "(multilevel) regression models, no matter how sophisticated, appear unable to identify useful neighborhood effects from observational data".

According to Oakes, the most significant problem with this methodology is that contextual and compositional factors are so closely intertwined and mutually causative that it is nigh on impossible to separate the relationships between them. This would appear to confirm the theoretical assertions of Harvey and Soja. Thus, while the multilevel modelling approach has proved fruitful in that it has enriched the debate on the population-level influences on health it has not been able to properly discern between context and compositional effects. Mitchell goes so far as to suggest that multilevel modelling may never be appropriate [175].

In view of the limitations discussed above, the multilevel modelling approach will not be adopted in the current piece of work. While the method in one sense appears to have offered promising results that suggest it might be applicable in the context of Glasgow's comparatively poor health, it does appear to have fundamental conceptual shortcomings that call into question the validity of the method altogether.

3.4 Social history of Glasgow

In the previous section, I reviewed some of the ways in which place and people create and influence one another. In this section, I will consider the social history of Glasgow in an attempt to understand the factors that led to the current social and physical composition of the city. It is probable that factors in the history of the city have contributed to the sort of place that it is today. If one can understand the things that shaped Glasgow *the place* then one can also understand what shaped Glasgow *the people*.

Glasgow began its existence as a site of religious importance. St Kentigern (better known as St Mungo) became established as a Bishop as long ago as AD 540. For many centuries, the city's main function was ecclesiastical, although the large community that developed around the Cathedral became an important place for commerce. It was during this time that the settlement was given the title Glasgu, which translates from scottish gaelic as 'dear green place'[1]. The settlement was given burgh status by King William the Lion in 1175[176]. In 1451, the University of Glasgow was founded. Over the next two or three centuries, Glasgow's population increased gradually: by 1630 it had a population of 4,500 and its location near a crossing point on the River Clyde (over which the first bridge had been constructed near Glasgow in 1411) helped it become one of the major commercial hubs in the Strathclyde area.

After the Acts of Union in 1707, Glasgow was able to benefit from the markets of the British empire that now opened up to it. The creation of a deepwater harbour at Port Glasgow, 30km further downstream on the River Clyde in 1667[177] was a key development as the West Coast of Scotland's favourable position for the trade winds of the Atlantic allowed ships a head start on vessels setting out for the Americas from other parts of the UK and mainland Europe. Glasgow's tobacco merchants, in particular, began to accrue vast profits from plantations on the Eastern seaboard of the USA. The American War of Independence which began in 1775 curtailed the tobacco trade between Glasgow and the American colonies. However, the tobacco merchants were able to turn their attention to trade with the British colonies in the Caribbean: thus cotton became the main source of wealth but profits were also made from sugar and molasses [153]. In 1770, the deepening of the Clyde make it navigable for ocean going vessels as far as Hutchesontown, just south of the city's commercial trading district[178]. This was an important development as it allowed the city itself to function as a port.

3.4.1 Glasgow during the industrial revolution

The population of Glasgow grew rapidly during the industrial revolution. The population of the city grew nearly eightfold from 147,000 in 1831 to approximately 1.1 million in 1931. Due to this population growth and also because of incorporation of the neighbouring settlements of Govan and Partick into the city, Glasgow overtook both Birmingham and Liverpool to become the most populous city in the UK outside of London during the period 1915-1941[179;180].

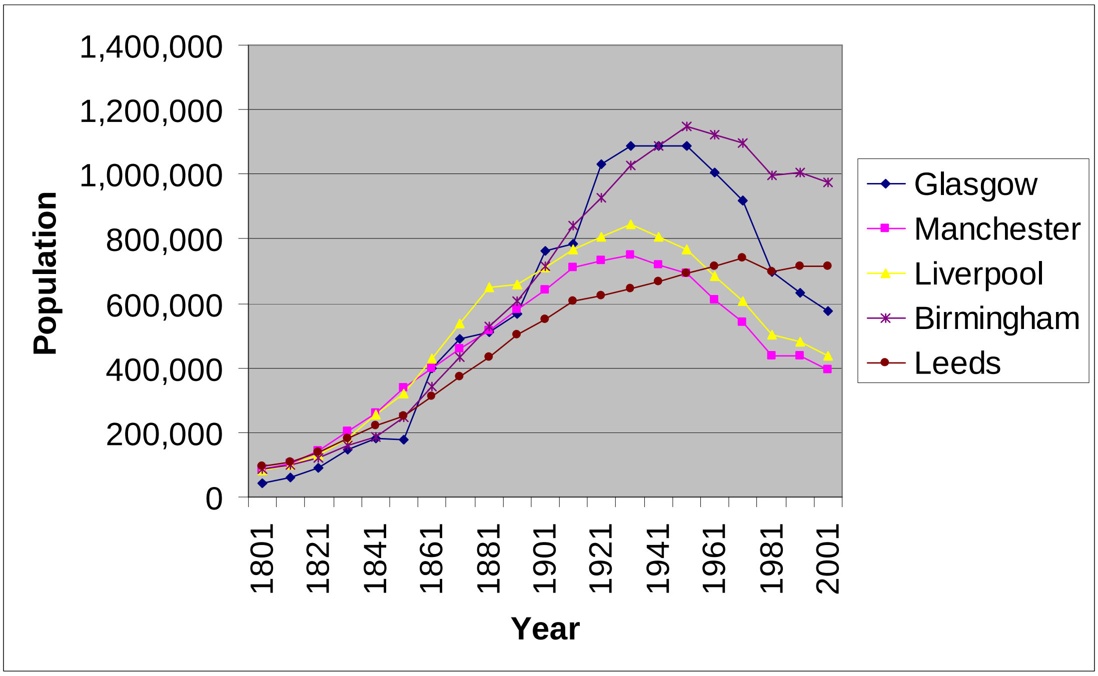


Figure 9: Population of the five most populous UK Cities; 1801-2001[180]

This population growth was driven by increasing fertility and also by immigration into the city, mainly from the Scottish highlands and islands, Ireland, and to a lesser extent from Eastern Europe, Italy and Lithuania[149;181].

In an early foreshadowing of the city populace's poor social circumstances in comparison with the population of other UK cities, Glaswegian workers tended to be paid less than their counterparts in Manchester and Bradford[153]. In addition, there were relatively high proportions of textile mill workers in Glasgow who were female or children under the age of 14: workers and who were paid substantially less than adult males for doing the same job. Thus, in a city that was already notable for having a low wage economy, payroll expenses were further reduced for mill-owners by employing women and children. One can speculate that this adversely affected the social circumstances of many of the city's residents and that, perhaps, Glaswegians were already fairing poorly in comparison with similar cities.

In common with many British cities immediately during the Victorian era, the first industry to take hold in the Glasgow region was the textile industry[148;182]. In 1841, 41% of industrial employment in Glasgow was in the textiles and clothing sector with the next largest sector, engineering, tools and metalworkers comprising just under 9%[183]. It was not until later in the 19th century that Glasgow became synonymous with Shipbuilding and heavy industry. After 1841, the textile industry in Glasgow gradually dwindled in importance so that by 1912, the proportion of industrial employment in this sector had fallen to under 8%.

The history of the textile industry in Glasgow is far more complex than has been summarised here. However, some key themes emerge that would later be repeated in the era of heavy industry on Clydeside. First, Glasgow's geographical position was important in allowing the industry to rise in the first place. Second, the markets of the British Empire allowed products from Glasgow to achieve global pre-eminence. Third, the abundance of immigrant workers allowed very rapid expansion of the local industry once it had taken root. These workers were so abundant that the industry was characterised by low pay, even by the standards of the time, although it is nearly impossible to verify this. Fourth, competitive advantages were gained initially by technical innovation but later, as other industrialising areas also started to compete, Glaswegian business remained competitive in the short term by recruiting more low cost workers rather than making substantial capital investments in the latest technologies. Fifth, the relative decline of the industry was gradual at first but had been signalled for some time and geopolitical factors such as the presence of the Empire artificially prolonged the life of the industry.

3.4.2 The peak and subsequent decline of heavy industry in Glasgow

No discussion of Glasgow's social history would be complete without reference to the period when the city was a major centre for heavy industry and manufacturing. Closest attention will be paid to the history of shipbuilding on the River Clyde. This industrial sector can be viewed as a bellwether for the Glasgow and Clydeside's wider economy.

In the mid to late 19th Century, shipbuilding on the Clyde was dominated by entrepreneurial individuals who were not afraid of adopting new and comparatively untested technologies[184]. Important individuals were the Napier brothers who founded the Fairfields yard at Govan (this shipyard is still in operation and is now owned by BAe Systems) and John Elder who founded his own yard at Linthouse. Shipyards on the Clyde were the first on a commercial basis to build ships that were powered by triple expansion steam engines and were amongst the first in the world to adopt the steam turbine as a method of propulsion. Early adoption of these systems ensured that vessels built by Clyde yards had a speed and reliability advantage over their rivals built elsewhere and served to advertise the craftsmanship of the Clyde builders to ship owners.

Payne[185] suggests that heavy industry on Clydeside reached its zenith in 1913. At this time, Payne and others[153;186;187] describe the enormous extent of heavy industry in the Glasgow conurbation. There were 50,000 men employed in the Clyde shipyards and these yards produced one third of British shipping tonnage and one fifth of the world's total. Other heavy industries employed large numbers of Scottish people too: there were 150,000 employed in coal mining, 100,000 in metal manufacture and 75,000 in mechanical engineering. Payne also asserts that:

> "It is undeniable that the general well being of the entire Scottish economy between, say, 1870 and 1950 was largely determined by the health of these basic heavy industries, to which Scotland was more heavily committed than any other region of the United Kingdom."[185](page 30).

If this assertion held for all of Scotland then it must be particularly true for West Central Scotland where there was a lower proportion of the population employed in non-industrial sectors such as services and agriculture.

As the figures quoted previously show, shipbuilding was by no means the largest source of employment in Scotland or even in Glasgow during the city's industrial heyday but it was nonetheless the keystone of the economy. With the West of Scotland being the region of the UK that had the highest portion of its workforce employed in heavy industry, it is obvious that the livelihoods of many thousands of families depended on the health of the shipbuilding industry.

The headline figures for the total number of individuals employed in heavily industrialised sectors of the economy disguised volatility in the local labour market[181] with most shipyards along the Clyde suffering fallow periods throughout their histories where workers were laid off in large numbers due to lack of orders. The following figure, adapted from data in Fraser and Maver's volume on Glasgow's history, depicts the cyclical nature of the shipbuilding industry in Glasgow during the period 1864-1912[188]

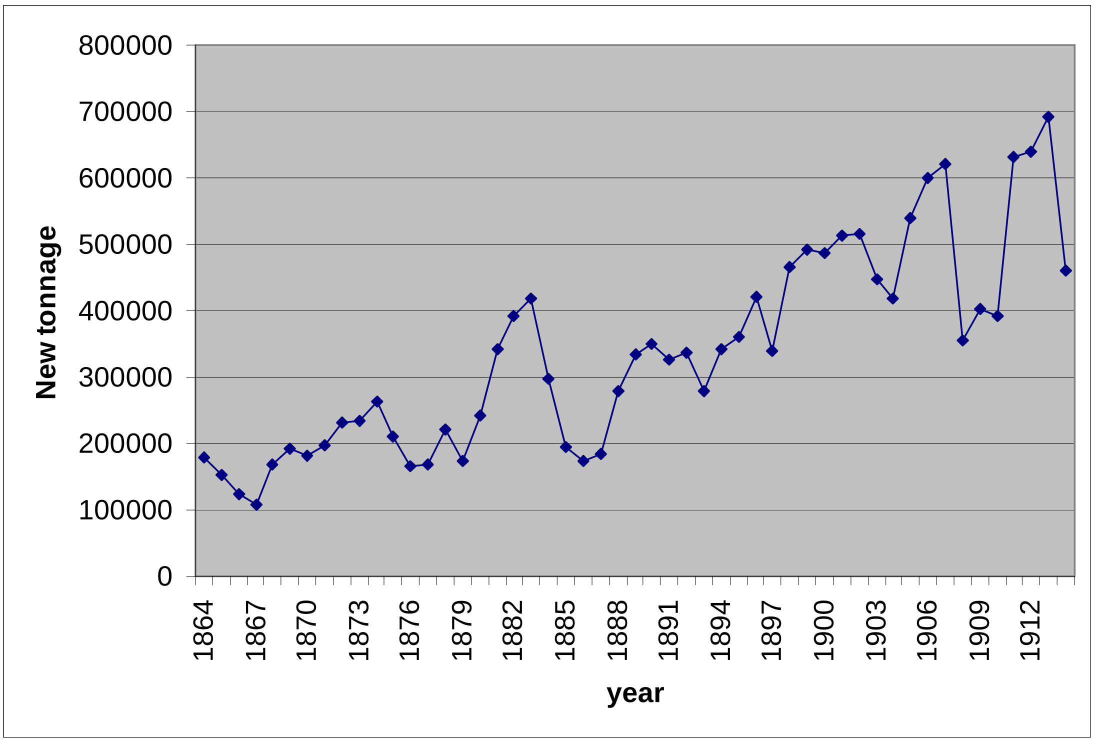


Figure 10: Tonnage launched from Clydeside yards; 1864-1912

Economists agree that sustained, continual growth of an industry is not to be expected and that cycles of growth and contraction with a general upward trend over time is the norm. In this respect, Clydeside shipbuilding was no different from any other industry. However, its importance to the economy of the West of Scotland and as an employer in Glasgow meant severe social repurcussions when when the industry went through one of its periodic troughs. A fall in shipbuilding output had a knock on effect in several other industry types[189;190] and, presumably, the general health and well being of the local population. It is perhaps ironic that this period of heavy industry is popularly conceived as Glasgow's heyday when Glaswegians of the time were concerned with the reality of job insecurity and the absolute poverty that would ensue should the market for new ships undergo one of its short term collapses.

So what factors contributed to the decline of heavy industry and, in particular, shipbuilding in the Clydeside conurbation? Moss[184] describes a number of factors that led to the precipitous drop in shipping output from the Clyde yards in the years following the Second World War. First, yard owners did not adopt the new technologies that had been pioneered by their rivals in Scandanavia, Germany and Japan. Seond, yard owners concentrated on passenger vessels when it was clear that international travel would soon be dominated by aviation. Third, locally produced raw materials were increasingly in short supply due to government rationing of raw materials for reconstruction projects and decline in output of local ironstone and coking coal mines[185;191]. Fourth the, the worldwide shipping market changed substantially in the 1950s such that ports on the mouths of rivers were increasingly used in preference to ports further upstream. This meant that demand for dredgers was reduced (in which four Clyde yards were specialists). Fifth, demand for small ferries diminished as new roads, tunnels and bridges were constructed at home and abroad: this adversely affected several smaller Clyde yards and many of these closed in the period 1945-55[190].

In the immediate post-war years, heavy industry in Clydeside appeared, in many respects, to be in reasonable health. Demand for new ships fuelled demand for steel which was still produced in significant quantities locally. In other parts of the UK, light industries had developed in the interwar years through automotive manufacturing, aerospace engineering, scientific instruments, electronics and so on. These industries were, in comparison, weakly represented on Clydeside but this was not seen as a cause for concern.

3.5 Urban Health

The previous section described the phenomenon of urbanisation and city growth. The population health of cities where the population is rapidly expanding is consistently described as being under threat from a variety of infectious and environmental agents. In other cities, where the population growth has slowed down, somewhat different, but still peculiar to the urban setting, threats to population health exist. In this section, I will review some of the literature that describes the health of urban populations and consider policies that exist for healthy urban planning.

3.5.1 General remarks

In cities in developing countries and to a lesser extent in cities in developed countries, the main threats to population health arise as a function of local population density and overcrowding[155;192]. It would also appear that though the diseases which afflict the populations of cities in the developing world are markedly different to those endured by urban residents in developed countries, that the distinction is not completely clear cut. The so-called ‘diseases of affluence’ are increasingly common in rapidly urbanising countries and some infectious diseases, notably tuberculosis, that were associated with previous historical eras in established cities are once again presenting a threat to population health[193]

Most writers draw a distinction between urban health and rural health although Vlahov[194] suggests that as yet there is no common understanding or language relating to urban-specific health issues while consensus does exist on such matters where *rural* health is concerned. This is curious given the continually increasing proportion of the globe’s population living in urban areas and the relative burden of disease that urban-dwellers carry. Vlahov recognises that the influences on the health of city residents are complex and are hard to describe let alone measure. However, other writers (whose work has been published more recently) such as Galea[195] and Harpham[196] mention that there is now a recognisable 'urban health' field of study that draws on sociological, political, economic and traditional public health perspectives.

Galea[195] suggests that urban health can be viewed in three ways. The first is to compare urban and rural health, the second is to compare health between cities[197] and the third is to look at *intra*-urban health differences as in the investigations of neighbourhood effects on health by Diez-Roux[198]. Galea asserts that there is such a thing as an 'urban health penalty': residents of urban areas face additional challenges to their health compared with those living in rural areas even though they have similar, if not better, levels of income, education and access to health services. Geronimus[199], writing about urban health in the USA and the UK, states that the differential in health outcome between urban and rural areas was large in the early period of urbanisation in the mid to late 19th Century with death rates in cities running much higher than in rural areas. With improvements in sanitary and public health measures, the gap narrowed such that cities had death rates only 5% in excess of urban areas. However, by the late twentieth century, the gap had widened considerably with the most disadvantaged urban areas having death rates between one and a half to three times higher than rural areas or small towns in the UK and the USA.

In 1991, a WHO Expert Committee on Environmental Health reported 3 broad health effects that could be attributed to urbanisation[200]. First, communicable diseases flourish where the environment fails to provide barriers against pathogens. Risk to health is further increased by overcrowding and the spread of urban dwellings into previously unpopulated areas where disease vectors are common. Second, toxins and hazards that result in non-communicable diseases and injuries are intensified by the living conditions in urban environments. Third, urban life is associated with a particular set of psychosocial health problems.

In cities where the population is growing rapidly, certain pathologies are particularly common. In the 21st Century, it has been estimated that urbanisation is progressing at a the rate of 2% per year[201] and that by 2015, 65% of the world's inhabitants will live in an urban area. Since the countries of the developed world have generally reached a stable level of urbanisation most of the remaining urbanisation is taking place in developing countries. Such countries fare poorly on most measures of population health and increasingly, it is the poor health of their urban residents that contributes to the disparity in health outcome between those countries and the developed world[200].

The focus of this thesis is on the population health of urban residents in the UK. The UK is a well developed country and the public health priorities here are very different to those in the developing world. As a result, I will concentrate on literature that describes the threats to the health of contemporary British urban residents but it is worth making reference to some of the current challenges to health faced by urban residents in other parts of the world as they are similar to the historical challenges to health faced by previous generations of UK urban residents and, as mentioned earlier in this section, there is not a clear cut divide between the urban health in developed countries and urban health in developing countries.

3.5.2 Urban Health in Developing Countries

Rapid, often unplanned, urban growth is the source for many of the environmental hazards faced by cities within the developing world. Substandard housing on marginal land, crowding, increasing levels of air pollution, water pollution and over usage, inadequate sanitation services, inadequate solid waste collection, and motor vehicle traffic and traffic injuries are all associated with rapid growth of urban centres[202]. For example, half of Turkey's urban population lives in unplanned residential areas, known locally as 'gecekondus'[79] while the 'barrios' of many Latin American cities are home to tens of millions of people. With all the listed examples of threats to environmental health, it is the urban poor who are particularly disadvantaged and this exacerbates the health problems that are associated with low income and low education levels[192;203].

Harpham suggests that the social inequalities in health associated with developed countries also exists in cities of the developing world[196]. She cites work carried out by researchers at the London School of Hygiene and Tropical Medicine looking at disease patterns in the cities of Accra, Ghana and Sao Paulo, Brazil[204]. There were two surprising findings in this study. The first was that in

1991 in Accra the major cause of death for adult males and females was circulatory disease, accounting for a quarter of all deaths registered. This was higher than the fraction of deaths attributable to infectious and parasitic diseases (one fifth). A traditional view is that circulatory disease is a 'disease of affluence' and that it is a health problem confined to more affluent societies. This study helps to dispel that assumption. The second finding was that even within Accra and Sao Paulo, there was a social gradient in health outcome: mortality from circulatory disease was twice as high in the poorest neighbourhoods of Accra as it was in the most affluent and there was a similar gradient for respiratory disease. In Sao Paulo, homicides (mainly among males aged 15-44) were three times more common in deprived areas than in the most affluent.

3.5.3 Urban health in developed countries

For urban residents in developed countries, the challenges to population health are somewhat different. Generally speaking, the presence of clean water supplies, sanitation, mains electricity and other infrastructural services can be assumed. For many, living in an urban area in a developed country confers a protective effect on health: access to health care services is better than in rural areas and there is greater range of employment, educational opportunities, transport options and consumer products that are all associated with better health status. Despite these opportunities, cities in developed countries are the location of the overwhelming majority of deprived neighbourhoods where health outcomes are the poorest in each of the countries in which they are located[205]. In other words, the urban health penalty is unequally divided amongst urban residents.

In a lengthy paper, Galea and colleagues[195] discuss the various influences on urban health and even go so far as to propose a model or conceptual framework for Urban Health which is, in part, based on the ecological model of health described by Evans and Stoddart[7] although they concede that their model of urban health lacks the complicated feedback loops of Evans and Stoddart's model. While Galea and his colleagues point out that the model is applicable to all urban residents across the globe, they stress that its development was rooted in the writers' experience of public health in the cities of the United States and that a degree of caution should be taken when considering its applicability to other societies. Nevertheless, I consider that the UK is sufficiently similar to the USA that it is worthwhile taking a closer look at Galea's model. The model is reproduced below.

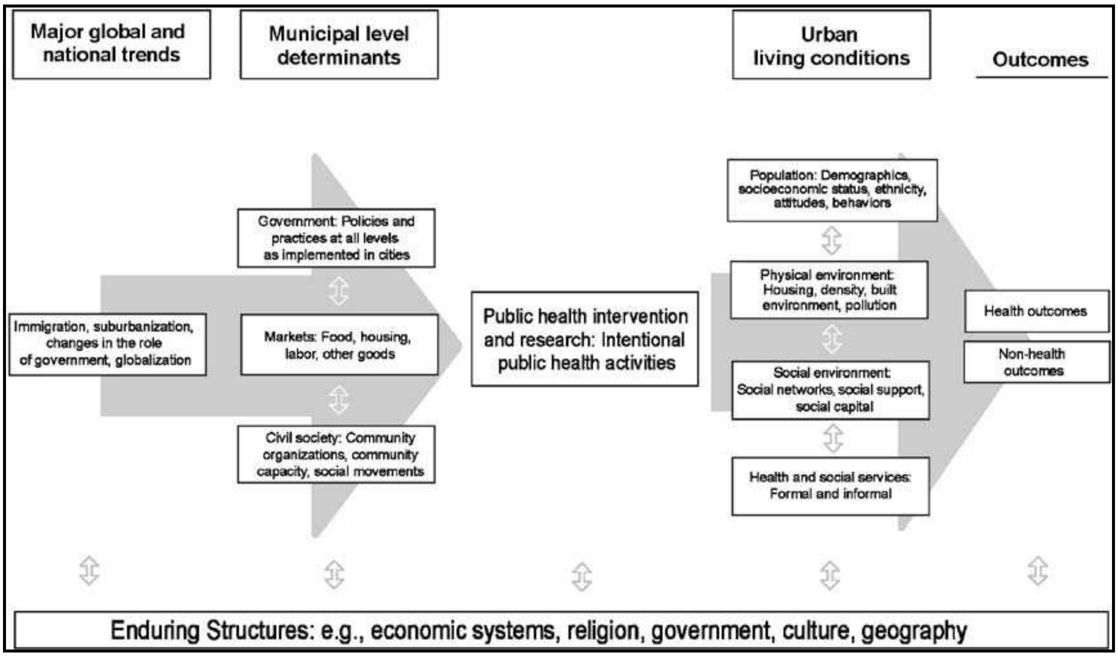


Figure 11: A Conceptual Framework for Urban Health in Galea et al, 2005[195]

According to this model, the domains that influence the health of urban residents operate at three spatial levels; global and national trends; municipal governmental factors and local urban living conditions.

Relevant global and national trends include migration patterns, suburbanisation, the changing roles of government and globalisation itself. The influx of migrants can positively or adversely affect the overall population health of an urban area. Migrants bring lifestyles and support systems that protect them from some of the adverse health outcomes of other low-income urban residents but on the other hand, immigrants are often impoverished and have a higher prevalence of particular diseases (especially HIV/AIDS and tuberculosis) than long term residents. With respect to Glasgow, migrants from West Asia and Eastern Europe have raised the birth rate in recent years[154] and the population growth that they and their children provide has contributed to increased prosperity.

The phenomenon of suburbanisation was described in the previous section on urbanisation. Galea cites the example of wholescale middle class migration from the inner city to the suburbs in Cleveland, Ohio over the last 40 years, resulting in an overall population loss of 400,000 from that city's administrative area. A similar relative decline in population size has occurred over the same time period in Glasgow which was also accompanied by population growth in middle class suburbs and commuter towns[206] and in several other UK cities. In Glasgow, it has been argued that the departure of middle class residents contributed to the city's poor overall health picture as those residents on low incomes and who were disposed towards poor health did not have the means to move to other parts of the country[207;208]. Frumkin[159] writes extensively about the threats to public health presented by the urban sprawl associated with suburbanisation including increased pollution through increased car use, changing exercise patterns and poor water quality

Globalisation has affected the well being of urban residents in several ways. As global trade has grown, corporations are no longer physically and politically tied to one locality and move their premises according to where costs are lowest. The departure of manufacturing corporations from the cities where they were traditionally located led to diminished employment levels which in turn are associated with poorer population health outcomes. As I described in the sub-section on Glasgow's social history, it is clear that the economic factors associated with globalisation partially contributed to the decline of heavy industry in the city and surrounding conurbation. Deindustrialisation in Glasgow has been cited as one of the key reasons for the city's poor socioeconomic profile and reputation for poor population health[5;209]

At the municipal level, there are several factors that determine the health of local urban residents. These include governmental services such as social housing, health care, public transport and traffic management. Local markets operate to make access to affordable housing relatively easy or difficult and can also influence the availability of items that directly influence health including tobacco, alcohol, firearms and high-fat foodstuffs[210]. Each of these determinants is influenced to a greater or lesser extent by global and national trends (hence the bi-directionality of the arrows in Galea's model).

Galea lists 'Civil Society' as a determinant of urban health at the municipal level. This refers to the interactions between individuals and groups in contexts that are not controlled by either the government or by market forces. The idea of civil society also includes such concepts as social capital, social cohesion and community competence. Low levels of social capital are associated with poorer health outcome at both the sub-national and neighbourhood levels of geography but the extent to which low social capital is causative of poor health is unclear[211]. In Glasgow and Clydeside, certain forms of mortality such as murder, suicide and drug-related deaths that are associated with low social cohesion are very high (and have become far more common in recent years): these mortality trends will be described in more detail in the next chapter. Furthermore, in the communities with the lowest life expectancy in the Greater Glasgow area, recorded crime rates are highest[212] and residents' fear of crime is also high[152].

According to Galea's model, urban living conditions are the primary determinants of the health of urban residents. Included as 'urban living conditions' are diverse factors ranging from population characteristics (socioeconomic composition, ethnicity, gender and age) to the physical and social environments and local service provision.

Certain characteristics of the urban physical environment can influence health in direct and indirect ways. Low housing quality can influence physical health, most notably by exacerbating symptoms of asthma and can cause psychological distress. In the UK, there is some evidence of an 'inverse housing law'[213;214] such that in areas where the climate is harshest, housing is of the lowest standard, resulting in increased likelihood of respiratory complaints and hypertension. Some research has been done to suggest that physical nature of the urban form may itself influence violent crime rates[215]. Glasgow is the most northerly of the UK's large cities and has a very high proportion of social housing: the Glasgow Housing Association is the largest landlord in the UK[216]. While it is not true to say that all social housing is of low quality, there are certain large areas of Glasgow where social renting is the dominant tenure type and the dwellings are of notoriously poor quality.

3.5.4 Healthy Cities Project

A key initiative in the field of urban health has been the WHO Healthy Cities project which had its inception at a meeting of representatives from 21 European cities in Lisbon in 1986 where it was agreed that the cities would form a collaborative network for developing sound approaches to city health. John Ashton, who was one of the representatives from the city of Liverpool at the initial meeting, writes that the Healthy Cities project was partly inspired by the aims of the Health of Towns Association which came into existence in Britain in 1844[217]. This Victorian initiative was part of a response to the threat posed to public health by industrialisation and urbanisation. Its basic aims were to raise awareness of the dreadful living conditions of many urban residents in Britain at that time and to work for changes in the law which would lead to improved public health.

The Health of Towns Association was important in facilitating the development of 'the Sanitary idea', the notion that factors such as overcrowding, inadequate sanitations, unreliable and infected food and water supplies created the conditions under which epidemics of infectious disease could survive. Accordingly, the Association worked to improve housing standards and hygiene regulations, increase the proportion of paved streets without open sewers and to lobby for publicly funded water and sewerage systems. This movement had huge success in inserting the sanitary idea into public-policy thinking with the passing of the Public Health Act of 1848. As the remainder of the 19th Century passed, the sanitary idea gradually diminished in influence as the germ theory of disease precipitated a move away from environmental reform to personal prevention. By the mid-1930s, the so-called therapeutic era of health was underway where the emphasis was placed on pharmaceutical and surgical interventions for treating pre-existing symptoms and disease[52].

However, McKeown[52] conducted statistical analysis of infectious disease mortality in England and Wales between 1840 and 1970 and concluded that therapies for infectious disease were not the primary reason for the reduction in mortality over this period. Instead, he gave four reasons, listed in order of their importance for why public health had improved in England and Wales. They were:

- limitation of family size
- increase in food supplies
- a healthier physical environment
- specific preventive and therapeutic measures

McKeown's analysis catalysed the development of a fresh way of thinking about public health that came to be known as *The New Public Health*. This fresh approach drew upon environmental, personal preventive and therapeutic perspectives and sought to synthesise their aims. A key document which gave the New Public Health movement momentum was Lalonde's 1974 report on the health of Canadians[19] (discussed elsewhere in this literature review). Lalonde's report highlighted the importance of intersectoral collaboration to improve health and stated that health should a consideration of all policy areas. It was against this background that the Healthy Cities project was born. The main thrust of the Healthy Cities Project (HCP) according to Harpham[218] is for health impact to be considered by all sectors at the city level from transport to industry to tourism. The Healthy Cities Project has four main objectives[219]:

- Political mobilisation and community participation in preparing and implementing a municipal health plan.
- Increased awareness of health issues in urban development efforts by municipal and national authorities, including non-health ministries and agencies.
- Creation of increased capacity of municipal government to manage urban problems and formation of partnerships with communities and community based organisations in improving living conditions in poor communities.

- Creation of a network of cities that provides information exchange and technology transfers.

Several cities across all five continents took the opportunity to become Healthy Cities and instigated programmes whereby municipal governments adopted the four objectives listed above. In the UK, Liverpool, Sheffield and Glasgow were all signatories to the Healthy Cities project.

3.6 Concluding remarks

In this chapter I have investigated the process of urbanisation, some of the social and economic history of Glasgow, and have introduced the concept of urban health and considered how it applies in Glasgow.

In terms of urbanisation, Glasgow is a mature city, it has experienced rapid population growth and then population decline towards a more stable level. Glasgow, along with other cities in the UK was amongst the first to experience the challenges of urbanisation that can now be observed in countries with rapidly expanding economies and population shifts from the countryside to the city. It now appears that Glasgow is included in a group of cities that are among the first to experience the next phase of existence. Glasgow is no longer a manufacturing centre and is defined as much by the 'new' local economy and the prosperity that has brought many of its residents as it is by factors such as poor social cohesion and ill-health. It remains to be seen how Glasgow will deal with these challenges but it does seem clear that Glasgow's experiences, both good and bad, will be observed and digested by others.

I have described some of the social and economic history of Glasgow, concentrating on the history of heavy industry in the city until the 1950s. Factors in the city's history may have contributed to the poor population health of the city's current residents and these need to be investigated as rigorously as behavioural, material and social factors that influence population health.

4 Literature review – part 3

There are two distinct sections to this chapter. First, I will present and discuss data comparing the population health of Scotland with other European countries. The second section will deal with population health in Glasgow and the West of Scotland compared to similar regions in the UK and Europe.

4.1 Excess mortality in Scotland

The earliest reference that I could find regarding Scotland's poor population health in relation to other countries (especially England) was the work of Carstairs and Morris from 1989[132]. In this paper, the authors reported that for the period 1980-1982, Scotland's age and sex adjusted standardised mortality ratio (SMR) was 112 for all age groups and 122 for the 0-64 age groups (when using the death rates of England and Wales as the standard rates). However, when adjusting for an area-based measure of deprivation (of the authors' own invention) SMR for all age groups in Scotland was reduced to 103 compared to England and Wales. Carstairs and Morris also noted that there was a socioeconomic gradient in mortality in Scotland. In all age groups, higher SMR's were recorded for those living in the most deprived areas than for those in the most affluent areas. The deprivation categories used by Carstairs and Morris to stratify the population of the UK by socioeconomic status is described in other sections of this thesis.

The initial work of Carstairs and Morris was followed up by McLoone and Boddy in 1994[220]. They repeated the earlier analyses of Carstairs, this time using deprivation data from the 1991 census, and death data for the years 1990-1992. McLoone made several findings regarding population health in Scotland. He broke the population of Scotland into 7 deprivation categories (or DEPCATs) according to the Carstairs score of Scotland's 1100 postcode sectors. He found that the death rate in the most deprived category in the period 1990-92 was 162% higher than the death rate in the most affluent category of the Scottish population. Between the period 1980-82 and 1990-2, the absolute death rate among people aged 0-64 in Scotland declined by 22% but the rate of improvement in the most affluent category was double what it was in the most deprived category. McLoone also showed that mortality among men aged 20-29 in the deprived sectors of the population increased by 29%, and that was attributable to increased rates of suicide and also to other external causes of death such as homicides and accidents within this group.

McLoone's paper has been cited by over 30 articles according to the Medline database and it has a number of strengths. First, it highlighted that the mortality gap between the rich and poor segments of the Scottish population grew throughout the 1980s. He also demonstrated that the death rates in the City of Glasgow were considerably higher than those in the rest of Scotland. However, he did not attempt to adjust for deprivation status when comparing death rates in Glasgow with the rest of Scotland and did not broaden his focus to compare Scotland's (and Glasgow's) health with other regions of the UK.

A more recent piece of work by Hanlon and colleagues[6] (which was presented in the Introduction chapter) used similar methods to Carstairs and Mcloone to look at mortality in Scotland at the time of the most recent census. The main finding of this reasearch was that adjustment for Carstairs deprivation reduced the excess mortality in Scotland (compared to England and Wales) by a smaller margin for deaths in the period 2000-02 than it did for deaths around the times of both the 1981 and 1991 censuses.

4.2 Scotland's health in an international context

Journal articles comparing Scotland's health with other countries are scarce. However, a relatively recent project (2003) by Leon and colleagues (commissioned by the Public Health Institute for Scotland) surveyed the available journal articles and grey literature and made a number of findings[221]. I will highlight Leon's main findings in the paragraphs that follow.

Leon used the WHO database of health statistics (WHOSIS)[222] to compare trends in mortality rates and life expectancy between different European countries and regions. The authors found that in the first half of the 20th Century, Scotland compared relatively favourably with several countries that are now perceived as having good population health. For example, life expectancy for both men and women in Scotland was higher than in France, Spain and Italy. Scotland started to slip down the life expectancy table from the middle of the 20th Century onwards. The authors stressed, however, that in absolute terms, life expectancy for Scottish men and women continued to improve throughout the last century but at a lower rate than in several other countries. By 1995 (the latest available date at the time of writing for which all countries' data were available) Scottish men had the second lowest life expectancy out of a group of 17 European countries (including the other constituent countries of the United Kingdom) while Scottish women had the lowest life expectancy. Leon's report then went on to look at mortality rates for individual causes of death in order to establish which particular forms of mortality were most responsible for Scotland's unfavourable position within Europe.

The following two charts illustrate Leon's primary finding concerning Scotland's position relative to several other European countries in health terms. They are reproduced (with minor modifications) from his report. Both figures show that at the start of the 20th Century, life expectancy for both males and females in Scotland compared favourably with that in several other countries. However, Scotland gradually slipped down the 'league table' as the century progressed such that by the mid 1990s men in Scotland had the second lowest life expectancy of these countries and women in Scotland had the lowest life expectancy.

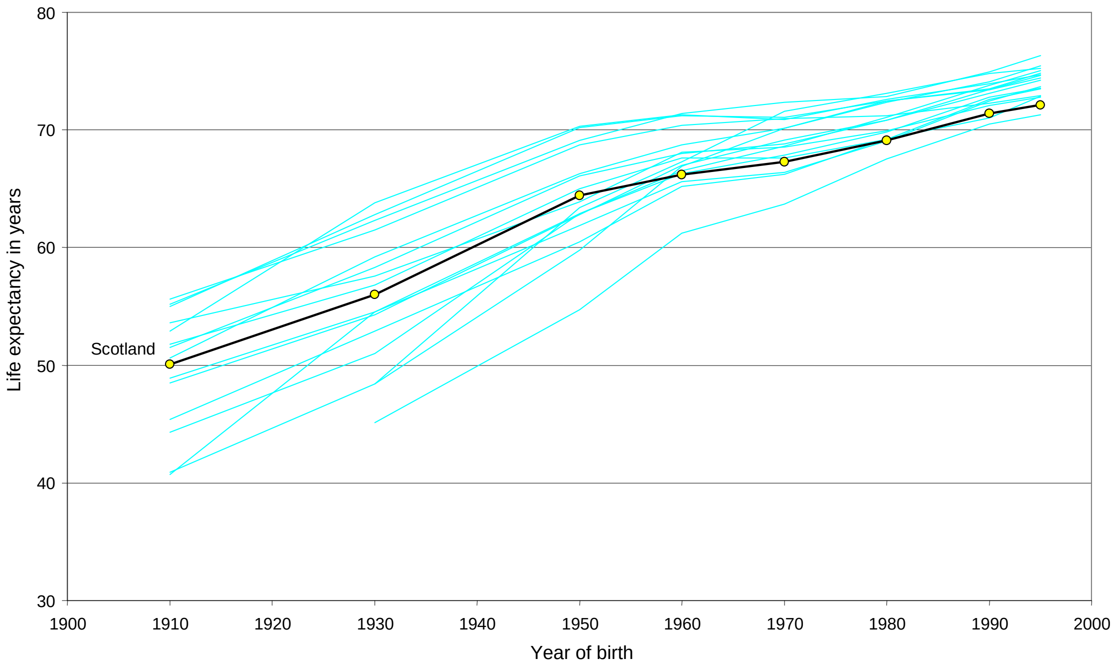


Figure 12: 20th Century trends in male life expectancy in Scotland and 16 other Western European countries, reproduced from report by Leon et al, Public Health Institute for Scotland, 2003.

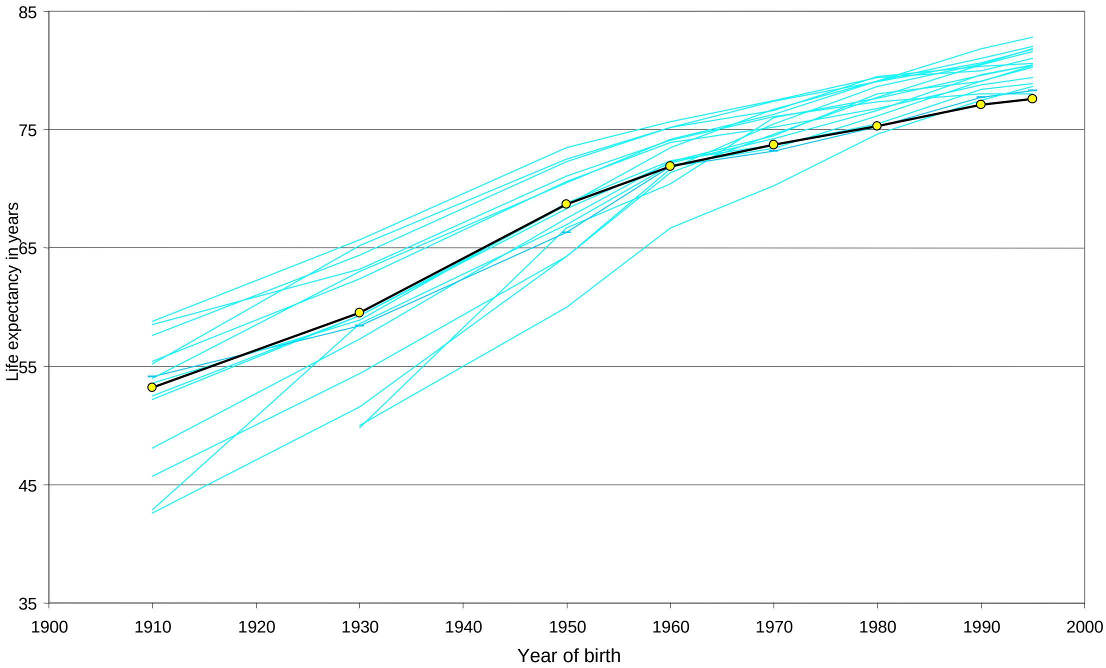


Figure 13: 20th Century trends in female life expectancy in Scotland and 16 other Western European countries, reproduced from report by Leon et al, Public Health Institute for Scotland, 2003.

I will not reproduce the rest of Leon's findings here. However, Leon confirmed that high rates of mortality from cardiovascular disease, cerebrovascular disease and lung cancer in Scotland contributed to Scotland's poor overall position in Europe. In addition, he highlighted recent rises in deaths due to cirrhotic liver disease and suicide in Scotland, forms of mortality where Scotland had previously compared very favourably with other European countries but was now the location of the highest mortalities due to these causes. Indeed Leon was so concerned by his findings relating cirrhotic liver disease mortality that he wrote a paper on that specific topic in the Lancet[223] where he expressed grave concern about mortality from this cause and alcohol availability in Scotland:

> "Per capita alcohol consumption has more than doubled in the UK over the past 40 years. Although beer consumption has been stable, increased consumption of wine and spirits in particular have contributed in a disproportionate way to this trend."

In the same paper, Leon also noted that the rate of liver cirrhosis mortality in Scotland was accelerating even with respect to England and Wales (which themselves experienced a startling rise in mortality compared to other European countries). Although Leon did not account for socioeconomic differences between the constituent countries of the UK, his data indicate that for this form of mortality there would appear to be a Scottish effect.

4.3 Self-reported health in Scotland

Taking his cue from the published works of Hanlon and colleagues on the same subject, Frank Popham of the University of Edinburgh investigated whether there was a Scottish effect when measuring self-reported health across the whole of the UK[224]. He had three research questions:

1. Taking account of country of birth, do people living in Scotland report higher rates of poor general health and liniiting illness than people living in England?

2. To what degree is Scotland's excess in poor general health and limiting illness explained by differences in employment and socioeconomic position?

3. Is Scotland's excess in poor general health and limiting illness seen in all employment status groups?

Popham used data from the Sample of Anonymised Records (SARS) from the 2001 UK census[225]. This is a 3% random sample of individual census records that have been altered to remove all personal details. This sample is made available to the research community who wish to complete micro-level analysis of the UK census. In response to his three research questions, Popham found that people born and living in Scotland reported higher levels of poor general health and limiting illnes compared to those born and living in England. Adjustment for socioeconomic position and employment status largely explained the higher rates in Scotland. Finally, when looking at particular strata of the populaiton, an excess in poor self-reported health and limiting illness was only observed among the economically inactive born and living in Scotland (compared to economically inactive people born and living in England). Popham concluded that the apparent Scottish excess in these self-reported measures of health could be explained by socioeconomic differences and that there was no 'Scottish effect' in operation.

4.4 Population health in Glasgow and Greater Glasgow

4.4.1 Let Glasgow Flourish

Let Glasgow Flourish is a comprehensive report on health and its determinants in Glasgow and West Central Scotland[152]. The complete report can be viewed online via the website of the Glasgow Centre for Population Health. However, some of the key findings contained within that publication will be reproduced and discussed here. The report has several chapters; some chapters concentrate on specific morbidities, mortalities and other measures of health *within* Glasgow and West Central Scotland and, where appropriate, compare Glasgow's status with that of the rest of Scotland or the United Kingdom. Other chapters focus on the determinants of health including social, environmental and behavioural factors.s

The authors of Let Glasgow Flourish used data from a pre-existing project that attempted to compile health related data for all 'communities' in Scotland[212]. The 'communities' in question are based on primary care geographies: Local Health Care Cooperative (LHCC) areas, or their replacements (which had very similar boundaries) Community Health (Care) Partnerships (CH(C)P) areas. These communities had populations of between 20,000 and 140,000 people. Where routinely collected data were available, the authors also compiled health-related data at the Postcode sector level (population 3000 to 5000). The authors created several hundred summary graphs for the Glasgow City and West Central Scotland area comparing communities across a large number of health indicators.

4.4.1.1 Inequalities in health in Glasgow and the West of Scotland

One of the main messages of *Let Glasgow Flourish* is that inequalities in health exist not only between Scotland and the rest of the UK, but also between Glasgow and the rest of Scotland, and even within Glasgow itself.

For example, Figure 14 (below) shows the inequality in all-cause mortality rates that exists between various small areas in and around the Glasgow City area. Within this area, there are several areas that in the period 2000-02 had death rates below the average for the whole of Scotland (approximately 600 per 100,000 population). However, across the West of Scotland, there was a four-fold variation in death rates from 350 per 100,000 in Kilmacolm (an affluent village in Glasgow's commuter belt) to 1475 per 100,000 in the Calton area, located to the East of Glasgow's city centre. Furthermore, in the 5 unhealthiest areas, the local age-standardised death rate was at least double the Scottish average.

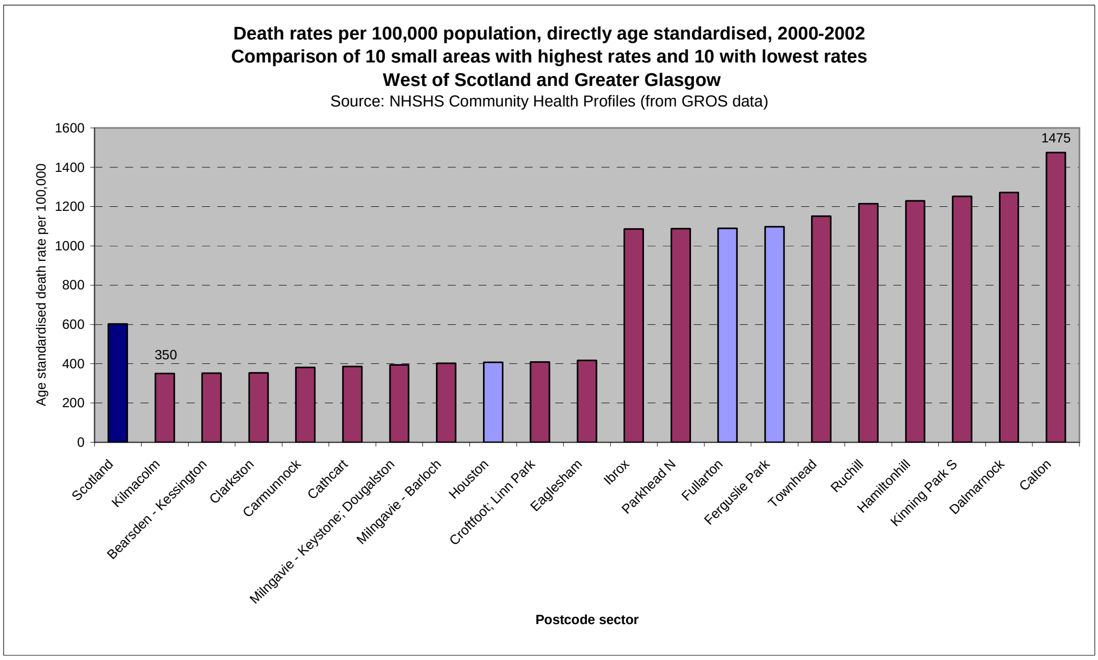


Figure 14: Death rates per 100,000 population, directly age standardised, 2000-02. Comparison of 10 small areas with highest rates and 10 with lowest rates in the West of Scotland and Greater Glasgow.

The above figure only gives a cross-sectional snapshot of the health status of the small areas in and around Glasgow and does not give an indication of how the health status of Glasgow's residents in comparison to the rest of the country has changed over time. However, the *Let Glasgow Flourish* report also contains longitudinal data for a limited set of indicators. For example, Figure 15 shows that the gap in male mortality rates among men aged 15-74 between the Greater Glasgow Health Board area and all of Scotland has actually increased over the last 30 years. The magnitude of the mortality gap between Greater Glasgow and the rest of Scotland is likely to be even larger than indicated in Figure 15 as the data for all of Scotland includes Greater Glasgow which was the most populous health board area in the country and contributes heavily to the national level figures.

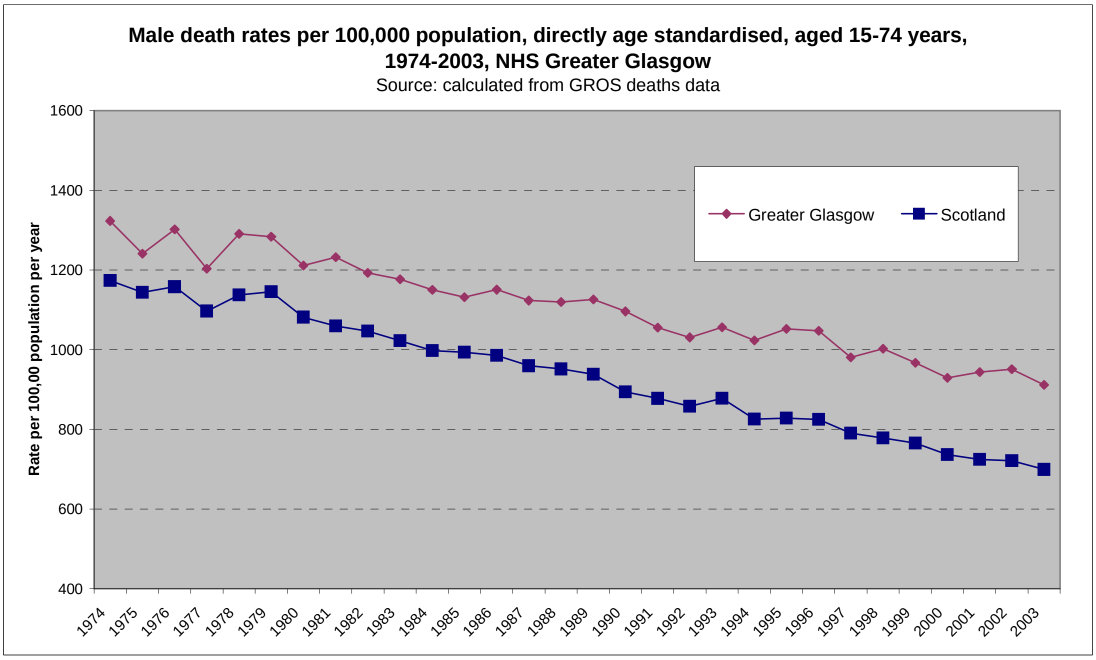


Figure 15: Male death rates per 100,000 population, directly age standardised, aged 15-74, 1974-2003, NHS Greater Glasgow

A similar picture emerged for mortality rates among females in Greater Glasgow aged 15-74, although the magnitude of the gap between Glasgow and the rest of Scotland in absolute terms was smaller than observed for males.

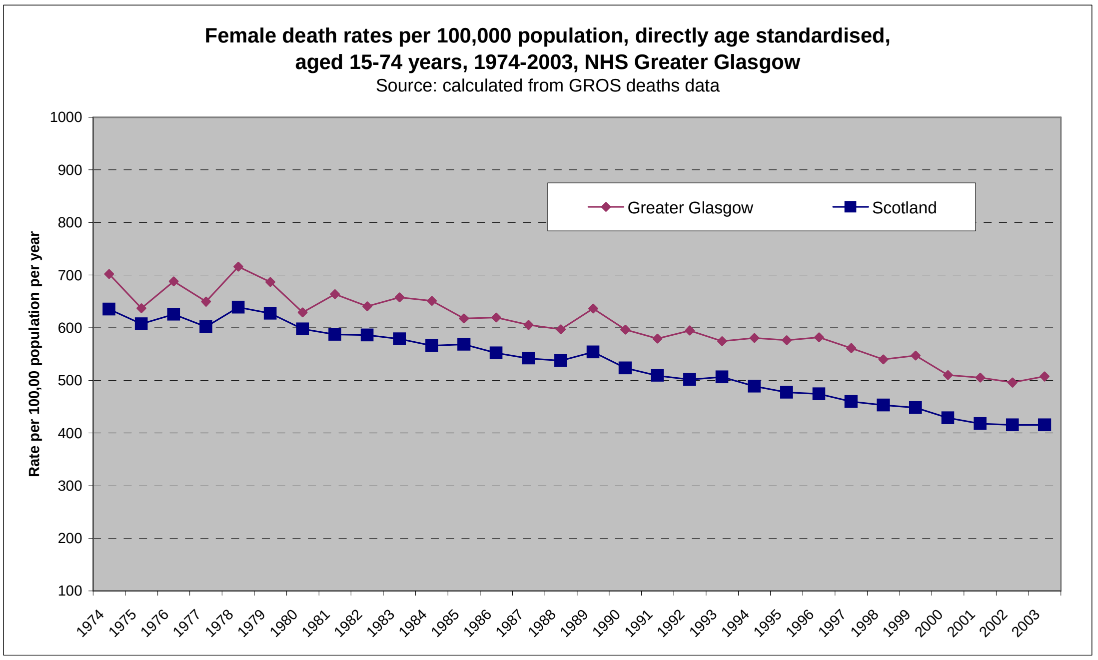


Figure 16: Female death rates per 100,000 population, directly age standardised, aged 15-74 years, 1974-2003, NHS Greater Glasgow

4.4.1.2 Health indicators and determinants in Glasgow and the West of Scotland

I have already described how poorly Scotland fares in comparison with other European countries in terms of alcohol related mortality. It is difficult for researchers to discover the true extent of alcohol misuse across a whole population, therefore proxy measures of alcohol use need to be used. The authors of *Let Glasgow Flourish* were able to collate a wider array of data from several different sources to gain a comprehensive understanding of alcohol related morbidity and mortality within Scotland itself.

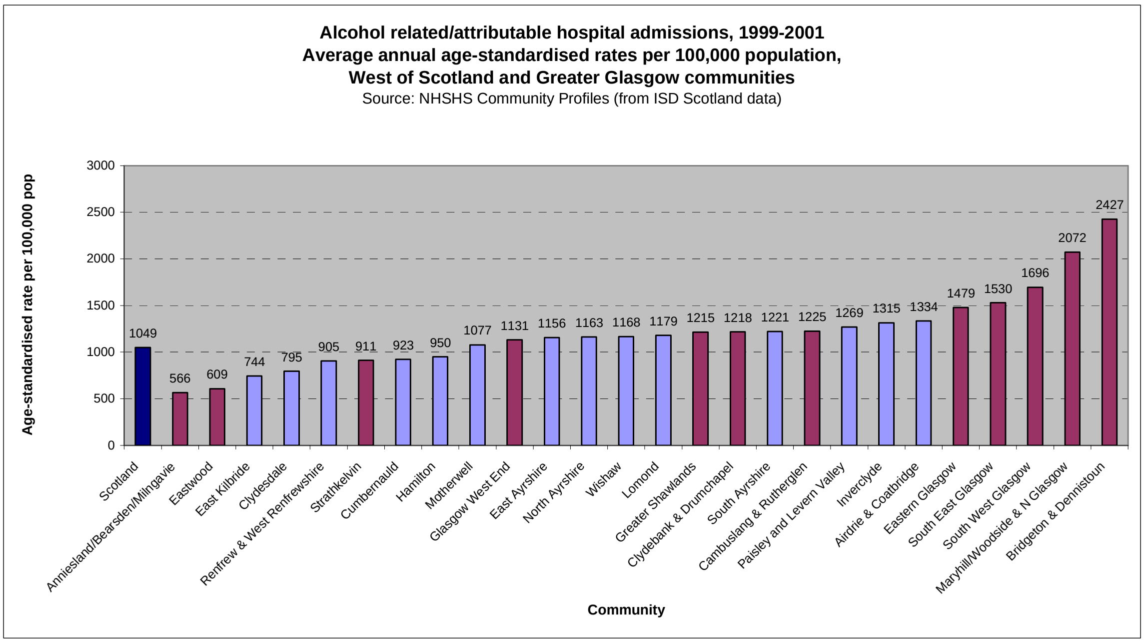


Figure 17: Alcohol related/attributable hospital admissions, 1999-2001. Average annual age standardised rates per 100,000 population, West of Scotland and Greater Glasgow communities

Figure 17 indicates that the majority of communities in the West of Scotland and especially those in Greater Glasgow had alcohol-attributable hospitalisation rates in excess of the Scottish average. In Bridgeton and Dennistoun, the rate was double the national rate and four times what it was in the community with the lowest rate (Anniesland, Bearsden and Milngavie). Figure 28 shows that between 1990/2 and 1999/2001 the alcohol-attributable hospitalisation rate increased in all West of Scotland communities but the rate of increase in many of these communities was greater than the Scottish average.

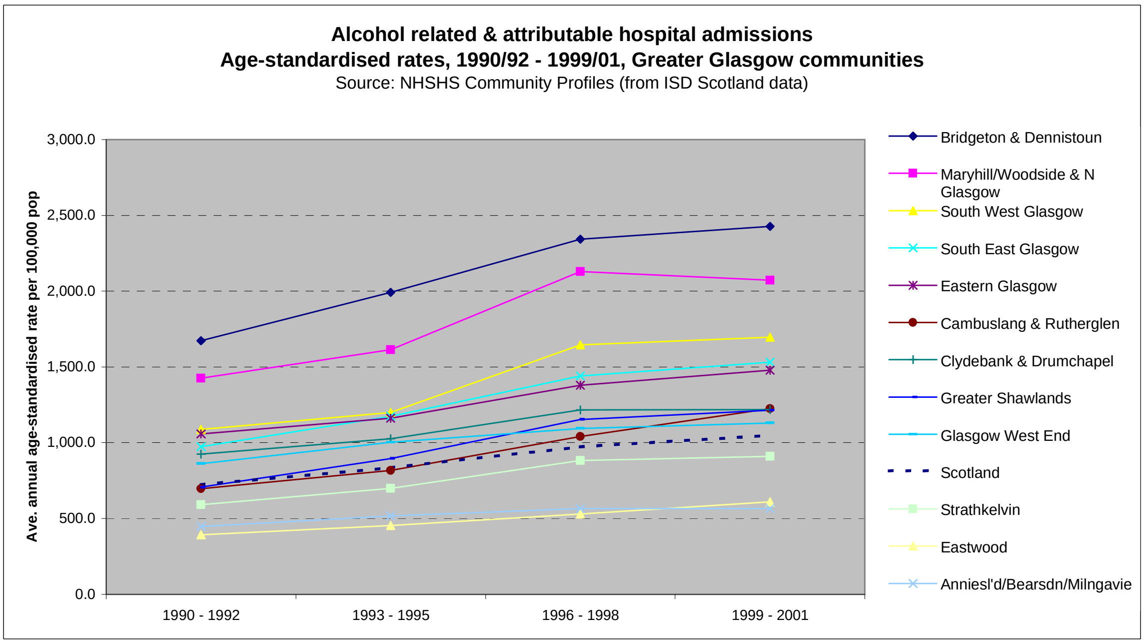


Figure 18: Alcohol related and attributable admissions, longitudinal trends, Greater Glasgow communities.

Smoking rates in Great Britain have declined considerably in the last 30 years[226]. In Scotland smoking rates have also fallen. The percentage of adults smoking was approximately 30% in 1999 but this figure had fallen to 26% by 2002/3. However, the rate in Greater Glasgow was somewhat higher – 35% in 1999 and decreasing to an estimated 33% in 2002/3. Modelled estimates suggest that smoking is far more common in deprived communities and postcode sectors than it is in affluent areas. In Greater Glasgow (and indeed across all of the UK) smoking cessation and activities to reduce exposure to second-hand tobacco smoke remain key targets for health promotion activities[227].

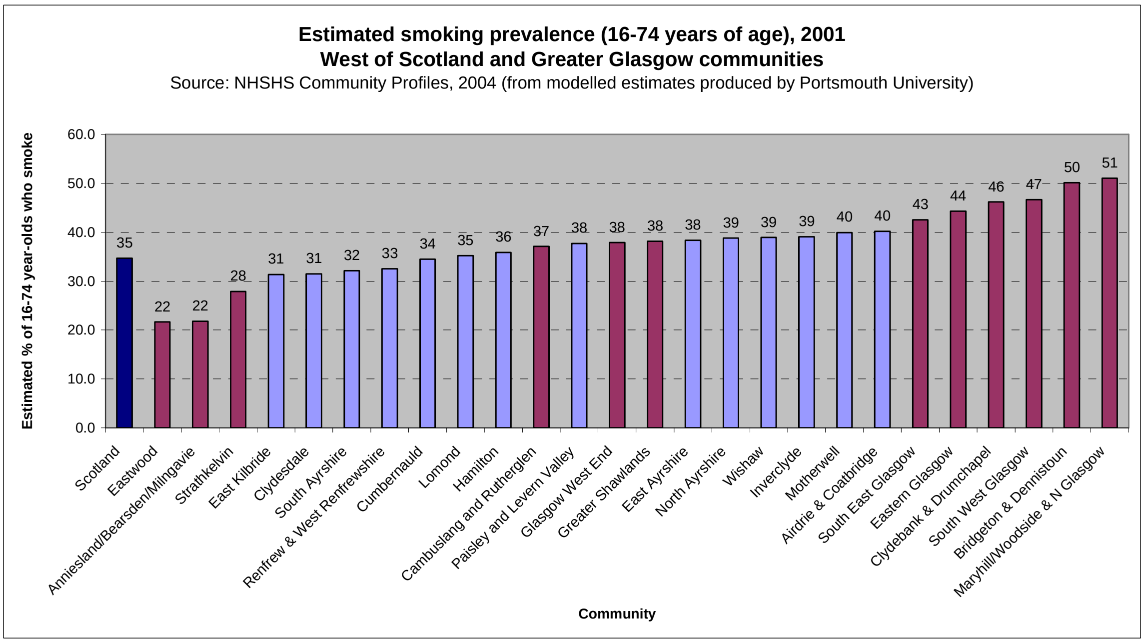


Figure 19: Estimated smoking prevalence (16-74 years of age), 2001. West of Scotland and Greater Glasgow communities

It is notable that the communities with the two highest smoking rates had a prevalence that was more than double what it was in the two communities with the lowest rates. Unsurprisingly, this pattern is repeated, indeed the trend from 'good' to 'bad' is even steeper, when looking at numbers of smoking attributable deaths in the same West of Scotland and Greater Glasgow communities.

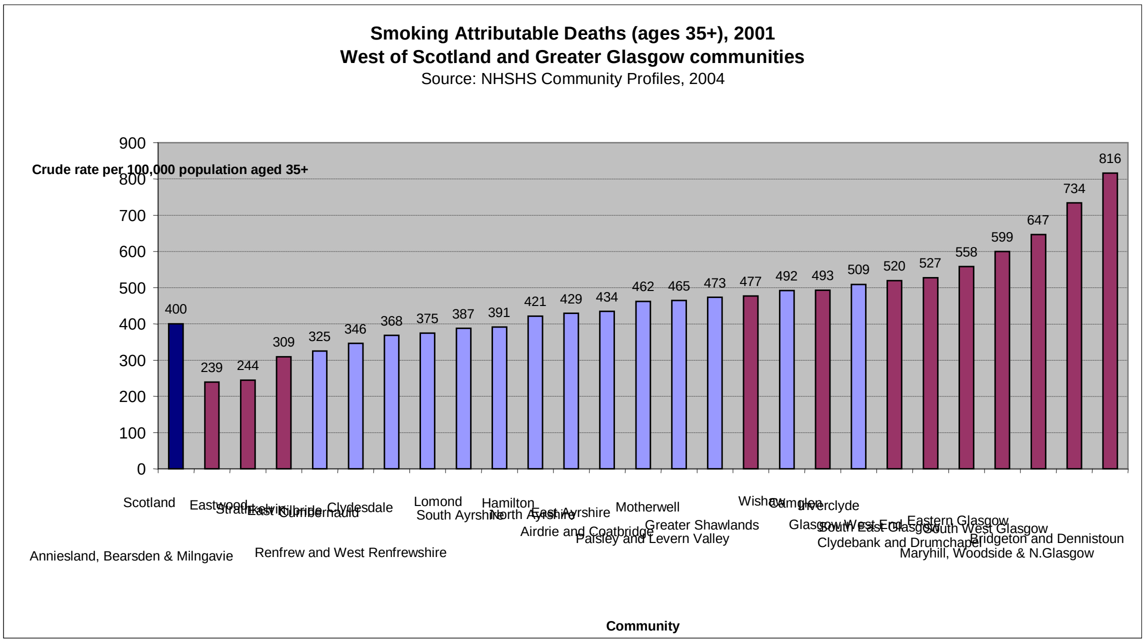


Figure 20: Smoking attributable deaths (ages 35+), 2001

Figure 20 indicates that in Bridgeton and Dennistoun the smoking attributable death rate in 2001 was double the national average and nearly four times the rate in Anniesland, Bearsden and Milngavie. Although smoking rates were estimated to be falling across Scotland (including Greater Glasgow) it is clear that smoking contributes heavily to the overall social and geographic inequality in death rates in the Greater Glasgow region. In addition, the difference in slope between the behaviour (smoking) and the health outcome (smoking attributable deaths) suggests that there is not a straightforward dose-response relationship between smoking and dying from smoking. Factors which might complicate this relationship might be previous smoking status and deprivation. Indeed the relationship between smoking status and mortality has been one of the foci of research on the Renfrew-Paisley cohort[228].

4.5 Explanations for Scotland's poor health

4.5.1 General remarks

The term 'Scottish effect' was first coined in a report published by the Public Health Insitute for Scotland (PHIS) in 2001[229], although the term seems to have been used anecdotally for a longer period of time. The 'Scottish effect' refers to Scotland's apparently inexplicable poor health, particularly as measured by death rates and life expectancy in Scotland (notwithstanding the issue that death is a poor proxy for health) although Hanlon used a much tighter definition in his 2005 paper[6]. Traditionally, Scotland's poor population health with respect to the rest of the UK was attributed to the greater levels of material deprivation in Scotland. However, by the time the PHIS report was published, it was clear that deprivation as it had previously been conceptualised did not explain the mortality gap between Scotland and the rest of the UK. This mortality gap became known as the 'The Scottish Effect' whereby Scottish residents suffered a health penalty, apparently by virtue of their residence in Scotland, above and beyond what might be expected given their social and material circumstances. In the period since the PHINS report was published, a small group of authors has attempted to explain what mechanisms might be in operation to cause the Scottish effect.

4.5.2 Population change

In a paper published in 2004, the geographer Paul Boyle of St Andrews University sought to establish the answers to three questions[230]. Thes were:

1. Is there a mortality gap between rich and poor in Scotland?

2. If so, has the magnitude of this gap changed from 1980-2 to 2000-2?

3. To what extent has change in the magnitude of the mortality gap arisen as a result of population change?

By ‘population change’ Boyle was referring to out-migration from deprived areas. He cited work conducted by Regidor in the Greater Madrid area of Spain where researchers showed that mortality in men was higher in areas where the population had diminished than in areas where the population had grown[231]. Historically, Scotland has experienced high levels of out-migration and until recently, had net levels of out-migration[232]. Therefore, it seemed feasible that migration and other mechanisms of demographic change might contribute to the observed excess mortality in Scotland. Boyle’s study controlled for deprivation and wealth indicators and led the investigators to the conclusion that population change could play a significant part in contributing to a growing rich-poor mortality gap.

In his study, Boyle analysed death rates in Scottish Postcode sectors that were classified into 5 quintiles according to their Carstairs deprivation score. In each of these quintiles, postcode sectors were further classified into one of three groups according to whether the local population grew, remained stable or shrank between the 1981 and 2001 censuses. Boyle confirmed that the mortality gap between rich and poor areas in Scotland grew between the 1981 census and the 2001 census: the difference in SMR between the quintile 1 areas (most affluent) and quintile 5 areas (most deprived) was larger in 2001 than it was in 1981. However, Boyle was unable to identify any relationship between population change and inequalities in mortality. Boyle concluded that the mortality gap in Scotland widened most in places that experienced population decline in the last two decades, but this gap was not significantly more than in places where the population remained stable during the period.

Boyle's findings somewhat contradict Davey Smith's 1998 suggestion that areas experiencing population decline had the highest mortality rates[233]. However, Boyle and colleagues confirmed their finding in a more recent paper[234] where they concluded that although net out-migration of healthy individuals from areas that have higher mortality exacerbates the poor health outcomes of that area, the effect is minor compared with the health consequences of pre-exisiting material and social deprivation.

4.5.3 Irish Immigration

Immigration to Britain's cities from rural regions fuelled much of the urban population growth during the years of the industrial revolution[142]. Immigrants from Ireland (which did not become independent from the United Kingdom until 1922) formed a large component of the labour force in several UK cities. Irish immigrants faced discrimination because of their language and religion and were likely to live in the most overcrowded slums and be employed in the least well-paid, most physically dangerous jobs. These immigrants, unsurprisingly, had higher mortality rates than other residents of the UK mainland and, also higher rates than in Ireland itself (except during the years of famine in the 19th Century). It has been suggested that their lowly position in Victorian society has been transmitted through subsequent generations of their offspring.

Researchers in Glasgow have published a series of papers examining morbidity and mortality among men of Irish Catholic descent in the West of Scotland[235-238]. Using data from two longitudinal cohort studies (The Midspan cohort and the Twenty -07 cohort) the researchers identified men of Irish Catholic descent by analysing their surnames. Catholics form a substantial portion of the West of Scotland population – 30%. Williams asserts that the vast majority of these are of Irish descent[238] although since his paper was published there has been an influx of Catholic migrants from Poland and other parts of Eastern Europe. Nevertheless, the researchers found that after controlling for established risk factors when examing all cause and cardiovascular disease mortality rates in the

West of Scotland, there remained an unexplained excess of premature mortality among men of Irish descent[235].

4.6 Concluding points

There now exists a substantial body of literature that highlights Scotland's unfavourable position in health terms compared to the other constituent countries of the United Kingdom and the rest of Europe. Most writers identify material deprivation as playing a key role in contributing to the health gap between Scotland and elsewhere, although other mechanisms, themselves influenced by deprivation, have been proposed as reasons for this gap. The most recent work undertaken by the Glasgow Centre for Population Health shows that the health gap between the unhealthiest region of Scotland (Glasgow and the West) is not confined to all-cause mortality but is apparent across several forms of mortality and morbidity. In addition, health inequalities exist across the board between Glasgow's poorest areas and the rest of the Greater Glasgow area.

5 Research questions

Following on from the literature presented in the previous chapter, there are a number of items that need to be resolved in order to explore the possible existence of a “Glasgow effect”.

First, there is the issue of comparing Glasgow with other cities and the need to ensure that like is compared with like. Therefore, a process of choosing cities similar to Glasgow needs to take place.

In addition, the question of how much excess mortality there is in Glasgow (if any) needs to be settled. It is unclear if poor population health is apparent in all large cities and if Glasgow is alone in having excess mortality compared to the rest of the UK population and if the excess mortality in Glasgow has been apparent throughout recent history.

Second, the issues of excess mortality and deprivation need to be untangled. As it has been defined, a Glasgow effect can only be confirmed if it continues to be apparent after adjustment for deprivation status.

Related to this, the nature of any residue of excess mortality in Glasgow (or any other city) would require detailed investigation in terms of the age and sex groupings who contribute to its presence and also to how the magnitude of the residue has changed over time.

Finally, if excess mortality in Glasgow is confirmed then its relationship with different definitions of ‘Glasgow’ would need to be investigated. Similarly, if a residue of excess mortality remained after adjusting for deprivation, could the measure of deprivation influence the size of the effect?

Thus, the following research questions will be investigated.

1. What is meant by excess mortality and what is the size and nature of Glasgow’s excess mortality when compared with comparable cities in the UK?

2. How much of this excess mortality (as defined by the previous question) can be attributed to deprivation as measured by the Carstairs index of deprivation?

3. What is the size and nature of any residue i.e. any excess mortality that is not explained by deprivation (as measured by the Carstairs Index of Deprivation)?

4. What do different definitions of geography and deprivation have on the size of this residue?

6 Concepts and defintions

6.1 The Census

The United Kingdom has taken a census of its population every 10 years since 1801, with the exception of 1941, because of World War II. The most recent census was conducted in 2001. Completion of the census form was compulsory, with non-completion being punishable by a £1000 fine. The census is a survey of every individual in the population and is unique within the United Kingdom because every individual is asked the same set of questions on the same day. Respondents are asked to answer questions on a diverse set of topics ranging from the age and number of people living within the residence to the health status, educational qualifications and economic activity of those in the home along with questions about the residence's type, tenure and size.

The information the census provides allows central and local government, health authorities and many other organisations to target their resources more effectively and to plan housing, education, health, transport and other services.

In England and Wales, the census is planned and carried out by the Office for National Statistics. Elsewhere in the UK, responsibility lies with the General Register Office for Scotland and the Northern Ireland Statistics and Research Agency.

6.1.1 Census Geography: 1981 and 1991

The constituent countries of the United Kingdom all had a slightly different approach to gathering and synthesising census data. For both 1981 and 1991, individual forms sent to households in England, Wales and Northern Ireland were coded according to the Enumeration District in which the household was located. Enumeration Districts contained, on average, 200 households, and were the lowest level of geography for which area statistics were made available[239]. The equivalent small areas in Scotland were Output Areas, which contained approximately 50 households. In the four countries, data at all other levels of

Geography were compiled by aggregating data from Enumeration Districts or Output Areas.

In England and Wales, data were available at the following levels of geography:

Enumeration District – explained above

Ward – Data built up from several Enumaration Districts. Wards contained an average of 2000 homes and were also part of UK electoral geography.

District – The third level of census geography in England, Wales, Northern Ireland and also Scotland. Districts were made up of several wards, although their boundaries changed from time to time such that certain Enumeration Districts and occasionally wards were reassigned to different neighbouring districts. Districts were replaced in time for the 2001 census by a new local government geography (which will be discussed shortly).

County – The highest level of geography at which census data were made available. Counties were comprised of several districts and their borders generally reflected historically recognised areas e.g. Wiltshire, Devon and so on.

In Scotland, the hierarchy of geography was similar, although the titles varied slightly:

Output Area – explained above

Pseudo postcode sector – These contained an average of about 2000 households in 1991. Pseudo postcode sectors were, in most cases, identical to postcode sectors apart from where local authority boundaries cut across a postcode sector, in which case there were two identically named Pseudo postcode sectors with the title (for example) G61 1(part). Unlike the equivalent geography in England, Wales and Northern Ireland, pseudo postcode sectors did not correspond with electoral geography.

Local Authority District – analagous to districts in the other UK constituent countries.

Region – regions were comprised of several districts. Local government was reorganised in 1994, and the two tier system of government in Scotland was replaced with Unitary Authorites[240].

Data from the 1981 and 1991 censuses used in this thesis were made available at the ward and pseudo postcode sector level. There were approximately 10,500 of these small areas and they all were all assigned a unique, alphanumeric identifier. These identifiers were coded on a hierarchical basis according to levels of geography previously described.

Table 2: 1991 Census coding for areas in England, Wales and Northern Ireland

Level	Total number of areas	Typical number of households	Zone code	Example code	Example area name
County	55	400,000	2 numbers	03	Greater Manchester
District	403	50,000	2 letters	03BN	Manchester District
Ward	9,930	2,000	2 letters	03BNFA	Ardwick Ward
Enumeration District	113,465	200	2 numbers	03BNFA01	n/a

Table 3: 1991 Census coding for areas in Scotland

Level	Total number of areas	Typical number of households	Zone code	Example code	Example area name
Region	12	150,000	2 numbers	57	Central Region
Local Authority District	56	35,000	2 numbers	5705	Clackmannan District
Pseudo postcode sector	1,003	2,000	2 letters	5705AC	Postcode sector “FK1 01”
Output Area	38,254	50	2 numbers (or 2 numbers plus 1 letter)	5705AC10A	n/a

6.1.2 Census geography, 2001

Results for the 2001 census were available for a wider range of areas than before. The main types of administrative area recognised by Census output are: local government; health areas; Parliamentary constituencies; urban areas; parishes (parishes are known as 'communities' in Wales); and postcode sectors. The boundaries of these different types of area are inconsistent with one another and subject to change, which gives a complex map of overlapping geographies. A summary diagram of the relationships between the various geographies for which data is available is in Figure 21.

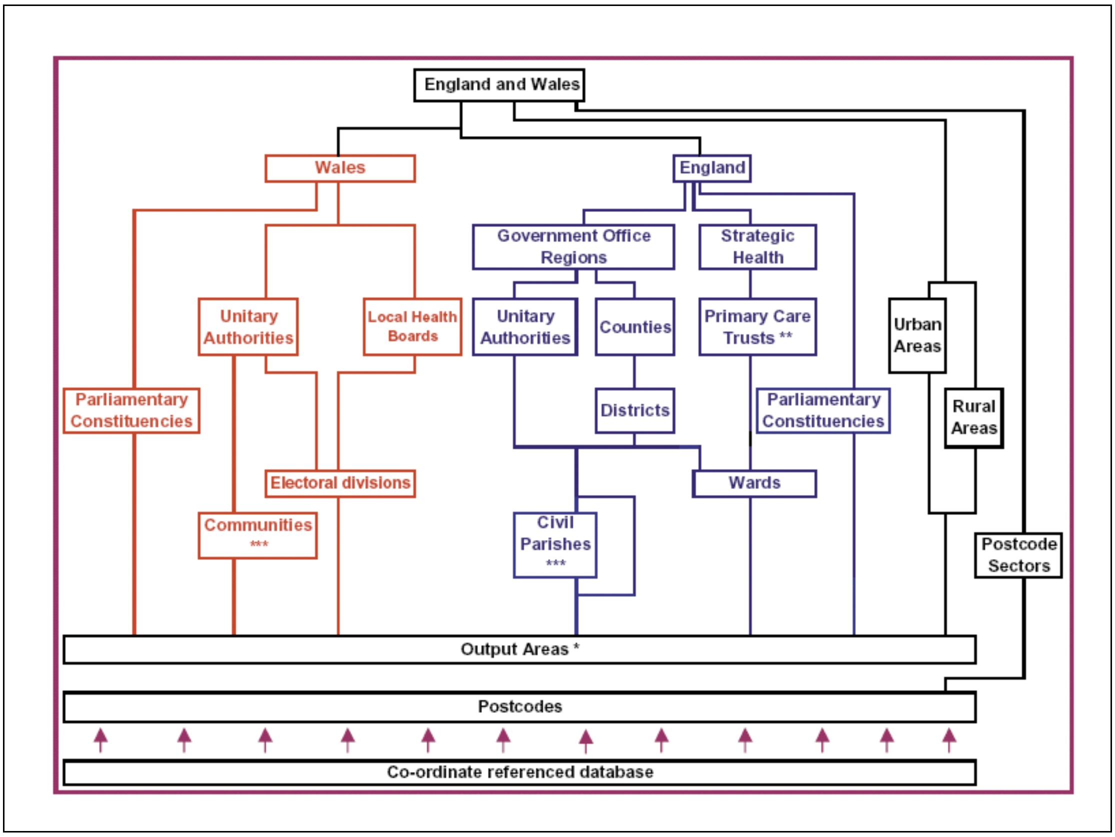


Figure 21: Summary of Census output geography for England and Wales, 2001 Source:www.statistics.gov.uk/census2001

Population and mortality data were available at the Ward level of geography. From the diagram above, it can be seen that information from Wards in England could be aggregated to form data for Unitary Authorities, Districts and Counties, or Primary Care Trust Areas. In 2001, Enumeration Districts had been replaced as the basic level of census geography in England and Wales by Output Areas. In Wales, Wards were given the title Electoral Divisions, although most official publications do not use this term and, instead, use phrases such as 'Electoral Wards in England and Wales'[241]. A similar nomenclature shall be used in thesis when making reference to Electoral Wards in England and Electoral divisions in Wales.

Census geography in Scotland differed slightly from England and Wales. The relationship between the various geographies at which census data were made available is shown in Figure 22 below.

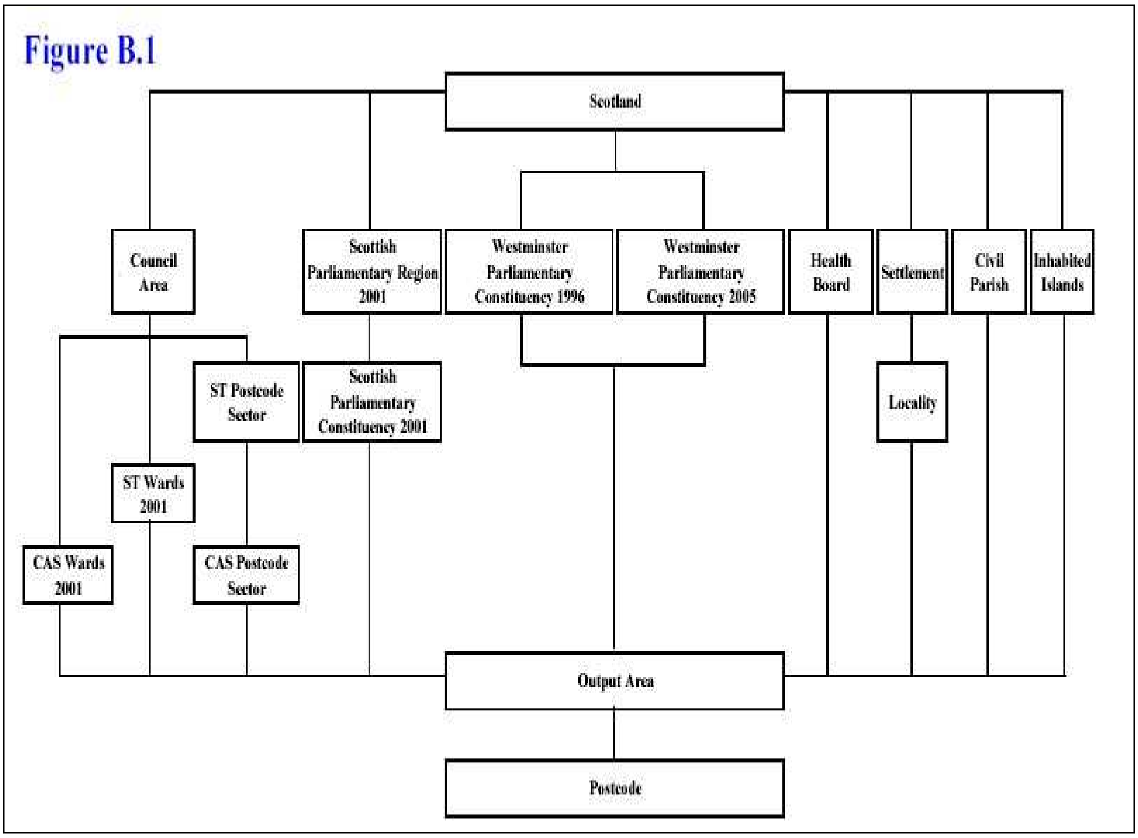


Figure 22: Summary of census output geography available for Scotland, 2001
Source:General Register Office for Scotland[242]

All census geography in Scotland was based on the set of postcodes and their boundaries, which were frozen in January 2001. Any postcode collected in enumeration that does not belong to this set was replaced during processing by the most appropriate frozen postcode.

Counts of the number of households with residents and the number of residents in each postcode were generated during processing. These headcounts were used to create Output Areas. The body responsible for carrying out the Census in Scotland (The General Register Office for Scotland or GRO(S)), attempted to ensure that 2001 Output Areas were continuous with output areas from the 1991 census, although this was not always possible due to development of new residential areas and the demolition of others.

Data from the 2001 census were provided at the postcode sector level. Postcode sectors are the set of unit postcodes that are the same apart from the last two characters. For example, the unit postcodes G12 8RX and G12 8DY both lie within the postcode sector G12 8. It can be seen that there are two types of postcode sector:

CensusArea Statistics (CAS) postcode sectors. These are equivalent to pseudo postcode sectors used in the 1981 and 1991 censuses i.e they are coterminous with postcode sectors except where postcode sectors cross local authority boundaries, in which case two identically named CAS postcode sectors were assigned to neighbouring local authorities. CAS postcode sector names that include ‘part’ indicate that the original sector had to be split.

Standard Table (ST) Sectors. ST Postcode Sector is the CAS Postcode Sector merged where necessary so as to satisfy the confidentiality thresholds for Standard Tables. Standard Tables are tables, made available by the Office of National Statistics and GRO(S), of the most frequently requested census data. Certain postcode sectors contain such small populations that confidentiality issues arise if data on a particular subject are released. To address this problem, those CAS sectors with the smallest resident populations are aggregated with neighbouring sectors until an arbitrary threshold of population is reached (either 400 households or 1000 persons). The combined sectors are entitled Standard Table Sectors.

CAS Sectors have a similar coding system to English and Welsh wards. Each of these small areas was given a unique, six-digit alphanumeric identifier. As was the case with 1981 and 1991 data, idenfication numbers were coded on a hierarchical basis as shown in Table 4.

Table 4: 2001 Census coding system for areas in England and Wales, 2001

Level	Total number of areas	Typical number of households	Zone code	Example code	Example area name
County/Unitary Authority	103	200,000	Two numbers	12	Cambridgeshire
District	403	50000	Two letters	12UB	Cambridge District
Electoral Ward/ Electoral Division	9930	2000	2 letters	12UBGA	Petersfield Ward
Output Area	175,434	100	4 Numbers	12UBGA0001	Output Area: Gwydir Street (north of junction with Hooper St)

In Scotland there was no hierarchical coding system for census data; CAS Sectors were given the same codes as their equivalent postcode sectors. Instead, CAS Sector data were provided in conjunction with a second numeric variable that coded for the Unitary Council Area in which the CAS Sectors were located. Thus, it was possible to distinguish between two identically named CAS Sectors (e.g. G61 1 part) which were in two neighbouring council areas.

6.2 The Carstairs Index of Deprivation

Vera Carstairs and Russell Morris published a paper in the British Medical Journal in 1989 entitled Deprivation: Explaining differences in mortality between Scotland and England and Wales[132]. In this paper the authors introduced an area based measure of deprivation, compiled from four census variables, with the explicit aim of explaining the gradient in mortality that they observed between Scotland and England&Wales in the period 1980-1982. When this paper was published, social class was most commonly used as the variable by which geographic variabilities in health outcome might be explained. Carstairs and Morris asserted that their measure of deprivation was a more sensitive measure of socioeconomic circumstance than social class alone and was therefore more able to account for the excess mortality in Scotland in 1980-2.

Carstairs and Morris used four variables from the census. These were as follows:

Overcrowding: Persons in private households living at a density of >1 person per room as a proportion of all persons in private households

Male unemployment: Proportion of economically active males who are seeking work

Low social class: Proportion of all persons in private households with head of household in social class 4 or 5

No car: Proportion of all persons in private households with no car.

Carstairs and Morris were able to write more extensively on their methods in a book published in 1991[113]. In this book, they described how they settled on the four variables listed above in preference to other census variables. The authors deliberately sought those variables that would have the greatest impact on health outcome. As such, the Carstairs score was not intended to be a picture of overall deprivation (as is the case with the later-published indices of multiple deprivation in Scotland and England) but was an explicit attempt to find census variables that were associated with geographic variations in health outcome.

Carstairs and Morris used the z-score method to compile deprivation scores for all areas of the UK. Z-score standardisation is a commonly used method when dealing with continuous data and has the effect of transforming the original distribution of scores to a distribution in which the mean becomes zero and the standard deviation becomes 1. A z-score quantifies the original variable score in terms of the number of standard deviations that this score is from the mean of the distribution.

Thus:

$z = (x - \mu)/\delta$

where

x = original variable score (e.g. Proportion of economically active males are seeking work)

μ = mean of original variable scores

δ = standard deviation of original variable scores

Provided the original data follow the normal distribution, the new z-score distribution will always have a mean value of 0 and a standard deviation of 1.

The Carstairs score is an unweighted sum of the z-scores of the four variables listed above. As a result, the overall Carstairs score does not have a mean of 0 and standard deviation of 1. A particular area's Carstairs score might be compiled as follows:

Overcrowding: z-score = -3.16

No car: z-score = 0.98

Social class: z-score = -1.12

Unemployment: z-score = 0.40

Overall Carstairs score = (-3.16 + 0.98 + -1.12 + 0.40) = -2.90

A high Carstairs score indicated that a particular area was deprived and a low Carstairs score (well below zero) indicated a more affluent area

7 Methods

In this chapter I will present the methods I used to answer each of the four research questions presented in the previous chapter. There is some overlap between the research questions and some of the methods used to answer one research question were also used to answer another. I have stated where this was the case and put in cross references to where the method was described in full.

7.1 What is meant by excess mortality and what is the size and nature of Glasgow's excess mortality when compared with comparable cities in the UK?

This first research question has two distinct parts. The initial section will describe my 'problem solving' approach to defining cities and suitable comparison areas to Glasgow. As such, it reads partially like a narrative description (and contains some results) but this is a necessary approach to inform the reader of the steps involved. First, there was the issue of 'comparable cities'. Three approaches to this issue are described: selecting cities on the basis of population size, selecting cities on the basis of their social and economic history and, finally, selecting cities on the basis of their deprivation profile. While investigating cities, the fact that certain cities (including Glasgow) are part of conurbations had to be addressed. Therefore, a similar approach to selecting conurbations was adopted. The second part of the research question concerns the issue of Glasgow's excess mortality: this was addressed with the method of indirect standardisation of death rates to produce standardised mortality ratios (SMRs). The SMR in Glasgow was calculated and compared with the SMRs of the chosen comparator cities.

7.1.1 Comparable Cities

The fundamental issue being addressed is whether Glasgow has poorer health than other 'similar' cities in the UK. To answer this question it is vital that like is compared with like. Therefore, great care was taken to define the concept of a city and ensure that similar decisions about city boundaries were used for Glasgow and all comparator cities. The first task was to define what a city is and to decide which cities in the UK were sufficiently similar to Glasgow to merit comparison. The two parameters chosen to select similar cities were population size and social history. Glasgow itself needed a precise definition. The boundary of this city has been expanded and contracted over the course of the city's history and, at the outset, it seemed conceivable that Glasgow's poor health record might partially be artefactual: a result of data from 'healthy' areas in the city's suburbs being excluded from the city's health indicators. It was, therefore, of interest to test this supposition about Glasgow's health record and to see if the same phenomenon existed for other UK cities with poor population health.

After exploring options, cities were defined on the basis of local authority boundaries in this thesis. The reasons for this choice are set out below. As Cheshire[243] has pointed out, cities vary significantly in their scope and scale and these differences are, in part, due to their boundaries. He describes 'under-bounding', where the administrative area of a city does not correspond with its real economic reach or influence while other cities are 'over-bounded' and incorporate large areas of rural or semi-rural land along with the urban area. British cities generally have high levels of deprivation in inner city areas and wealthier suburbs on the periphery. Tightly drawn boundaries can exclude wealthier areas. Therefore, to ensure true comparability when evaluating the performance of cities, city boundaries would need to be standardised, ideally on a basis that reflected the functional reach of the urban area rather than administrative boundaries. However, data are not readily available for boundaries defined in this way (although two reports have recently been published by the Scottish Executive examining the extent of functional boundaries for the largest cities in Scotland[206;244]) so data in this thesis will be presented in terms of standard geographies based on administrative units. Although this was a pragmatic decision, there are three advantages to this approach. First, this is the level of political accountability. Second, this is the level at which many services are delivered (although, importantly, Health Board Areas in Scotland do not match standard administrative boundaries). Finally, and most importantly, this is the spatial level at which secondary data is usually made available. This final point is the decisive argument. The issue of over-bounding and under-bounding remains important and is discussed in detail later.

As was outlined in the Concepts and Definitions section, population and mortality data were made available at the level of Census standard wards (in England and Wales) and postcode sectors (in Scotland). Census standard wards and postcode sectors are coded in the UK Census by the local government authority area in which they are located. The most sizeable cities are large enough entities to merit being local authority areas in their own right rather than being part of a larger county or region. A coding key was obtained from the Office of National Statistics website detailing which six-digit alphanumeric codes corresponded with which local authority areas. The population of individual cities was then calculated on the basis of the population of the wards or postcode sectors within the boundary of the local authority. This process was carried out on data from the three relevant censuses (1981, 1991 and 2001).

Local Government was reorganised in the UK in 1993. In Scotland, there had been a two-tier system dating back to the mid 1970's. There were nine large regional councils (Highland, Strathclyde, Central, Lothian, Tayside, Fife, Grampian, Borders and Dumfries and Galloway). These contained several smaller Districts and local voters elected both district councillors and regional councillors. The two tiers of government had distinct responsibilities. Regional Councils oversaw policy areas such as education, policing and social work while Districts looked after matters like refuse collection, local roads and lighting. Health care in Scotland was controlled by local health boards that had different administrative boundaries to both the Regional Councils and the local Districts. The two-tier system of local government in Scotland was replaced by a single-tier system with 27 Unitary Authorities in 1993, although health care was still administrated by independent health boards and certain other services such as policing and fire fighting continued to be organised within the old Regional Council boundaries. In England, there was a patchwork of Counties which were administered as Unitary Authorities. Most Unitary Counties had a significant rural element and did not have a large regional city. Typical examples included Wiltshire and Devon. There were also a few Metropolitan Counties such as Merseyside and Greater Manchester. These all included a large urban population and were administered in two tiers much like the Regional Councils in Scotland where certain services were controlled at County level and certain other services were controlled by the Boroughs that were nested within each Metropolitan County. This system was replaced with nationwide Unitary Authorities, although several of the new authorities had identical names and boundaries to pre-existing Counties or Metropolitan Boroughs.

In this thesis, Glasgow City was used as the basis for comparison with other cities and urban centres. The entity ‘Glasgow City’ slightly changed in definition over the time period studied. The first definition refers to data from the 1981 and 1991 censuses. During this period, Glasgow City was a district within Strathclyde Regional Council. Data from postcode sectors within this district were used. In 1994, local government reorganisation led to the Glasgow City district of Strathclyde Regional Council being replaced by the Glasgow City Council unitary authority[245]. The new unitary authority had a boundary that enclosed a slightly smaller area than the previous district, with the Fernhill and Rutherglen electoral ward excluded from the new Glasgow City unitary authority. This ward was assigned to the neighbouring unitary authority of South Lanarkshire (Rutherglen had historically been part of the county of Lanarkshire prior to the inception of Strathclyde Region in 1974). This change, along with a few other, minor changes led to Glasgow losing some 35,000 of its population between the 1991 and 2001 census (in addition to the ‘natural’ population loss that also occurred in the city during this period). For mortality rate calculations, this population loss makes little difference (as mortality rates in Rutherglen are not much lower than those within Glasgow) but when comparing the trends in population demographics among major UK regional cities, these boundary changes need to borne in mind. To address this issue, when making comparisons of population change across time, population data from the postcode sectors that correspond with the old Rutherglen and Fernhill ward was included along with Glasgow City data. In short, efforts were made to maintain a constant geography over time.

Two approaches for selecting cities for comparison with Glasgow were used. The primary method was to identify cities with similarly sized populations to Glasgow. A description of this method appears below. The second method was based on identifying those cities that had similar social and economic histories to Glasgow. This allowed for comparison between Glasgow and those cities and large towns that might not have a sufficiently large population to qualify for comparison based on the first method. In addition, it added important contextual information to the first method since it indicated which of the similarly sized cities to Glasgow had a similar social history and reputation for poor population health.

7.1.1.1 Selection of cities by population size

Cities were assigned to one of two categories based on a definition provided by a report for the Office of the Deputy Prime Minister[246] (ODPM), although the responsibilities of this Governmental Office were subsumed into the Home Office and the Ministry for Transport in 2005. In that report, large cities were defined as those settlements with a population of more than 275,000 while medium-sized cities were those with populations larger than 125,000 but less than 275,000. In this thesis, cities were defined on the basis of administrative boundaries, however, the ODPM report had an alternative definition for city boundaries, using the term ‘Primary Urban Areas’ (PUAs). These PUAs are not coterminous with local authority boundaries – they are larger and reflect the functional boundaries of cities rather than their administrative boundaries. These are areas of at least 20 hectares with an associated population of at least 1,000 people and a continuous built-up area of land that contains urban structures that are within 50 metres of each other. PUAs provide more realistic definitions of cities than administrative boundaries but they were not used to define cities in this thesis for three reasons. First, it is apparent that a highly labour intensive method was taken to define these areas. It is probable that there exists a more pragmatic method of defining cities. Second, population and mortality data released from NHS Scotland’s Information Services Division (ISD) were available at the postcode sector and ward level of Geography and not at the datazone level. Third, the ODPM had jurisdiction over England and Wales only, with urban development policy in Scotland being a matter devolved to the Scottish Executive. Even though the Executive has published *A Review of Scotland’s Cities – The Analysis*[206], which has a similar focus to the ODPM report, no attempt is made to objectively quantify what settlements are cities in Scotland. Instead, the Scottish Executive’s report simply lists the 6 most populous settlements in Scotland (Glasgow, Edinburgh, Aberdeen, Dundee, Inverness and Stirling, in that order) and does not state why the next most populous settlement, Paisley, was excluded. Even though legislatures on both sides of the border have produced publications that explore the functional boundaries of cities, there exists no single definition of functional city limits that can be applied with ease to urban settlements in both Scotland and England. With these issues in mind, cities were defined on the basis of their administrative boundaries and even though PUA boundaries were not used, the 125,000 and 275,000 population cut offs were considered to be useful and workable definitions of medium and large sized cities for the purposes of this thesis.

Trends in population change in large cities were examined. Changes in population were cross referenced against boundary changes to identify if population gain or loss over time was due to ‘natural’ gain or wastage (through mechanisms such as in-migration and out-migration) or if districts that had previously been part of a particular city were now assigned to a neighbouring local authority and vice versa.

For the purposes of this thesis, only large cities (those with a population greater than 275,000 in 2001) were selected for comparison with Glasgow in later analysis. Despite some cities increasing in population and some cities losing population between 1981 and 2001, only the city of Leicester in the East Midlands changed category between 1981 and 2001. In 1981, its population was around 280,000. In 1991, the population was 230,000 but by 2001, Leicester’s population had returned to 280,000. This curious pattern of population change was simply the result of local government reorganisation with certain wards being excluded from and then reclassified within the city boundary.

London was excluded from these analyses as it is both quantitatively (its population is an order of magnitude larger than the next most populous city, Birmingham) and qualitatively different to regional cities such as Glasgow. London is such a large and socially diverse city that it is difficult to make meaningful comparisons of social and health outcomes between it and the smaller UK cities. There are, of course, substantial portions of its population that suffer from the same sorts of social ills and population health outcomes as do other areas of the UK[247] but these problems are invariably masked by the very affluent and successful areas also within the Greater London boundary. Many single boroughs of Greater London have similarly-sized populations to regional cities; for example, according to 2005 figures, the London borough of Croydon had a population of 342,000[248] and there are several other London boroughs with a resident population in excess of 275,000. Deciding which of these boroughs might merit comparison with other cities presented a problematic but unnecessary challenge as the published literature recognises that the issues affecting regional cities are substantially different from those in operation in so called *Global cities* such as London, New York, Paris and Tokyo[151;249-251].

A list of large cities in the UK that were compared with Glasgow, with their total populations appears in Table 5 overleaf:

Table 5: Population of large UK Cities at 2001 Census (Newcastle was included in all comparative analyses because of its similar social history to Glasgow)

City	**Population at 2001 Census**
Birmingham	977,063
Leeds	715,421
Glasgow	577,869
Sheffield	513,242
Bradford	467,649
Edinburgh	448,624
Liverpool	439,444
Manchester	392,827
Bristol	380,641
Coventry	300,851
Sunderland	280,773
Leicester	279,887
Newcastle upon Tyne	*242,388*

7.1.1.2 Selection of cities – social history

In the context of this research, the work of Professor Tom Devine was influential[209]. He has argued that Scotland experienced industrialisation and deindustrialisation on a greater scale and at a greater rate than any other region of the then industrialised world. Devine's insights are augmented by the published work of Professor Ray Hudson of Durham University[252-254]. Hudson has asserted that the rapid rate of deindustrialisation in North East England has contributed to a broad range of social ills in the region, including higher rates of repartnering, falling birth rates, an increase in the number of households with a lone parent and dependent children and higher rates of crime and anti-social behaviours in certain areas. He suggests that the relatively sudden, wholescale loss of traditional employment types, particularly for working class men, has, to a large extent, created social ills far beyond the immediate material impact of loss of industry.

Devine's thesis is that a similar phenomenon happened in Scotland and particularly West Central Scotland. The relatively sudden deindustrialisation of this region had its roots in the rate at which the industrial revolution took hold. Glasgow in particular became more heavily industrialised than any other city in the UK with a large proportion of its population employed in heavy industries such as shipbuilding, steelmaking and locomotive manufacture[153;176]. While many cities became at least partially dependent on similar industries, they had more diverse economies. With the rise of heavy industries in other nations such as Germany and Japan, heavy industry in the UK started to decline after the World War One, and the proportion of the working population of many cities employed in this sector began to fall. While this brought about some social upheaval (as described by Hudson) many local economies were sufficiently diverse to absorb the decline of one sector. In Glasgow, however, heavy industry still dominated the local economy. As late as 1960, 15% of the world's shipping was still built on the Clyde[209(page3)]. Devine suggests that not only was Glasgow more reliant on heavy industries than other UK cities but it also continued relying on them at a time when the other cities had diversified their economies into other areas. Thus, when the perhaps inevitable decline of heavy industry occurred in Glasgow and the West of Scotland, it happened at a rate unmatched in any other region of the UK and perhaps Western Europe. There was no gradual transition from one type of economy to the other, as happened in places such as the West Midlands and London, and that the social changes brought about by this rapid transformation left (in his words) 'the nation's collective psyche with a scar'.

To summarise Devine's arguments, it can be said that Scotland (and particularly the West of Scotland and Glasgow) had a greater 'dose' of industrialisation and in-migration than many other regions. This was associated with high levels of social and health problems. Subsequently, Glasgow and the West of Scotland had a high 'dose' of deindustrialisation during the 1980's. This second dose, in his eyes, is to blame for many of the social and behavioural patterns that have in turn contributed to the continuing population health problems within the region. While the area's economy may have recovered and diversified to become more modern, dynamic and flexible, the local population still bears the scars of the previous social upheaval.

Out of the theses espoused by Hudson and Devine, a second method of selecting cities for comparison with Glasgow in terms of their recent social history suggested itself. A number of authors indicated that many of the large cities already selected on account of their population were also worthy of comparison with Glasgow because of their history of heavy industry, deindustrialisation, population loss and recent large-scale regeneration of their urban fabric[148;153;182;208]. Manchester and Liverpool stood out as having very similar histories to Glasgow and these cities also have the reputation for poor population health[247]

In 2001, the city of Newcastle upon Tyne had a population of 240,000. This was not sufficient for it to qualify as a large city according to the definition described earlier. Newcastle, however, has such a similar social history to Glasgow and reputation for poor population health that, despite its relatively small population, it was included for comparison with Glasgow.

7.1.2 All cities amalgamated data

In addition to making comparisons between Glasgow and various single cities, it was of interest to investigate the extent to which the urban population of Glasgow differed from the urban population of the rest of the UK. A similar issue was to see if all urban areas suffer poor population health outcomes or if there were some cities that enjoyed better population health than the rest of the UK's urban population.

To address these issues, an amalgam of the population of the thirteen cities listed in Table 5 was created. A new variable entitled *All cities* was generated in Microsoft Excel spreadsheets which contained population and death data for every UK postcode Sector and ward at each Census time point (these will be described in greater detail later). This variable contained the value '1' if the ward or postcode Sector was in one of the 13 cities and '0' if it was located in any other region of the UK. The population of the wards that had a value of '1' for the *All cities* variable was calculated. The population of the *All cities* entity fell from approximately 6.5 million in 1981 to just under 6 million in 2001. This reflected the population loss in several UK cities in the same time period.

Data from the *All cities* variable were included in all subsequent analyses of demographic and mortality trends.

7.1.3 Over-bounding and under-bounding

The issue of under-bounding and over-bounding of cities was investigated. Over-bounding and under-bounding was investigated by comparing the population density of the 13 cities chosen for comparison. This information is displayed in Table 6, overleaf.

Table 6: Population of UK Cities, ordered by population density

City	Population (2001 Census)	Area (km^2)	Density (persons/ km^2)
Liverpool	439,444	112	3929
Leicester	279,887	73	3817
Birmingham	977,063	268	3649
Bristol	380,641	110	3460
Manchester	392,827	116	3397
Glasgow	577,869	176	3293
Coventry	300,851	99	3050
Newcastle upon Tyne	242,388	99	2437
Sunderland	280,773	137	2043
Edinburgh	448,624	264	1701
Sheffield	513,242	368	1395
Leeds	715,421	552	1297
Bradford	467,649	366	1276

Table 6 indicates that over-bounding and under-bounding of cities does exist in the UK. Examples of each can be made from the cases of Bradford and Liverpool respectively. These cities had near equal populations in 2001, yet the administrative area of Bradford City Council was more than three times the size of the Liverpool City area. A satellite image of the Bradford area (Figure 23) reveals that the city's boundary encloses quite a large rural component: the urban portion of this Unitary Authority occupies only the lower right portion of the administrative area as it appears in the figure. Meanwhile, a similar map of the Liverpool area (Figure 24) shows that the heavily urbanised Liverpool administrative area is continuous with the urban areas of the neighbouring local authorities of Sefton and Knowsley. These maps were created using *Google Earth* software. This application, which is free to use for all non-profit purposes, is a 'virtual' globe composed of several million satellite and aerial photographs and allows the user to zoom in on individual houses and cars or take an overview of a particular country or region.

The difference in urban/rural composition of these cities makes comparisons of deprivation and health outcome problematic since different social factors operate in rural areas than in urban areas and also because rural areas tend to enjoy better population health than urban areas. In addition, while Bradford's boundary encloses all of that city's suburbs, one cannot rule out the possibility that suburbs of Liverpool (be they affluent or deprived) actually lie in neighbouring local authority areas. Therefore, it was necessary to create other definitions of UK cities that encompassed greater areas than their eponymous administrative units to allow fairer comparisons of deprivation and health outcome.

Figure 23: Aerial map of Bradford City Council Area

Figure 24: Aerial map of Liverpool City Council area

Deciding what areas to include in addition to the administrative boundaries of UK cities in order to make further comparisons of urban population health outcomes formed the basis of the next task. When describing under-bounding and over-bounding, Cheshire[243]wrote about the importance of understanding the 'functional reach' of cities rather than simply making comparisons on the basis of their administrative boundaries. A recent analysis of Scotland's cities published by the Scottish Executive[206] explored this theme. In that analysis, several definitions of the 6 most populous cities in Scotland were discussed. By order of Census-measured population size, these were; Glasgow, Edinburgh, Aberdeen, Dundee, Stirling and Inverness. The definitions included continuously built up areas, 30 minute travel to work areas, 60 minute travel to work areas, and travel to shop or leisure areas. This paper highlighted the importance of transport corridors to the functional reach of Scottish Cities. For example, the M8 and M74 motorways and the Strathclyde Rail Network were fundamental in creating a very large 60 minute travel to work area for Glasgow City; this area encompassed most of West Central Scotland, Stirling and parts of the City of

Edinburgh, thereby defining Edinburgh and Stirling as suburb of Glasgow. Clearly, applying such a definition as the standard way for creating functional city boundaries would not be worthwhile since similarly defined boundaries of many UK cities (not just Glasgow, Edinburgh and Stirling) would overlap with each other.

From the point of view of creating a standardised set of city boundaries, all of the definitions provided in the Executive's report were problematic. Each definition only reflected a single functional aspect of cities; retail, employment, leisure opportunities, education and so on. The report did not have the explicit aim of creating a single standardised set of boundaries for Scottish cities and instead described how the cities are used by the Scottish population and the multi-dimensional influence they have over the rest of the country. As a result, the definitions provided by this report were not used for two main reasons. First, the report only discussed the various functional boundaries of Scottish cities and did not mention English cities. Second, and most importantly, none of the boundaries described could easily be matched with the level of geography for which secondary data had been made available.

7.1.3.1 Population and demographics of cities and conurbations

Three population datasets were obtained from NHS Scotland's Information Services Division. Each of these contained the population of each ward and postcode sector in Scotland, England and Wales as measured at the Census. Population data was broken down into 9 age groups for each sex. All demographic analyses were performed using Microsoft Excel software or SPSS (version 14.0)

Using a coding key for the six digit identifiers (also obtained from ISD) for all of the small areas, it was possible to calculate the total population of each of the thirteen UK cities chosen for comparative analysis. A new variable entitled 'city' was generated within each spreadsheet. This was a categorical variable where individual postcode Sectors and wards were assigned a particular value based upon the city in which they were located. For example, all postcode Sectors within Glasgow were assigned a value of '1' in the city variable; those wards within Manchester were given a value of '2' and so on. Those postcode sectors and wards that were located outwith the 13 cities were assigned a value of '0' in the city variable. The total population of each city was then calculated in a simple manner by summing the population of each city's wards or postcode Sectors. The total population of each city was calculated for 1981, 1991 and 2001

7.1.4 Deprivation Profiles

A key idea in this thesis is the relationship between deprivation and mortality. If one area (be it a country, conurbation or city) has a higher proportion of deprived residents than another, it is reasonable to assume that its mortality rate will be higher. It is, therefore, of great interest to compare the relative deprivation status of various cities and also how this has changed over time. Because the Carstairs index of deprivation is based on questions from the UK census, it is possible to make both cross-sectional and longitudinal comparisons of UK cities.

To create the deprivation profiles, it was necessary to find a way to categorise the deprivation status of wards and postcode sectors. I used the same method for creating deprivation profiles that was used in the 'Scottish Effect' paper by Hanlon[6] where the population of the UK was classified into ten equal sized deciles according to the Carstairs z-score of local wards and postcode sectors. A deprivation profile for a particular area was created by tabulating the number of residents in each decile and then turning these numbers into percentages of the total local population within each decile. Once these percentage figures had been obtained, a deprivation profile was created by using the figures as the basis for a bar chart. Carstairs deciles were again used in this study although other published works have used Carstairs quintiles[255] or deprivation categories (DEPCATS)[256]. DEPCATS are not equal-sized categories: they are designed to mirror the normal distribution such that approximately 50% of the population are classified into the middle two DEPCATS and only the most deprived 7% of the population are classified into DEPCAT 1 with a further 7% in the most deprived category, DEPCAT 7. This approach has the advantage of highlighting the extreme ends of the deprivation distribution and it is used to highlight inequalities in health between those in DEPCAT 1 areas and those living DEPCAT

7 areas [256]. However, it does not lend itself to comparing the deprivation status of different cities because of the non-regular way in which the DEPCATS are assigned.

Each ward or postcode sector was assigned to a Carstairs decile based on its Carstairs score. Each decile represents one tenth of the total UK population but does not represent one tenth of the total number of postcode sectors and wards. This is an important distinction. The total population of wards and postcode sectors varies widely: wards and postcode sectors in rural areas have smaller populations than those in urban areas. In general, wards and postcode sectors in urban areas had the highest Carstairs scores so more deprived deciles contained fewer wards or postcode sectors than the most affluent deciles. This is shown by Table 7 overleaf.

Table 7: Summary data of postcode sectors and wards by Carstairs decile, 2001

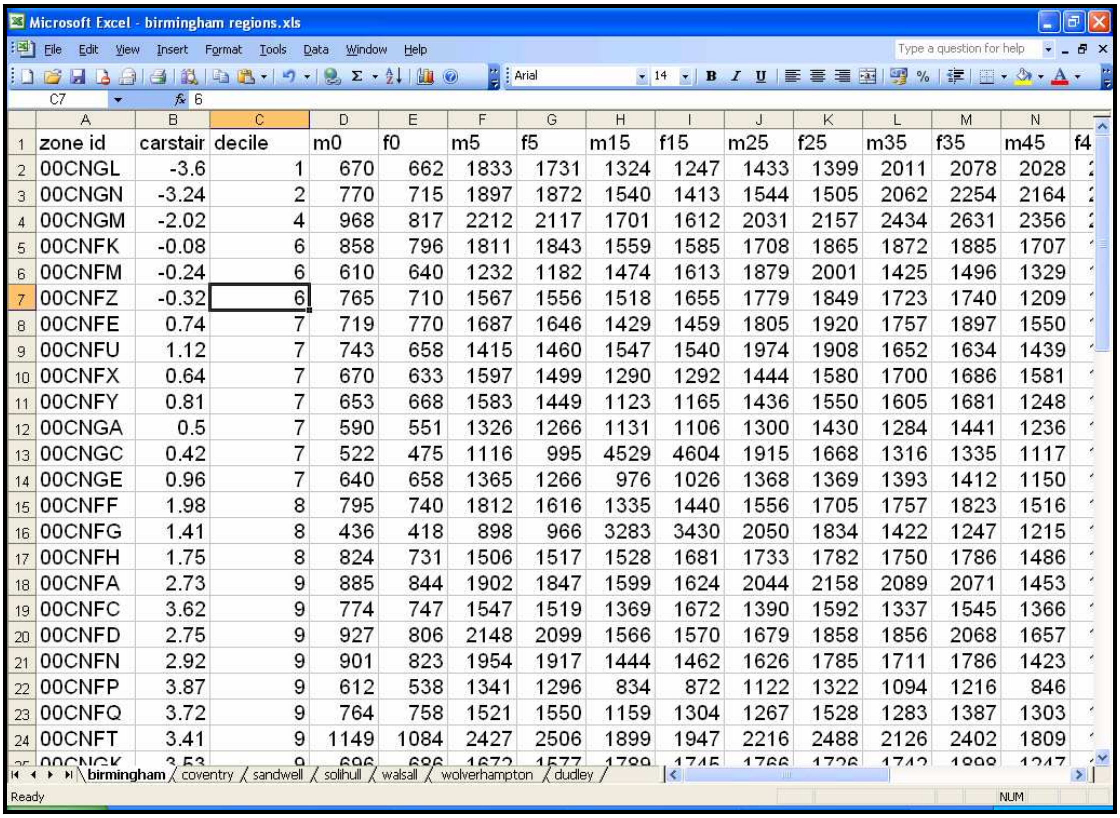
Decile	Number of wards or postcode sectors	Total population of wards and postcode sectors	Average population of individual wards or postcode sectors
1	1,324	5,708,176	4,311
2	1,282	5,706,161	4,451
3	1,102	5,713,556	5,185
4	965	5,710,949	5,918
5	886	5,701,355	6,435
6	816	5,720,383	7,010
7	708	5,703,278	8,055
8	651	5,712,517	8,775
9	604	5,711,231	9,456
10	512	5,715,976	11,164

7.1.4.1 Deprivation Profiles – worked example

To create deprivation profiles, the following steps were taken (using data from Birmingham in 2001 as a worked example).

Population data for all wards in a particular area were selected. In this example, all wards in Birmingham were identified using a lookup table. Wards in

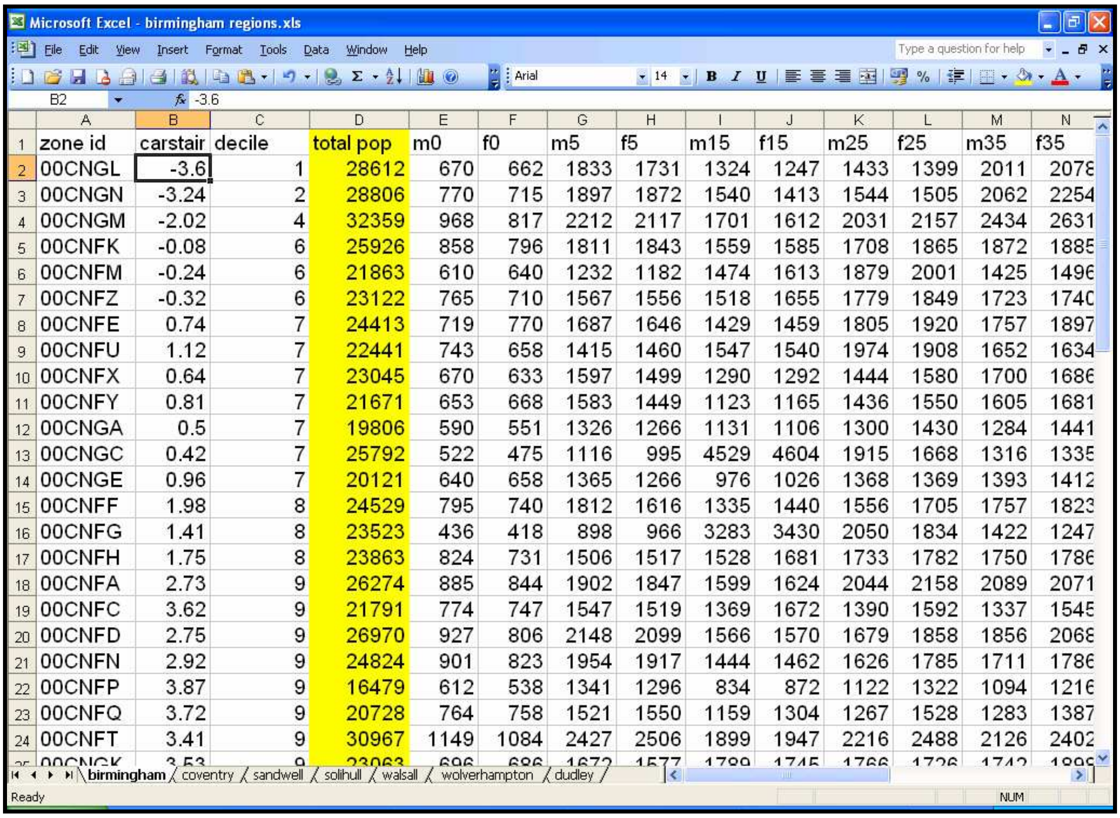
Birmingham at the 2001 census all had an identification code that began 07CN. There were 39 wards in Birmingham in 2001. Data from these wards were selected and pasted into a fresh spreadsheet (see Figure 25, below).



zone id	carstair	decile	m0	f0	m5	f5	m15	f15	m25	f25	m35	f35	m45
00CNGL	-3.6	1	670	662	1833	1731	1324	1247	1433	1399	2011	2078	2028
00CNGN	-3.24	2	770	715	1897	1872	1540	1413	1544	1505	2062	2254	2164
00CNGM	-2.02	4	968	817	2212	2117	1701	1612	2031	2157	2434	2631	2356
00CNFK	-0.08	6	858	796	1811	1843	1559	1585	1708	1865	1872	1885	1707
00CNFM	-0.24	6	610	640	1232	1182	1474	1613	1879	2001	1425	1496	1329
00CNFZ	-0.32	6	765	710	1567	1556	1518	1655	1779	1849	1723	1740	1209
00CNFE	0.74	7	719	770	1687	1646	1429	1459	1805	1920	1757	1897	1550
00CNFU	1.12	7	743	658	1415	1460	1547	1540	1974	1908	1652	1634	1439
00CNFX	0.64	7	670	633	1597	1499	1290	1292	1444	1580	1700	1686	1581
00CNFY	0.81	7	653	668	1583	1449	1123	1165	1436	1550	1605	1681	1248
00CNGA	0.5	7	590	551	1326	1266	1131	1106	1300	1430	1284	1441	1236
00CNGC	0.42	7	522	475	1116	995	4529	4604	1915	1668	1316	1335	1117
00CNGE	0.96	7	640	658	1365	1266	976	1026	1368	1369	1393	1412	1150
00CNFF	1.98	8	795	740	1812	1616	1335	1440	1556	1705	1757	1823	1516
00CNFG	1.41	8	436	418	898	966	3283	3430	2050	1834	1422	1247	1215
00CNFH	1.75	8	824	731	1506	1517	1528	1681	1733	1782	1750	1786	1486
00CNFA	2.73	9	885	844	1902	1847	1599	1624	2044	2158	2089	2071	1453
00CNFC	3.62	9	774	747	1547	1519	1369	1672	1390	1592	1337	1545	1366
00CNFD	2.75	9	927	806	2148	2099	1566	1570	1679	1858	1856	2068	1657
00CNFN	2.92	9	901	823	1954	1917	1444	1462	1626	1785	1711	1786	1423
00CNFP	3.87	9	612	538	1341	1296	834	872	1122	1322	1094	1216	846
00CNFQ	3.72	9	764	758	1521	1550	1159	1304	1267	1528	1283	1387	1303
00CNFT	3.41	9	1149	1084	2427	2506	1899	1947	2216	2488	2126	2402	1809

Figure 25: Spreadsheet of population data for Birmingham, 2001

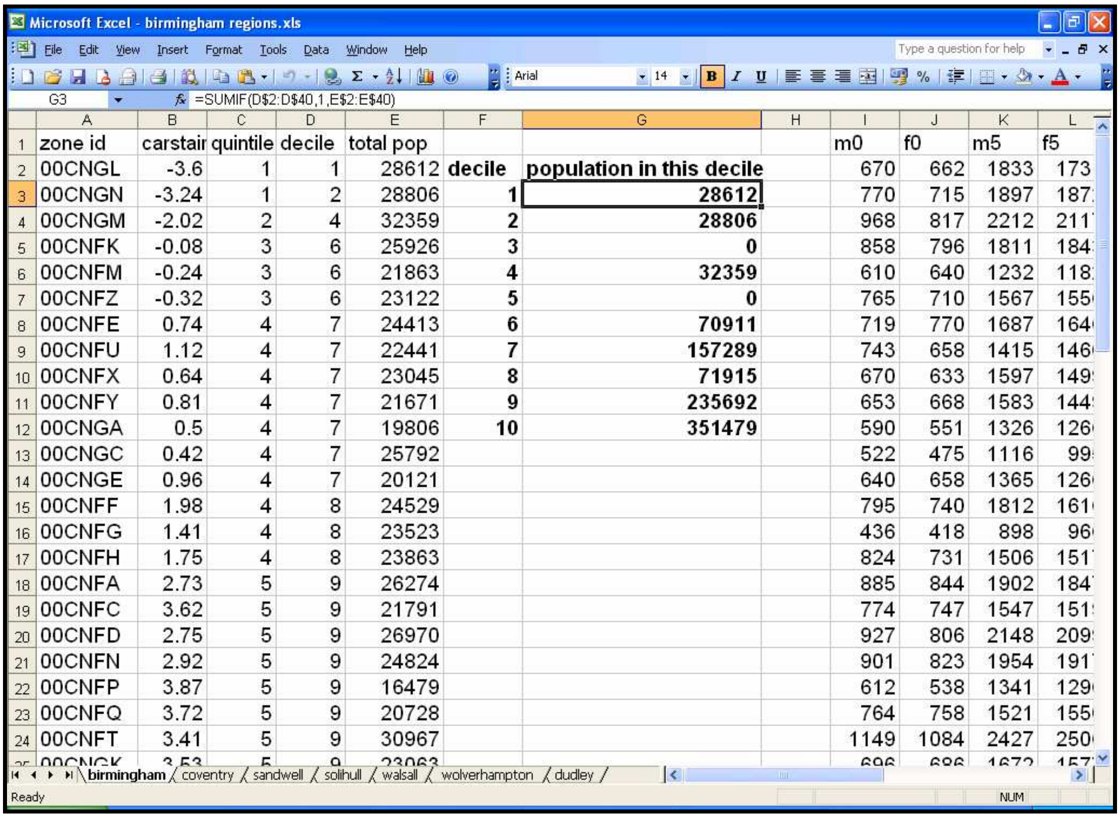
Next, the total population of each ward was calculated by summating the values given by variables m0 through f75. A new variable *total pop* was created to store the result of this sum for each ward and is shown highlighted in Figure 26, below.



zone id	carstair	decile	total pop	m0	f0	m5	f5	m15	f15	m25	f25	m35	f35
00CNGL	-3.6	1	28612	670	662	1833	1731	1324	1247	1433	1399	2011	2078
00CNGN	-3.24	2	28806	770	715	1897	1872	1540	1413	1544	1505	2062	2254
00CNGM	-2.02	4	32359	968	817	2212	2117	1701	1612	2031	2157	2434	2631
00CNFK	-0.08	6	25926	858	796	1811	1843	1559	1585	1708	1865	1872	1885
00CNFM	-0.24	6	21863	610	640	1232	1182	1474	1613	1879	2001	1425	1496
00CNFZ	-0.32	6	23122	765	710	1567	1556	1518	1655	1779	1849	1723	1740
00CNFE	0.74	7	24413	719	770	1687	1646	1429	1459	1805	1920	1757	1897
00CNFU	1.12	7	22441	743	658	1415	1460	1547	1540	1974	1908	1652	1634
00CNFX	0.64	7	23045	670	633	1597	1499	1290	1292	1444	1580	1700	1686
00CNFY	0.81	7	21671	653	668	1583	1449	1123	1165	1436	1550	1605	1681
00CNGA	0.5	7	19806	590	551	1326	1266	1131	1106	1300	1430	1284	1441
00CNGC	0.42	7	25792	522	475	1116	995	4529	4604	1915	1668	1316	1335
00CNGE	0.96	7	20121	640	658	1365	1266	976	1026	1368	1369	1393	1412
00CNFF	1.98	8	24529	795	740	1812	1616	1335	1440	1556	1705	1757	1823
00CNFG	1.41	8	23523	436	418	898	966	3283	3430	2050	1834	1422	1247
00CNFH	1.75	8	23863	824	731	1506	1517	1528	1681	1733	1782	1750	1786
00CNFA	2.73	9	26274	885	844	1902	1847	1599	1624	2044	2158	2089	2071
00CNFC	3.62	9	21791	774	747	1547	1519	1369	1672	1390	1592	1337	1545
00CNFD	2.75	9	26970	927	806	2148	2099	1566	1570	1679	1858	1856	2068
00CNFN	2.92	9	24824	901	823	1954	1917	1444	1462	1626	1785	1711	1786
00CNFP	3.87	9	16479	612	538	1341	1296	834	872	1122	1322	1094	1216
00CNFQ	3.72	9	20728	764	758	1521	1550	1159	1304	1267	1528	1283	1387
00CNFT	3.41	9	30967	1149	1084	2427	2506	1899	1947	2216	2488	2126	2402

Figure 26: Birmingham population data with total population variable calculated and highlighted in yellow

Next, the population of the city in each of the 10 Carstairs deciles was calculated. This was accomplished by using MS Excel's *sumif* function. This function sums only those cells in a column or row, specified by a particular criterion. In the first instance, cells in the *total pop* column were summed if the corresponding cell in the adjacent *decile* column contained the value '1'. The result of this sum was stored in a separate cell of the spreadsheet. The *sumif* calculation was repeated to find the total number of Birmingham residents in all other Carstairs deciles (see Figure 27, below).



	A	B	C	D	E	F	G	H	I	J	K	L
1	zone id	carstair	quintile	decile	total pop				m0	f0	m5	f5
2	00CNGL	-3.6	1	1	28612	**decile**	**population in this decile**		670	662	1833	173
3	00CNGN	-3.24	1	2	28806	**1**	**28612**		770	715	1897	187
4	00CNGM	-2.02	2	4	32359	**2**	**28806**		968	817	2212	211
5	00CNFK	-0.08	3	6	25926	**3**	**0**		858	796	1811	184
6	00CNFM	-0.24	3	6	21863	**4**	**32359**		610	640	1232	118
7	00CNFZ	-0.32	3	6	23122	**5**	**0**		765	710	1567	155
8	00CNFE	0.74	4	7	24413	**6**	**70911**		719	770	1687	164
9	00CNFU	1.12	4	7	22441	**7**	**157289**		743	658	1415	146
10	00CNFX	0.64	4	7	23045	**8**	**71915**		670	633	1597	149
11	00CNFY	0.81	4	7	21671	**9**	**235692**		653	668	1583	144
12	00CNGA	0.5	4	7	19806	**10**	**351479**		590	551	1326	126
13	00CNGC	0.42	4	7	25792				522	475	1116	99
14	00CNGE	0.96	4	7	20121				640	658	1365	126
15	00CNFF	1.98	4	8	24529				795	740	1812	161
16	00CNFG	1.41	4	8	23523				436	418	898	96
17	00CNFH	1.75	4	8	23863				824	731	1506	151
18	00CNFA	2.73	5	9	26274				885	844	1902	184
19	00CNFC	3.62	5	9	21791				774	747	1547	151
20	00CNFD	2.75	5	9	26970				927	806	2148	209
21	00CNFN	2.92	5	9	24824				901	823	1954	191
22	00CNFP	3.87	5	9	16479				612	538	1341	129
23	00CNFQ	3.72	5	9	20728				764	758	1521	155
24	00CNFT	3.41	5	9	30967				1149	1084	2427	250
25	00CNGK	3.53	5	9	23063				696	686	1672	157

Figure 27: Birmingham Residents in each Carstairs decile

It should be noted that the Birmingham data have been sorted in ascending order of column D (*decile variable*). It can be seen that there was only one ward (00CNGL) that was in Carstairs decile 1 in 2001. This ward had a total population of 28,612 (cell E2), thus the *sumif* function when it summed the population of all the wards that were in Carstairs decile 1 returned a value of 28,612 in cell G3 in the figure above. It can also be seen that the sumif function returned a value of 0 for deciles 3 and 5. This indicates that there were no wards in Birmingham in 2001 that were classified into these Carstairs deciles. This is confirmed by scanning column D of this spreadsheet, where the figures ‘3’ and ‘5’ do not appear.

Next, the proportion of the city’s residents in each of the 10 deciles was calculated. This involved a simple percentage calculation whereby the figures in cells G3 to G12 were divided by the total population of Birmingham (stored in cell G13) and multiplied by 100 to give a percentage. The percentage figure was stored in the adjacent cell to the relevant decile population figure (see Figure 28, below

Microsoft Excel - birmingham regions.xls

G7 =F7/F$13*100

	A	B	C	D	E	F	G	H	I	J	K
1	zone id	carstair	decile	total pop				m0	f0	m5	f
2	00CNGL	-3.6	1	28612	**decile**	**decile population**	**decile percentage**	670	662	1833	
3	00CNGN	-3.24	2	28806	**1**	**28612**	**2.93**	770	715	1897	
4	00CNGM	-2.02	4	32359	**2**	**28806**	**2.95**	968	817	2212	
5	00CNFK	-0.08	6	25926	**3**	**0**	**0.00**	858	796	1811	
6	00CNFM	-0.24	6	21863	**4**	**32359**	**3.31**	610	640	1232	
7	00CNFZ	-0.32	6	23122	**5**	**0**	**0.00**	765	710	1567	
8	00CNFE	0.74	7	24413	**6**	**70911**	**7.26**	719	770	1687	
9	00CNFU	1.12	7	22441	**7**	**157289**	**16.10**	743	658	1415	
10	00CNFX	0.64	7	23045	**8**	**71915**	**7.36**	670	633	1597	
11	00CNFY	0.81	7	21671	**9**	**235692**	**24.12**	653	668	1583	
12	00CNGA	0.5	7	19806	**10**	**351479**	**35.97**	590	551	1326	
13	00CNGC	0.42	7	25792	**City's pop**	**977063**		522	475	1116	
14	00CNGE	0.96	7	20121				640	658	1365	
15	00CNFF	1.98	8	24529				795	740	1812	
16	00CNFG	1.41	8	23523				436	418	898	
17	00CNFH	1.75	8	23863				824	731	1506	
18	00CNFA	2.73	9	26274				885	844	1902	
19	00CNFC	3.62	9	21791				774	747	1547	
20	00CNFD	2.75	9	26970				927	806	2148	
21	00CNFN	2.92	9	24824				901	823	1954	
22	00CNFP	3.87	9	16479				612	538	1341	
23	00CNFQ	3.72	9	20728				764	758	1521	
24	00CNFT	3.41	9	30967				1149	1084	2427	
25	00CNGK	3.53	9	23063				696	686	1673	

birmingham / coventry / sandwell / solihull / walsall / wolverhampton / dudley

Ready NUM

Figure 28: Percentage of Birmingham residents in each Carstairs decile

Using the figures that appear in cells G3:G12, it was possible to create a histogram to graphically represent the profile of deprivation in Birmingham in 2001. The same process as has been described above was repeated for all cities and conurbations at all three census time points.

Throughout this thesis, unless otherwise stated, when discussing the relative deprivation status of cities, reference to the first type of deprivation profile described above will be made.

From the approach described here, several deprivation profile histograms were created and these appear in the results chapter.

7.1.5 Age and sex standardisation of death rates

Death rates in cities and conurbations were compared using the indirect standardisation method described by Goldblatt[257]. This commonly used epidemiological method is based on the ratio *observed deaths: expected deaths.* 'Observed deaths' stands for the number of deaths recorded in a particular locality and 'expected deaths' is the calculated number of deaths, were the population of the local area to have the same death rate as the *standard population*. The resultant ratio is usually multiplied by a standard factor (in most cases, 100) to give an unadjusted *standardised mortality ratio* or SMR. The standard population can be any population against which death rates in several areas can be compared. In this thesis, three different standard populations were used depending on the dataset. For 1981 death data, the standard population was the population of Scotland, England and Wales as measured by the 1981 census. The 1991 census was the basis for the 1991 standard population and the 2001 census was used for the 2001 standard population.

It should be noted that 3 year aggregates of death data were used. Thus 1981 death data was the aggregated number of deaths in each ward or postcode sector in the years 1980, 1981 and 1982. This method of aggregation diminishes the effect of an unusually high (or low) number of deaths, in any area in any one year.

Indirect standardisation is a straightforward method that makes allowances for local differences in age and sex structure. Those local populations with relatively high numbers of older people will have higher crude or unadjusted death rates and will therefore appear to have poorer population health than areas with a higher proportion of younger people. Indirect standardisation takes account of the relative size of the various sub-groups or *strata* of the local population. It compares the observed number of deaths in these strata with the number that might be expected if the local strata had the same death rate as standard population. In this case, average death rate for that strata of the population of Scotland, England and Wales.

The following method was used:

Local population and death data were compiled for each age and sex category. The sum of death counts in each age and sex grouping is the total *observed deaths* for the local area.

Standard death rates were calculated for each age and sex specific group in the standard population using the formula: *rate = number of deaths / population*

Expected deaths for the local area were calculated by applying the standard age and sex specific death rates to local age and sex specific population data using the formula: *expected deaths = standard age and sex specific rate*local age and sex specific population count.*

These calculated numbers of age and sex specific expected deaths were summed to give a count of *total expected deaths* in the population.

The ratio *total observed deaths: total expected deaths* was calculated.

The above ratio was multiplied by 100 to give a *Standardised Mortality Ratio* for the local area.

It was possible to calculate standard errors for these SMRs and then, using this standard error, confidence intervals. The standard error is calculated using the formula described by Goldblatt[257]:

Standard error = 100*(√ (sum observed deaths/expected deaths))

Lower confidence interval = SMR – (1.96*standard error)

Upper confidence interval = SMR + (1.96*standard error)

Age and sex adjusted SMRs were calculated for the previously listed large cities and conurbations with data from 1981, 1991 and 2001.

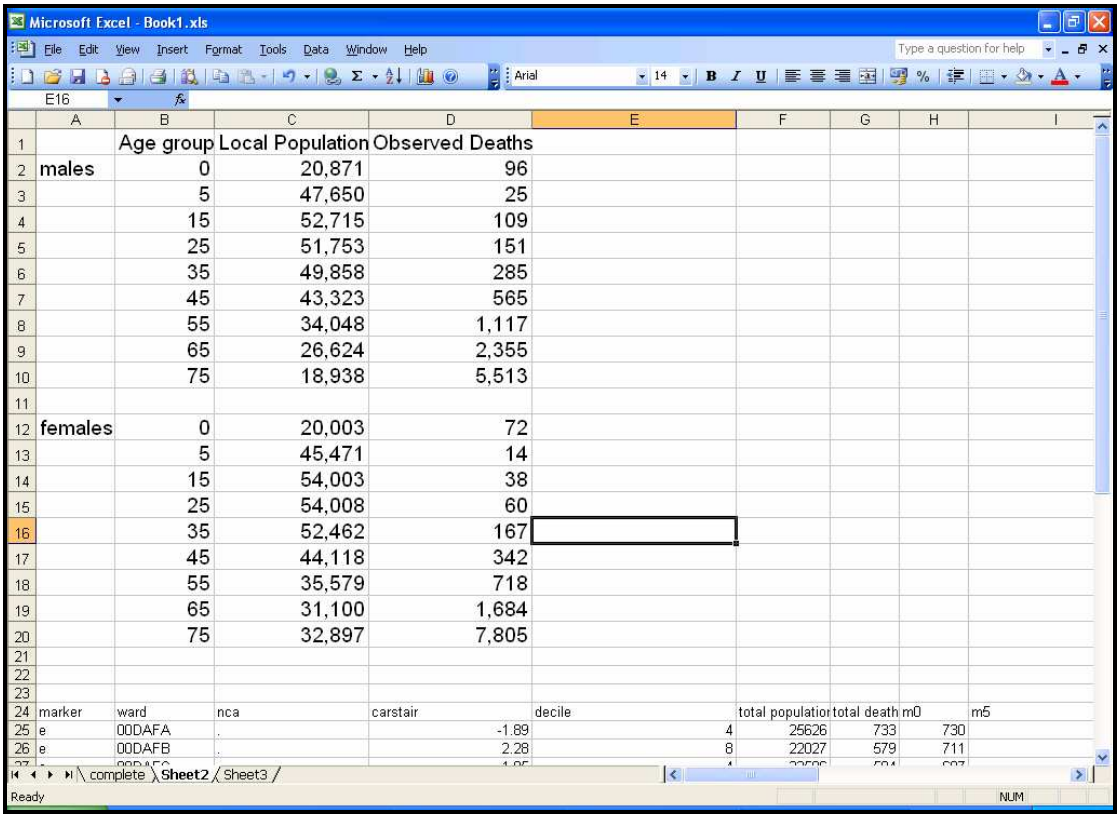
In addition to age and sex adjusted SMRs for whole city populations, age and sex specific mortality ratios were calculated for those cities with the highest SMR. This was to identify those segments of the local populations that bore most of the burden of excess mortality.

7.1.5.1 Indirect Standardisation – worked example

This method of indirect standardisation will be described by showing a worked example, in this case Leeds in 2001.

First, Carstairs & population data were merged with mortality data, using *ward* as the variable for matching cases, into one large dataset. This dataset was saved and given a title such as *Carstairs and mortality 2001.sav*. Two new variables were created in this large data file; *total pop* (this was the total population of each ward or postcode sector) and *total deaths* (the total number of deaths in the ward or postcode sector).

Second, data for a particular city or conurbation (in this case, Leeds) were identified using a lookup table of all wards and postcode sectors in the original datasets. Leeds data were then pasted into a new spreadsheet. Using the *sum* function of MS Excel, the total number of Leeds residents in each age and sex specific category was calculated. This was repeated to find the total number of deaths in each age and sex specific category in the city. These totals were displayed in a separate part of the spreadsheet (see Figure 29, below).

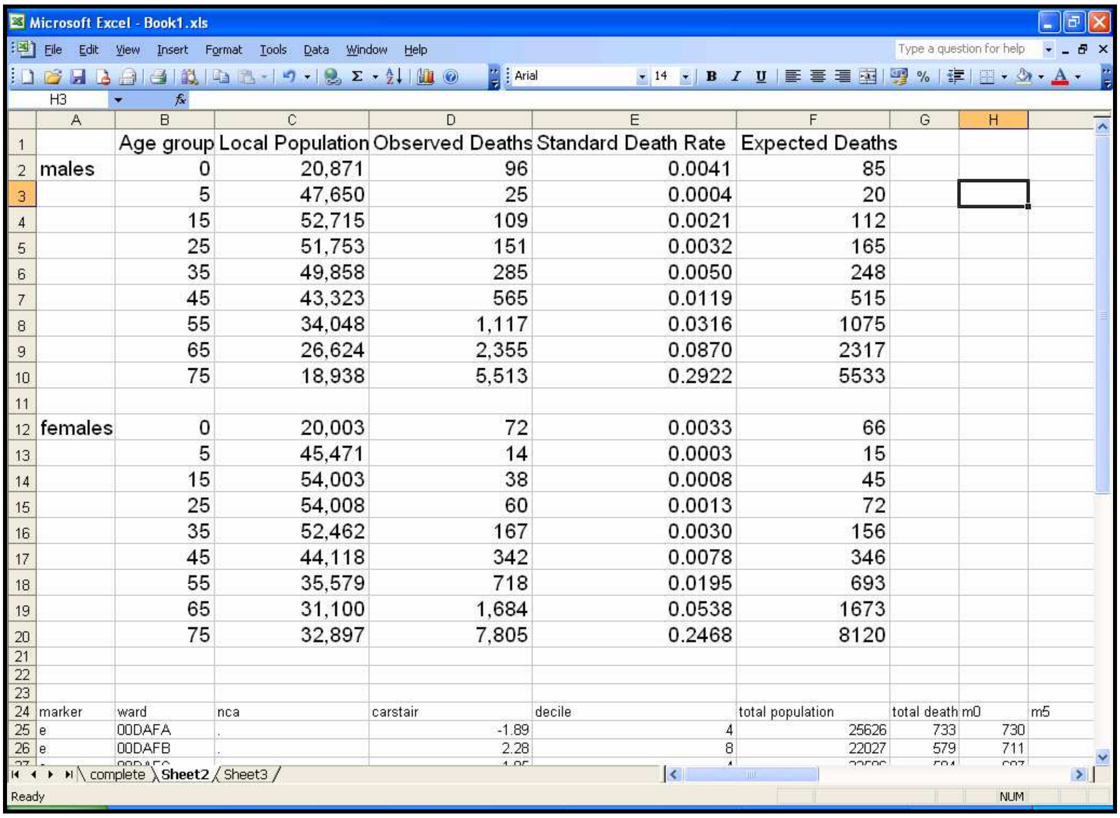


	Age group	Local Population	Observed Deaths
males	0	20,871	96
	5	47,650	25
	15	52,715	109
	25	51,753	151
	35	49,858	285
	45	43,323	565
	55	34,048	1,117
	65	26,624	2,355
	75	18,938	5,513
females	0	20,003	72
	5	45,471	14
	15	54,003	38
	25	54,008	60
	35	52,462	167
	45	44,118	342
	55	35,579	718
	65	31,100	1,684
	75	32,897	7,805

marker	ward	nca	carstair	decile	total populatior	total death	m0	m5
e	00DAFA	.	-1.89	4	25626	733	730	
e	00DAFB	.	2.28	8	22027	579	711	

Figure 29: Population and death counts in each age and sex specific category in Leeds, 2001

The next step was to calculate the expected number of deaths in each age and sex specific category. Standard death rates in each age and sex specific category had previously been calculated using data from all wards and postcode sectors in Scotland, England and Wales as the standard population. The standard death rates were applied to the local population segments to provide expected death counts, shown in Figure 30.



	A	B	C	D	E	F	G	H	I
1		Age group	Local Population	Observed Deaths	Standard Death Rate	Expected Deaths			
2	males	0	20,871	96	0.0041	85			
3		5	47,650	25	0.0004	20			
4		15	52,715	109	0.0021	112			
5		25	51,753	151	0.0032	165			
6		35	49,858	285	0.0050	248			
7		45	43,323	565	0.0119	515			
8		55	34,048	1,117	0.0316	1075			
9		65	26,624	2,355	0.0870	2317			
10		75	18,938	5,513	0.2922	5533			
11									
12	females	0	20,003	72	0.0033	66			
13		5	45,471	14	0.0003	15			
14		15	54,003	38	0.0008	45			
15		25	54,008	60	0.0013	72			
16		35	52,462	167	0.0030	156			
17		45	44,118	342	0.0078	346			
18		55	35,579	718	0.0195	693			
19		65	31,100	1,684	0.0538	1673			
20		75	32,897	7,805	0.2468	8120			
21									
22									
23									
24	marker	ward	nca	carstair	decile	total population	total death	m0	m5
25	e	00DAFA	.	-1.89	4	25626	733	730	
26	e	00DAFB	.	2.28	8	22027	579	711	

Figure 30: Calculation of expected deaths by age and sex specific categories, Leeds 2001

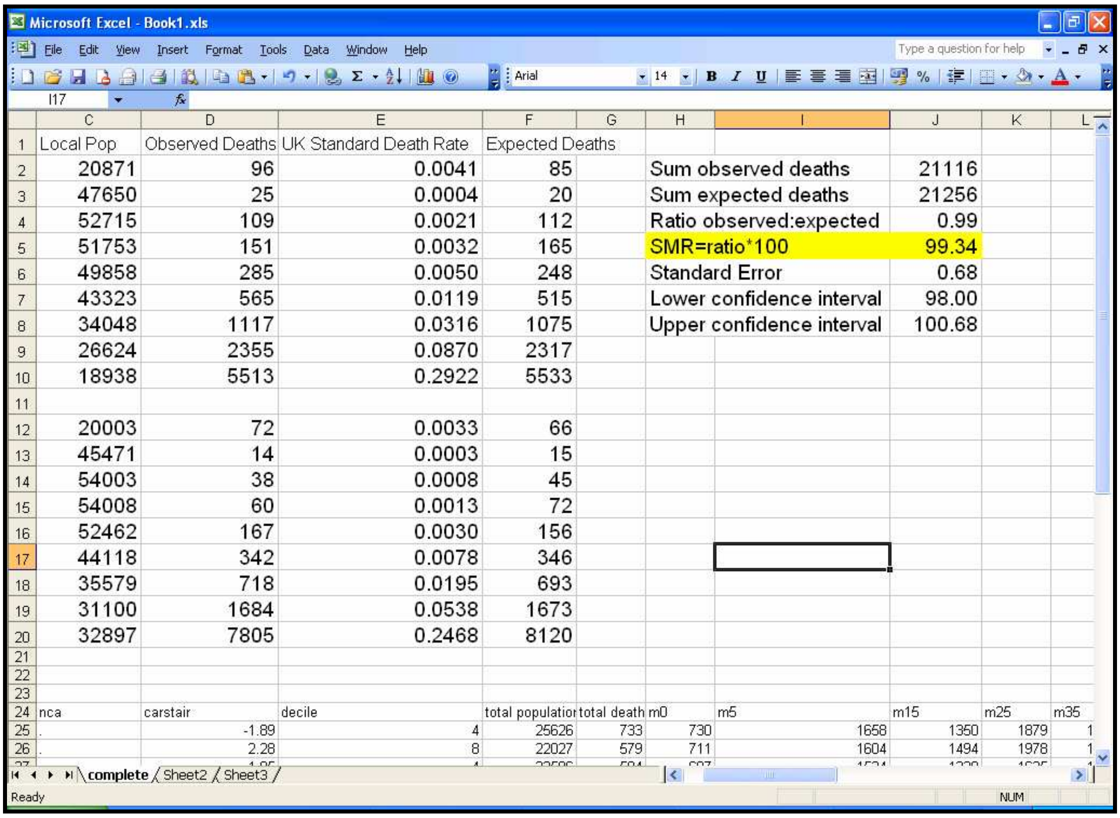
The age and sex adjusted standardised mortality ratio for Leeds was then calculated. This was the ratio (*sum (observed deaths): sum (expected deaths))*100*. A standard error for this SMR was also calculated using the formula:

Standard Error = 100*(($\sqrt{\ }$ sum observed deaths)/(sum expected deaths)

The standard error was then used to calculate 95% confidence intervals using the formula:

Confidence Interval = SMR $\pm$ 1.96*Standard Error

These calculations are displayed in Figure 31.



	Local Pop	Observed Deaths	UK Standard Death Rate	Expected Deaths
2	20871	96	0.0041	85
3	47650	25	0.0004	20
4	52715	109	0.0021	112
5	51753	151	0.0032	165
6	49858	285	0.0050	248
7	43323	565	0.0119	515
8	34048	1117	0.0316	1075
9	26624	2355	0.0870	2317
10	18938	5513	0.2922	5533
11				
12	20003	72	0.0033	66
13	45471	14	0.0003	15
14	54003	38	0.0008	45
15	54008	60	0.0013	72
16	52462	167	0.0030	156
17	44118	342	0.0078	346
18	35579	718	0.0195	693
19	31100	1684	0.0538	1673
20	32897	7805	0.2468	8120

Sum observed deaths	21116
Sum expected deaths	21256
Ratio observed:expected	0.99
SMR=ratio*100	99.34
Standard Error	0.68
Lower confidence interval	98.00
Upper confidence interval	100.68

nca	carstair	decile	total population	total death	m0	m5	m15	m25	m35
.	-1.89	4	25626	733	730	1658	1350	1879	1
.	2.28	8	22027	579	711	1604	1494	1978	1

Figure 31: Calculation of age and sex adjusted SMR (and confidence interval) using Microsoft Excel

7.1.6 Excess Mortality

The concept of 'excess mortality' is central to this thesis and refers to a higher number of deaths in one region in comparison to another. The method of indirect standardisation of death rates allows excess mortality to be quantified. In this thesis, a population with an SMR that was higher than 100 was said to have excess mortality. The magnitude of this excess mortality was expressed as a percentage excess according to the following rationale.

Let **X** = local SMR

Excess mortality = **X** – 100

Thus, if a particular population had a calculated SMR of 125, then it was said to have and excess mortality of 25% with respect to the reference population. In most circumstances and unless otherwise stated, the reference population was the population of Scotland, England and Wales at the relevant census. On certain occasions, an alternative reference population was used. For example, the population of England was used to calculate excess mortality in Scotland with respect to England.

7.2 Indirect standardisation of death rates with adjustment for Carstairs decile

The following section describes methods that answer the following research questions:

- How much of this excess mortality (as defined by the previous question) can be attributed to deprivation as measured by the Carstairs index of deprivation?

- What is the size and nature of any residue i.e. any excess mortality that is not explained by deprivation (as measured by the Carstairs Index of Deprivation)?

A method of drawing deprivation profiles for particular cities, conurbations and other areas was described earlier in this chapter. These deprivation profiles are displayed in the results section. Deprivation profiles for many cities were highly skewed; cities had large proportions of residents in deprived deciles and fewer residents in affluent deciles. Given the wealth of literature describing the link between deprivation and many forms of health outcome including all cause mortality, it was necessary to also standardise death rates in cities for local deprivation status.

The Carstairs index was used as the basis for standardisation of death rates by deprivation status. This measure of deprivation was adopted for a number of reasons. First, when Carstairs and Morris originally devised this measure they specifically chose variables that correlated with area health outcome in Scotland. Second, the Carstairs index is based on standardised Census variables, therefore every area in the UK is covered by the same variables. Third, because it is based on the Census, longitudinal trends in deprivation status of areas can be measured and the relationship with population health can be quantified.

A discussion of the methods used to calculate the Carstairs index of deprivation can be found in the Concepts and Definitions chapter. Death rates were adjusted for age, sex and Carstairs decile. This allowed the contribution of Carstairs deprivation to excess mortality in cities such as Glasgow to be estimated.

The method for calculation of local age, sex and deprivation decile adjusted SMR was very similar to the previously described method for calculating SMR with adjustment for age and sex only. The method can be summarised as follows:

The local population was divided according to the total number of residents in each Carstairs decile.

The sum of the number of deaths in these age, sex and decile specific groups was added together and this total was termed the *sum of observed deaths*.

The standard population was broken into ten equal sized groups according to Carstairs decile. Age and sex specific death rates for every population sub-group in each decile of the population were calculated (*standard death rates)*

These standard death rates were applied to local age, sex and decile specific populations to give *expected deaths*.

The ratio *sum observed deaths: sum expected deaths* was calculated. This ratio was multiplied by 100 to give *age, sex and deprivation decile adjusted standardised mortality ratio* for the local population.

The most important feature of indirect standardisation with adjustment for age group, sex and Carstairs decile was the stratification by Carstairs decile of both the local population *and* the standard population. The age group and sex characteristics of each decile of the standard population were obtained. Thus, the portion of the local population in a particular decile was compared with the rest of the UK's population *in that decile only* and not against all other UK citizens (which was the case with age and sex standardisation).

7.2.1 Problems with the indirect standardisation method

The method of indirect standardisation provides a result that is easily understood and is straightforward to calculate. The method also has the advantage that comparisons of the population health of various cities and conurbations can be made with ease.

Despite its obvious advantages, indirect standardisation does have two limitations. Adjustment for a fourth categorical variable (after age group, sex and Carstairs decile) would be an unnecessarily complicated and time consuming task when other statistical techniques exist that give similar results without the requirement to do several layers of manual calculations in Microsoft Excel.

Second, indirect standardisation is only appropriate when the adjustment variables are categorical rather than continuous. For example, while it is possible to create standardised mortality ratios with adjustment for age group, it would be impossible to create SMRs with adjustment for age, since the standard death rate for every conceivable age would need to be calculated. Therefore, when adjusting death rates for any continuous variable, another method of calculating SMRs must be found.

Up until this point, the indirect standardisation method served me well but it became clear that a more nuanced view of excess mortality in Glasgow could only be achieved with a more advanced technique.

7.2.2 Regression of death count data

7.2.2.1 Preparation of data

Mortality and population data were received from NHS ISD in SPSS format. SPSS is a statistical software package that is commonly used by researchers across a wide range of scientific disciplines. Many routine statistical techniques can be performed using this software but it does have some limitations. Most importantly for this thesis, there is no straightforward way of computing either Poisson or negative binomial regression models in SPSS (it is not impossible to perform these techniques, but the method is convoluted).

Instead, data were transformed into Stata format. This software does have the capability to compute both Poisson and negative binomial regression models. Some manipulation was required so that data were in a format on which regression could be performed. First, 18 separate files (corresponding to the 18 separate age and sex sub-groups of the population for which data were made available) were created. Table 8 describes the variables contained in each of these files.

Table 8: Variables included in SPSS files used to create Stata regression file

Variable Name	**Description**
marker	Country: Scotland or England
ward	Census identification code for wards in England or postcode sectors in Scotland
decile	Carstairs decile of ward or postcode sector
Sex	male or female
agegrp	age group
Dth	number of deaths
Pop	Population
carstair	Carstairs z-score

Each file was saved under an appropriate name (such as *males_0_1981.sav* for the file containing data for males in the 0-4 years age group at the 1981 census).

These 18 files were then merged to create one very large file (with approximately 177,000 cases for the 2001 data). This new file was saved with a suitable title. The process was then repeated for data from the other time points.

StatTransfer (version 8) software was used to convert the SPSS data file to Stata format.

7.2.2.2 Poisson regression

Death data were counts of deaths in each small area. A statistical method used to model count data is Poisson regression. Ordinary least squares regression (OLS regression) is inappropriate for count data because of the assumption that values for the dependent variable will follow the normal distribution[258]. Poisson regression assumes that values for the dependent variable fall into the Poisson distribution; this is a specific type of distribution in which scores take the form of non-negative integer values. The Poisson distribution is truncated at 0 and is highly skewed in the positive direction. Inspection of death count data in postcode sectors and wards revealed that they were positively skewed and so Poisson regression models were judged as being more appropriate than ordinary linear models.

The Poisson distribution is central to Poisson regression. The derivation of this distribution will be described prior to the description of the regression model.

Let μ be the rate of occurrence or the expected number of times an event will occur over a given period. Let y be a random variable indicating the number of times that an event did occur. Sometimes the event will occur fewer times than the average rate or even not at all, and at other times it will occur more often.

The relationship between the expected count, μ, and the probability of observing any given count, y, is specified by the Poisson distribution (the following equation is also known as the *probability mass function of the Poisson distribution*[259]:

$$Pr(y \mid \mu) = \frac{e^{-\mu}\mu^{y}}{y!} \text{ for } y = 0,1,2,3 \text{ etc}$$

The Poisson distribution can be used to find the probability of discrete events occurring. For example, suppose a PhD thesis of 250 pages has 50 typographical errors. The Poisson distribution can be used to estimate the probability that a particular page will have precisely 2 errors. The average number of misprints on a page is 50/250 = 0.2.

Using the probability mass function described above, we have

y = *2*

μ = *0.2*

Thus, the probability of precisely 2 errors on a particular page of the thesis is as follows:

$$Pr(2|0.2) = \frac{e^{-0.2}0.2^2}{2!} = 0.016$$

There is a 1.6% probability that there will be 2 errors on any one page of the thesis. However, since there are 250 pages in the thesis, it is reasonable to conclude that at least 4 of them will have precisely 2 errors.

The Poisson regression model extends the Poisson distribution by allowing each observation to have a different value for μ. More formally, the Poisson regression model assumes that the observed count for observation, *i,* is drawn from a Poisson distribution with mean μ_i where μ_i is estimated from observed characteristics. This is sometimes referred to as incorporating *observed heterogeneity* and leads to the regression equation:

$$\mu_i = E(y_i \mid x_i) = \exp(x_i\beta)$$

Or alternatively,

$$\log_e(\mu_i) = (x_i\beta)$$

Exponentiating $(x_i\beta)$ forces μ_i to be positive since counts can only hold non-negative values. Since there is a log transformation involved, Poisson regression is said to be an example of a general linear model with a log link (or canonical) function[259].

The above regression equation is the univariate Poisson model. In this thesis, several variables were of interest including location, age group, sex, Carstairs decile and Carstairs score. The univariate Poisson model can be easily extended to a multivariate model. For example, with three independent variables, the Poisson regression model is:

$$\mu_i = \exp(\beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3})$$

In the context of this thesis, the following variables were substituted into the above Poisson regression equation

μ_i = expected count of deaths

B_0 = constant (this is estimated by the statistical software)

X_{i1}= age group

X_{i2} = sex

X_{i3} = location (i.e. Glasgow or another urban centre)

The Poisson regression might then read:

Expected death count = exp(constant + B_1 age group + B_2 sex + B_3 location)

A fundamental property of the Poisson distribution is that its mean is equal to its variance[259-261]. This property is known as equidispersion. Long[259] reports that in real life, the variance of response data is often larger than its mean (a property known as *overdispersion*) and that if such overdispersion exists then Poisson models are not the most appropriate method for modelling count data.

Overdispersion of death count data was assessed in two ways. First, summary statistics were generated and the variance and mean values were compared. Second a post-hoc goodness of fit test was applied to all Poisson regression models generated in Stata. If the p-value returned by the goodness of fit test was less than 0.05, then data did not conform to the Poisson distribution.

Figure 32 shows Stata output detailing both summary statistics of death count data for all wards and postcode sectors (further codified by age and sex specific groupings) in the UK in 2001, while Figure I shows typical output from a post-hoc goodness of fit test (in this case a model adjusting for age group and sex in Scotland).

```
. summ dth, detail

                             dth
-------------------------------------------------------------
      Percentiles      Smallest
 1%            0              0
 5%            0              0
10%            0              0       Obs              177387
25%            0              0       Sum of Wgt.      177387

50%            1                      Mean           9.998207
                        Largest       Std. Dev.      24.53731
75%            7            510
90%           28            570       Variance       602.0797
95%           52            644       Skewness       5.334085
99%          122            653       Kurtosis        48.1786
```

Figure 32: Summary statistics of UK death data, 2001

The column on the right hand side of this excerpt shows that the mean number of deaths in each and specific group within each ward or postcode sector was 9.99 while the variance was 602.08. Given the huge disparity between these two figures, it was reasonable to conclude that death count data were overdispersed.

```
. xi:poisson dth marker i.age, exposure(pop) irr nolog
i.agegrp          _Iagegrp_0-75       (naturally coded; _Iagegrp_0 omitted)

Poisson regression                                Number of obs   =     177387
                                                  LR chi2(9)      = 4777103.19
                                                  Prob > chi2     =     0.0000
Log likelihood = -369309.73                       Pseudo R2       =     0.8661

------------------------------------------------------------------------------
         dth |        IRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      marker |   1.135618   .0028833    50.09   0.000     1.129981    1.141283
  _Iagegrp_5 |   .1018716   .0021356  -108.95   0.000     .0977708    .1061444
 _Iagegrp_15 |   .4004632   .0053207   -68.88   0.000     .3901694    .4110286
 _Iagegrp_25 |   .6036602   .0070145   -43.44   0.000     .5900674    .6175662
 _Iagegrp_35 |   1.067147   .0111724     6.21   0.000     1.045473    1.089271
 _Iagegrp_45 |   2.652832   .0256406   100.94   0.000      2.60305    2.703566
 _Iagegrp_55 |    6.85194   .0637288   206.92   0.000     6.728165    6.977991
 _Iagegrp_65 |    18.6644   .1700532   321.21   0.000     18.33406     19.0007
 _Iagegrp_75 |   71.04044   .6389486   474.00   0.000      69.7991    72.30386
         pop | (exposure)
------------------------------------------------------------------------------

. estat gof

         Goodness-of-fit chi2  =  329562.5
         Prob > chi2(177377)   =    0.0000
```

Figure 33: Stata output from a Poisson regression model of death counts in Scotland

The goodness of fit test (highlighted in the figure above) for the Poisson regression model of death counts in Scotland with adjustment for age group produced a p-value of 0.0000, indicating that the Poisson model is inappropriate for the count data available. The calculation of this p-value is explained by Long and Freese [260].

Similar p-values were recorded for all Poisson models. This method of regression was, therefore, judged to be inappropriate and data from these models *were not included* in the results section. However, the method of Poisson regression is very similar to that of negative binomial regression (which was ultimately used) and having understood the details of the Poisson method, I was able to adopt the negative binomial method with some confidence.

7.2.2.3 Regression of death count data: negative binomial regression

The literature on modelling count data is nearly unanimous in recommending the negative binomial distribution as a basis for models where the Poisson distribution fails due to overdispersion.[258;260;261]. As such, negative binomial models were adopted for analysis of data in this thesis.

The negative binomial regression model is very similar in structure to the Poisson model described above with the key exception that it includes a random error term, ε_i, representing the effect of omitted explanatory variables or additional randomness (and thereby allows for discrepancy between the mean and the variance). Therefore, the general multivariate negative binomial regression equation (for a model with three independent variables) is as follows:

$$\tilde{\mu}_i = \exp(\beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \varepsilon_i)$$

Notice that the negative binomial model has a *fitted* μ_i (i.e. $\tilde{\mu}_i$). This $\tilde{\mu}_i$ is said to be a random variable (thanks to the introduction of ε_i).

By substituting the following values into the general negative binomial regression model, a specific regression equation can be generated:

μ_i = expected count of deaths

β_0 = constant

X_{i1}= age group

X_{i2} = sex

X_{i3} = country (i.e. Scotland or England)

ε_i = random error

Therefore a negative binomial regression equation might read;

Expected death count = exp(constant + β_1 age group + $\beta_2$sex + $\beta_3$country + error)

Age group, decile and location were modelled as categorical variables. This necessitated the creation of dummy variables so that any one category was compared with all other values in that category. For example, when modelling death rates in Glasgow, the relevant dummy variable was defined as 'not Glasgow' and so on.

7.2.2.4 Exposure variable in count models

The two model types described so far refer to models of death counts in Scottish postcode sectors and English & Welsh electoral wards. Wards and postcode sectors do not have equal population numbers. Those small areas with larger populations naturally have higher death counts than areas with smaller populations. Therefore, regression models for counts of death need to make some sort of allowance for the size of the local population. The local population can easily be incorporated as an *exposure variable* in negative binomial regression models, where it is written on the right hand side of the equation as t_i:

$$\mu_i = t_i + \exp(X_i\beta + \varepsilon_i)$$
$$\mu_i - t_i = \exp(X_i\beta + \varepsilon i)$$
$$therefore$$
$$\log\left(\frac{\mu_i}{t_i}\right) = X_i\beta + \varepsilon_i$$

The final equation here gives an incidence rate ratio (since μ_i, the expected death count, is divided by t_i, the population, to give a rate). Multiplying this incidence rate ratio by a factor of 100 gives a standardised mortality ratio if the dependent variable is the local death count and the exposure variable is the local population count. Stata is also able to calculate confidence intervals around these incidence rate ratios.

Results from regression models including age group, sex and deprivation decile as covariates were calculated with SMRs calculated by indirect standardisation. However, the main purpose of creating the regression models was to adjust death rates for continuous variables, particularly Carstairs z-scores. Figures comparing the SMR with adjustment for age, sex and Carstairs z-score and SMR calculated by indirect standardisation are displayed in the results chapter.

7.2.3 Summary

In summary, three methods were used to identify the extent to which deprivation contributed to excess mortality in the Glasgow conurbation and other urban areas. First, indirect standardisation was used with adjustment for age group, sex and Carstairs decile. Second, Poisson regression of death counts among small areas (using small area population size as an exposure variable) were used to model for other categorical and continuous independent variables and also to reflect variation in death rates at the small area level. Third, negative binomial regression models were used as a contingency against overdispersion of death count data.

The paper of Hanlon et al on the 'Scottish effect'[6] identified the portions of the Scottish population that had the largest excess mortality in comparison with the equivalent sectors of the English population. They made two important findings in this regard. First, the authors showed that excess mortality in Scotland (relative to England and Wales) was highest in Carstairs deprivation deciles 8, 9 and 10 with excess mortality being 10%, 10% and 16% in each of these segments of the Scottish population in 2001. It is important to note that Scottish residents in decile 10 had an excess mortality of 16% compared to English residents in *equally deprived* areas. Second, when looking at age and sex specific sections of the Scottish population that younger working aged men (16-44 years old) had the largest excess mortality in comparison to similarly aged English males. This excess mortality increased significantly between 1981 and 2001.

Figure 40 and Figure 58 in the Results chapter show that Glasgow City and the Clydeside conurbation had large numbers of residents living in postcode sectors 8,9 and 10 of the Carstairs distribution. It was therefore of interest to identify the extent to which there was excess mortality in these segments of the local population in comparison to equally deprived parts of the rest of the UK and also to see if the same phenomenon could be observed in other UK cities and conurbations.

7.2.4 Age and sex specific comparisons

In order to understand the nature of excess mortality in cities and conurbations, I was interested to look at age and sex specific mortality ratios within particular city populations. This would enable me to suggest which population groups within a city had the highest excess mortality relative to their peers in the whole of the UK. Stata appears to lack the capability of running a regression model in conjunction with a conditional function. That is, one cannot command Stata to regress death counts in a particular area but only among a particular age group. Thus, steps were taken to manipulate data in such a way that age specific mortality ratios for certain localities could be calculated

Population and death data for each ward and postcode sector were available for both sexes and for 9 separate age groups (0-4, 5-14, 15-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75 years and older). Therefore, 18 population variables and 18 death count variables were created. For example, the variable *mdth0* was created to return the value in the *dth* (death count) variable if the case in question referred to the males aged 0-4.

Typical Stata syntax for one of these models is as follows:

nbreg mdth0 Glasgow, exposure(mpop0) irr

Where:

nbreg: this is the Stata command to run a negative binomial regression

mdth0: this is the dependent variable in the model, deaths of males aged 0-4

Glasgow: this covariate instructs Stata to use only death counts of postcode sectors that are marked as being in Glasgow

exposure(mpop0): this is the exposure variable (for an explanation of the exposure variable see section 7.2.2.4 in this chapter).

irr: this command instructs Stata to produce the output of the model as an incidence rate ratio. This ratio can then be multiplied by 100 to obtain a standardised mortality ratio.

7.3 Different definitions of geography and deprivation

The methods in this section address the final research question which states:

- What do different definitions of geography and deprivation have on the size of this residue?

In the above research question, the term ‘this residue’ refers to the portion of excess mortality in Glasgow (and other cities) that remains after adjusting for Carstairs deprivation decile.

7.3.1 Geography

7.3.2 Selection of conurbations

In the light of the available data and because of the impracticality of other city definitions, a second set of comparator cities was created that was also based on data from local authority areas. Data from heavily urbanised local authority areas that lay immediately adjacent to certain large cities (or where a city was part of a recognisable conurbation) were used to create a second set of deprivation profiles and standardised mortality ratios. This second set of urban areas was referred to as ‘conurbations’. A description of these conurbations appears below.

One hypothesis is that Glasgow has excess mortality because of the way in which the city has been defined. Glasgow City is the most populous settlement in a large, urban area located in West Central Scotland. There are many affluent suburbs of the city (including Bearsden, Milngavie, Lenzie, Clarkston, Newton Mearns and Bishopbriggs) that do not lie inside the boundary of the Glasgow City Council area but are immediately adjacent to and continuous with the City’s built-up area (an example of under-bounding). The suburbs listed have a combined population of 75,000 and since they enjoy better than average population health (in comparison to the rest of Scotland, at least[212]) it is conceivable that their exclusion from Glasgow City's health data leads to a misleadingly pessimistic picture of health within the city. Therefore, I created a second definition of Glasgow, which I included in certain analyses. This was an 'optimistic' definition in that it included postcode sectors within the Glasgow City boundary as well as those from East Dunbartonshire, East Renfrewshire, and the two council areas where Glasgow's most affluent dormitory towns are located. In addition, I included Renfrewshire as there are numerous relatively prosperous small towns in this council area which are, in effect, suburbs of Glasgow such as Kilbarchan, Erskine and Bishopton, although this council are also contains the large town of Paisley which has its fair share of deprived areas. Glasgow was the only city where I created such a second, optimistic definition as my own local knowledge allowed me to identify areas of affluence adjacent to the city and I only calculated SMRs for 2001 for this entity.

Several UK cities are located within larger continuous urban areas or conurbations. The same issues that affect population health in a particular city will, in all likelihood, also be in operation in the wider conurbation. The *Scottish Effect* paper[6] identified that most of Scotland's excess mortality could be attributed to postcode sectors in deciles 8, 9 and 10 of the Carstairs deprivation score distribution (this is certainly true of the 2001 census but less so in earlier years). It is well established that the most deprived areas of Scotland are located in Glasgow and West Central Scotland[119;262]. West Central Scotland, in addition to Glasgow, is very densely populated and is the location of several large towns and can be seen as a conurbation that has the city of Glasgow at its core (see Figure 34 below). While Glasgow City has the deserved reputation of having the worst population health in the UK, many of the surrounding towns also have very unfavourable population health outcomes. Shaw and Dorling's work on life expectancy in UK parliamentary constituencies indicated that of the fifteen constituencies with the lowest life expectancy for males in 1999, ten were in the Strathclyde region (including all 9 constituencies within the Glasgow City Council boundary)[263]. Moreover, constituencies around the city also ranked poorly, with life expectancy significantly below the UK average. There was, therefore, an issue of geography and identifying the extent to which the relationship between deprivation and excess mortality was confined to post-industrial cities or if the phenomenon could be observed across the region of urban hinterland that are present around many UK cities. It was therefore necessary to identify regions similar to West Central Scotland in existence around other UK cities and make comparisons of their population health.

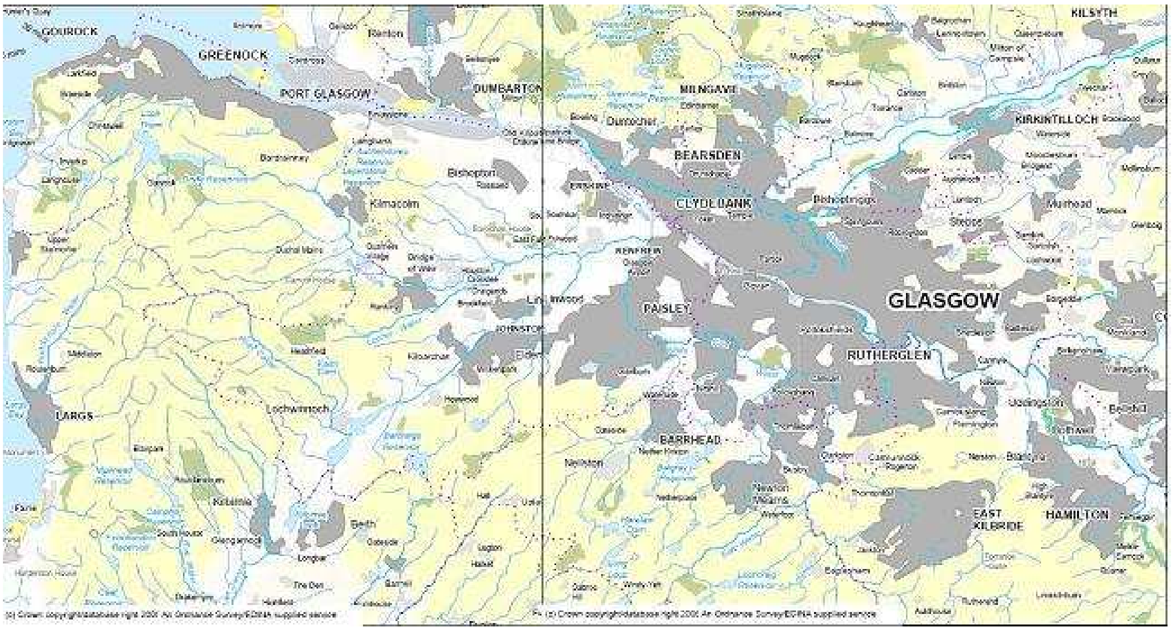


Figure 34: Map of Clyde side conurbation

7.3.2.1 Description of conurbations

Glasgow is at the centre of a large conurbation that stretches from Greenock in the West to Airdrie in the East and from Balloch in the North to East Kilbride and Larkhall in the South. This conurbation spans eight local authority areas (see Error! Reference source not found. below). There are six that have an immediate border with Glasgow City Council area while Inverclyde (the location of towns such as Port Glasgow and Greenock) does not border Glasgow directly but these towns have such similar social histories and health outcomes as Glasgow that for the purposes of this thesis, the Inverclyde Council area will be included as being part of the 'Clydeside' conurbation. Therefore, the Clydeside conurbation will be defined for analysis as comprising postcode sectors in the following Scottish Local Authority areas (working clockwise round Glasgow City Council area from Northwest to Southwest): West Dunbartonshire, East

Dunbartonshire, North Lanarkshire, South Lanarkshire, East Renfrewshire, Renfrewshire and Inverclyde. Three of these council areas (South Lanarkshire, Renfrewshire and Inverclyde) have a large rural component. Rural areas present different challenges to population health than heavily urbanised areas. However, in each of these areas, the large towns provide the overwhelming majority of the local population and so the effect on population health statistics of including data from these rural areas is likely to be small. For example, in 2001, South Lanarkshire had a total population of 337,000. Of these, only 35,000 lived in the largely rural district in the southern portion of that Local Authority that was previously known as 'Clydesdale District' in the time of the previous Strathclyde Regional Council.

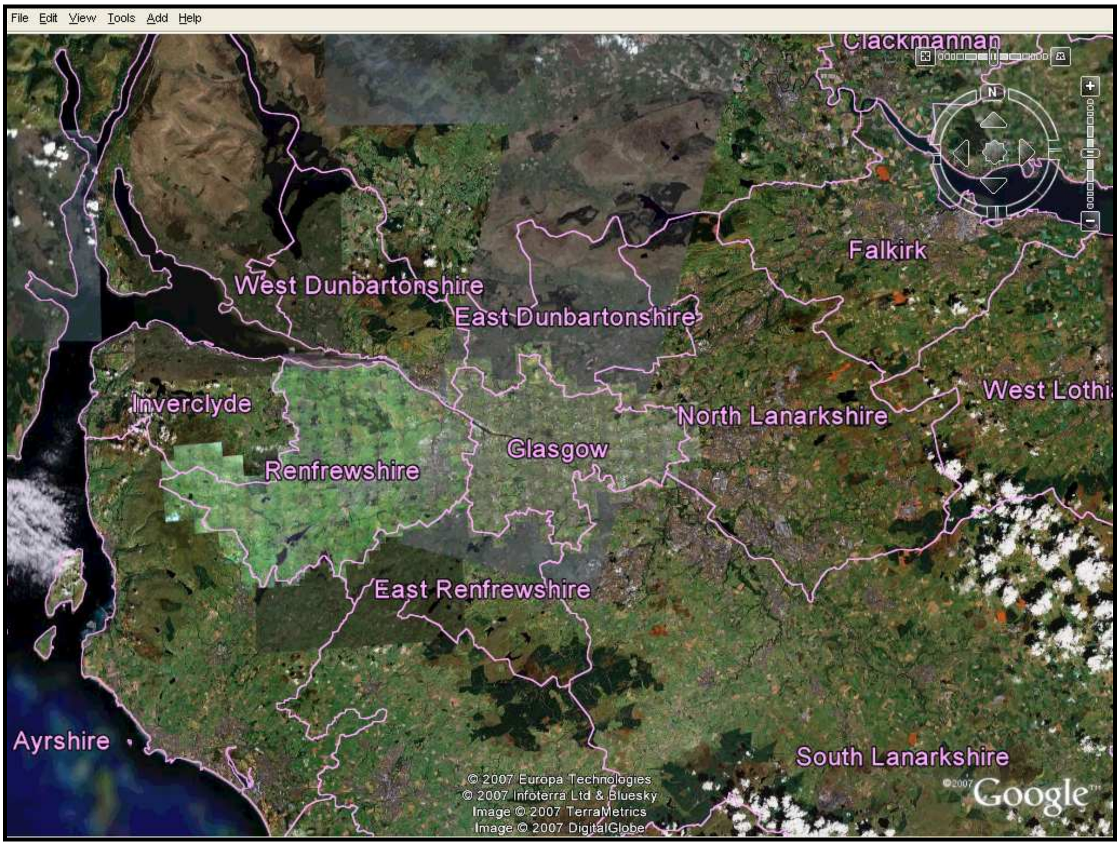


Figure 35: Local authority areas in the West of Scotland

None of the other large Scottish cities are part of a conurbation in the same sense as Glasgow but there are a few recognisable conurbations in England that are comparable and therefore were compared with Clydeside. All of the conurbations in England that will be compared with Glasgow were, until 1986, part of Metropolitan counties. There were six of these in England and functioned as elected local government authorities with powers to run regional public transport, main roads, emergency services, civil protection, waste disposal and strategic town and country planning. They were created by the Westminster Government with the explicit intention of administering the large conurbations outside London. As the White Paper proposal for the creation of these counties passed through parliament, their boundaries were gradually trimmed so that by the time of the counties' inception their borders were, generally speaking, limited to continuously built-up areas. The Metropolitan counties came into existence in 1974 but were abolished by the Thatcher administration in 1986[245]. Even though they are no longer formally recognised as administrative entities, their borders serve as reasonable indicators of the extent of conurbations in England.

Manchester was previously part of the Metropolitan county of Greater Manchester. This county ceased to formally exist following local government reorganisation in 1986. The county contained 10 boroughs (City of Manchester, City of Salford, Trafford, Tameside, Wigan, Bolton, Oldham, Bury, Rochdale and Stockport) that have now been replaced by Unitary Authorities with identical names and borders. Therefore, in this thesis, when the term *Greater Manchester* is used, it will refer to census and mortality data from the wards located within these 10 Unitary Authorities.

Liverpool is the main city in the Merseyside conurbation. Like Greater Manchester, Merseyside was formerly a Metropolitan county. It comprised five boroughs (Liverpool City, The Wirral, Sefton, Knowsley, St Helens) that have since been replaced by five identically named and bounded Unitary Authorities. Data from the wards contained within will be referred to as *Merseyside* throughout this thesis.

Newcastle upon Tyne was previously part of the Metropolitan County of Tyne and Wear. The other boroughs in this county were Gateshead, Sunderland, North Shields and South Shields. Wards from the unitary authorities that replaced these boroughs will be referred to as *Tyneside* throughout this thesis.

Leeds and Bradford are two large cities that are situated immediately adjacent to one another. These cities were previously part of the Metropolitan County of West Yorkshire. There were five boroughs in this county in total, but the other three boroughs (Calderdale, Kirklees and Wakefield) have a much higher proportion of their population living in more rural areas and isolated towns. Given the population density of the other conurbations, these areas were left out of the West Yorkshire conurbation (leaving just Leeds and Bradford) in order to make a more suitable comparison.

The city of Sheffield was part of the Metropolitan county of South Yorkshire. This comprised 4 boroughs; Sheffield, Rotherham, Barnsley and Doncaster. Of these, Sheffield and Rotherham had the highest population density whilst Barnsley and Doncaster, despite containing some large towns, had a more rural character. Therefore, in order to define a conurbation that was appropriate for comparison with Clydeside, data from Sheffield and Rotherham boroughs only were included as the South Yorkshire conurbation.

There also existed a West Midlands Metropolitan county. This was the most populous of all the Metropolitan counties and included 7 boroughs: City of Birmingham, City of Coventry, City of Wolverhampton, Dudley, Sandwell, Solihull and Walsall. The wards within the Unitary Authorities that replaced these boroughs will be referred to as *West Midlands* throughout this thesis with the exception of the City of Coventry which will not be included since it is separated from the rest of the urban area by a 15 mile wide stretch of green belt known as the 'Meridien gap' which retains a strong rural character and also because it is not included in the West Midlands conurbation defined by the Office of National Statistics in 2001[264].

There are other conurbations in England; Southampton, Portsmouth and Gosport in Southern Hampshire; the cluster of towns around Nottingham in the East Midlands; Bournemouth, Christchurch and Poole in Dorset. However, these conurbations differed significantly from those previously listed in terms of their administrative, social and economic history and so were not included for comparison with Clydeside.

A detailed breakdown of the conurbations selected for comparison is provided in Table 9 overleaf.

Table 9: Conurbations selected for analysis.

Conurbation Name	Population (2001 Census)
Clydeside	1,749,071
Greater Manchester	2,482,259
Merseyside	1,362,055
Tyneside	1,075,975
West Midlands	2,254,702
West Yorkshire	1,183,070
South Yorkshire	761,411

Certain conurbations have constituent areas with populations in excess of 275,000. For example, Wigan Unitary Authority in Greater Manchester has a population of 300,000, sufficient to merit its inclusion on the list of large UK cities. However, the Wigan Unitary Authority Area is the location of several, distinct urban settlements, of which the town of Wigan is by far the largest with a population of 166,000 according to the Office of National Statistics[264]. Similar explanations could be given for the other areas with a population of greater than 275,000 that do not otherwise appear on the list of large cities.

7.3.3 Deprivation

As has been described, regression models of death counts were used to quantify excess mortality in Glasgow and other cities after adjusting for age, sex and deprivation, where the deprivation variable was either Carstairs decile or Carstairs z-score. It was not the intention of Carstairs and Morris to create an index that would measure all the domains of deprivation; instead they deliberately chose indicators that were best able to account for high mortality rates in Scotland[113] and excluded other deprivation related variables that had a smaller *independent* explanatory effect. As was discussed in the literature review, more recent indices of multiple deprivation have attempted to describe the true extent and nature of deprivation in the UK but these have not been compiled with the explicit intention of explaining gradients in health outcome. The Carstairs index was first published in 1989 and was based on data from 1981[132]. In the intervening period, it is conceivable the deprivation factors that are associated with excess mortality have changed; perhaps some of the variables originally excluded by Carstairs and Morris from their index have become more closely associated with health outcome or perhaps altogether different variables that were not even considered by Carstairs and Morris are now able to explain patterns of mortality. In addition, the Carstairs index is an amalgam of four standardised census variables. There is no published work that examines how these four variables have varied in their own independent explanatory ability over time and if they contribute equally to the overall explanatory effect of the Carstairs index.

These questions could not be answered using indirect standardisation, so negative binomial regression models of death counts (with population of wards or postcode sectors as the exposure variable) were used.

Models were created to compare the explanatory ability of the four Carstairs component variables on death rates. For each city or conurbation, eight regression models (with the following variables as covariates) were created (and these models were repeated with data from each census year):

Age group, sex and no_car

Age group, sex and overcrowding

Age group, sex and unemployment

Age group, sex and social class

No_car

Overcrowding

Unemployment

Social class

Whole-city incidence rate ratios calculated by these models were tabulated (along with their confidence intervals) and were compared with previously calculated results for the same areas.

For 2001 data only, additional census variables were introduced as covariates in regression models. There are several variables in the census that can be used as indicators of material or social deprivation and some of these have been incorporated into other indices of deprivation[116;126]. Census variables chosen for analysis were:

- Percentage of households with one adult and dependent children (for the purposes of analysis this was given the title *lone_par*)
- Percentage of adults who were long-term unemployed i.e. adults who had not worked for more than two years (*long_term)*
- Percentage of residents over the age of 16 who had never worked (*never_worked*)
- Percentage of adults without qualifications (*no_quals*)

- Percentage of adults rating their own health as 'not good' (*health*)

Data at postcode sector and ward level were downloaded from the GRO(S) and ONS websites for Scotland and England & Wales respectively. The datasets from each country were merged. To make a valid comparison with existing Carstairs data, scores for each new variable were standardised using the z-score technique previously described.

Deprivation profiles were drawn for cities based on z-scores from these variables. For each variable, the Scottish and English population was broken into ten deciles according to z-scores of individual postcode sectors and wards. These profiles were compared with previously drawn Carstairs deprivation profiles. Correlation coefficients between these variables and the four Carstairs variables were calculated and are tabulated in the results section

Regression models of death counts were generated which had each of these variables as covariates (along with age and sex). The resultant standardised mortality ratios for cities and conurbations were tabulated and compared with the SMRs calculated when adjusting for age, sex, Carstairs decile, Carstairs z-score and the four constituent components of the Carstairs index

8 Results

In this chapter, I will present the results that answer each of the research questions in turn.

8.1 What is meant by excess mortality and what is the size and nature of Glasgow's excess mortality when compared with comparable cities in the UK?

8.1.1 .Deprivation Profiles

Carstairs deprivation profiles were created for several areas for each census time point. First, Scotland and England were compared in 1981, 1991 and 2001. A deprivation profile with 10 equal-sized columns indicates that 10% of the area's population (be it a country, conurbation or city) lived in wards or postcode sectors of each of the 10 Carstairs deciles. Carstairs deciles, unless otherwise stated are the tenths of the UK population ranked by the Carstairs score of the local ward or postcode sector area. For example, when talking about decile 5 residents in Scotland, the population in question are Scots who live in the fifth most affluent decile of the UK population.

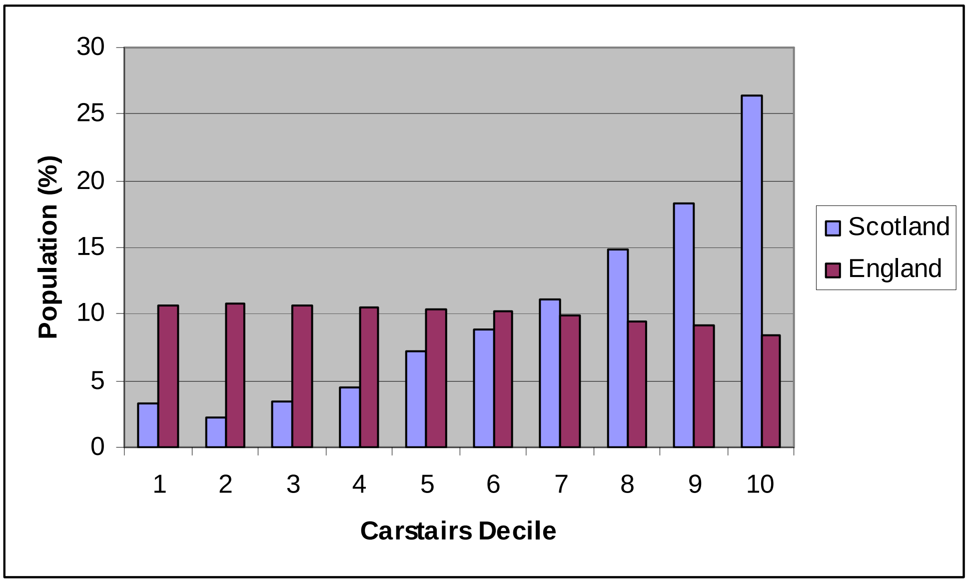


Figure 36: Carstairs deprivation profile, Scotland and England, 1981

Figure 36 shows that in 1981, Scotland had higher proportions of its residents in the more deprived Carstairs deciles than did England. More than 25% of the Scottish population lived in a postcode sector that was in decile 10 of the Carstairs score distribution. Approximately 8% of the English population lived in a ward that was in decile 10. However, in absolute terms, England had far more people in this decile than Scotland. The total population of England in 1981 was 48 million: 8% of this figure is 3.8 million, while 25% of Scotland's population of 5 million is 1.25 million. However, the deprivation profile serves as an indicator of the extent of affluence and deprivation in each country at the time of the 1981 census.

By 1991 and 2001, Scotland's position relative to England (in terms of deprivation as measured by the Carstairs score) improved considerably. As both Figure 37 and Figure 38 show, Scotland gained residents living in affluent areas and lost residents in deprived areas.

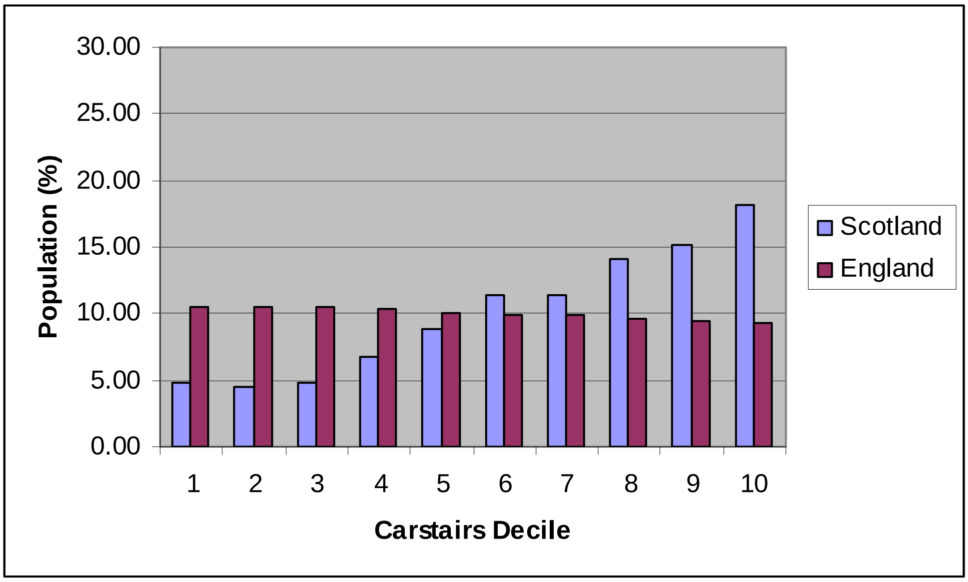


Figure 37: Carstairs deprivation profile, Scotland and England, 1991

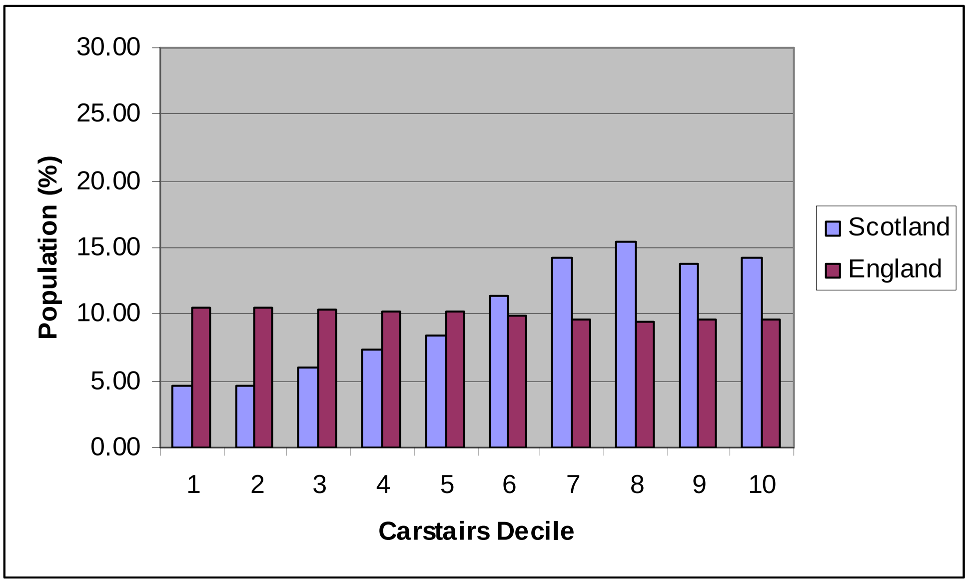


Figure 38: Carstairs deprivation profile, Scotland and England, 2001

The deprivation profiles for Scotland and England disguise wide variations in the deprivation status of specific cities and conurbations within each of the two countries. There now follows a series of figures which show the Carstairs deprivation status of certain large UK cities (outside of London) over the period 1981-2001. These deprivation profiles were deliberately drawn with the same maximum value on the ordinate axis in order to make quantitative differences in the deprivation profiles of cities clearer.

The first deprivation profile displayed here is for the amalgamated population of all UK cities with a population in excess of 275,000 at the 2001 census (plus Newcastle upon Tyne). This amalgam was given the title *All cities* and was created with the intention of showing the deprivation profile of the UK's non-London urban population and can be thought of as the 'average' deprivation profile of UK cities.

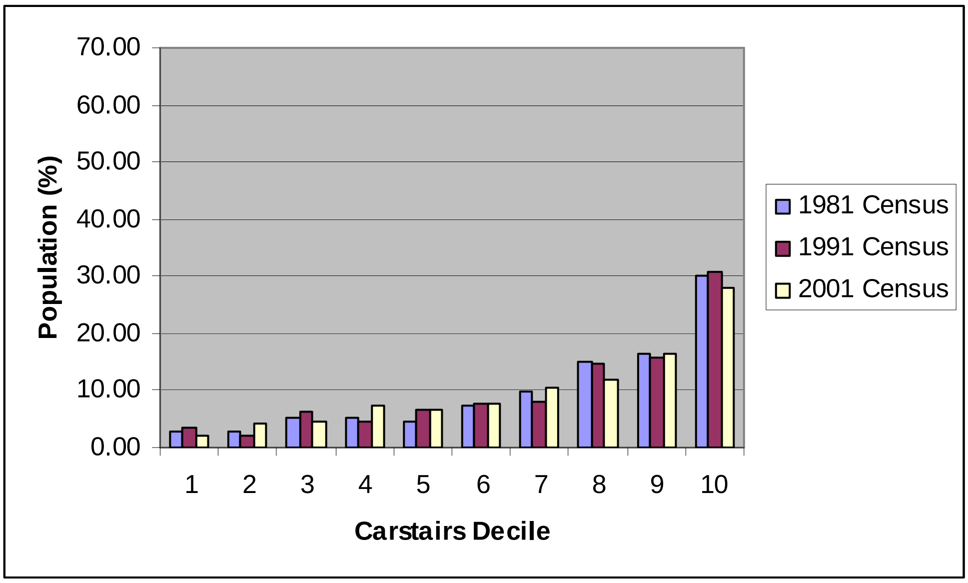


Figure 39: Carstairs deprivation profiles for *All cities*, 1981-2001

Figure 39 shows that the UK's cities have more than their fair share of the most deprived postcode sectors and wards and less than their fair share of affluent areas. The deprivation profile for *All cities* remained relatively unchanged between 1981 and 2001. Approximately 30% of the UK's 6 million residents of large cities lived in a ward or postcode sector classified into the most deprived decile.

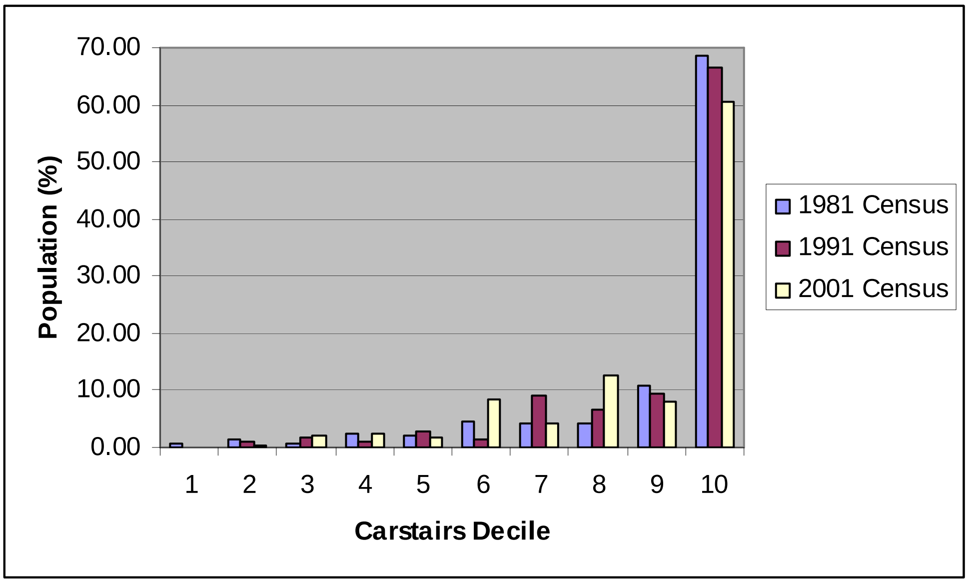


Figure 40: Carstairs deprivation profile for Glasgow City area*, 1981-2001
***Glasgow City was a district of Strathclyde Regional Council at the 1981 and 1991 censuses but local government reorganisation led to the creation of the Glasgow City Council Unitary Authority. This area had a slightly different boundary to the pre-existing district.**

The majority of Glasgow residents lived in the most deprived Carstairs decile at each census. Sixty eight percent of Glasgow residents in 1981 lived in a postcode sector area that was classified as being in the most deprived tenth of all UK areas in 1981. Although this figure had improved appreciably by 2001 (to 60.2%), Glasgow was still a city overwhelmingly characterised by deprivation. The fact that Glasgow has a very large deprived component to its population is well known to policy makers but it is of interest to see how Glasgow compares against the UK as a whole on an objective measure. In addition to relative population loss in the most deprived deciles, Glasgow lost residents in the two most affluent Carstairs deciles during this period.

Glasgow has a number of comparatively affluent suburbs, which are characterised by middle class residents and comfortable detached houses, situated immediately beyond its city boundaries (including Bearsden, Milngavie and Lenzie to the North and Newton Mearns, Busby and Giffnock to the South). The exclusion of these suburbs adversely affects the appearance of Glasgow's deprivation profile. As discussed in the Methods chapter (page 116), Glasgow can be seen as an under-bounded city whereby the city's administrative boundaries do not match its functional boundaries. Nonetheless, in 2001, 61% of the city's 577,000 residents lived in a decile 10 area (that is 350,000 people). This is more than for any comparable UK city. A deprivation profile for the wider Clydeside conurbation is presented along with profiles for other conurbations later in this chapter.

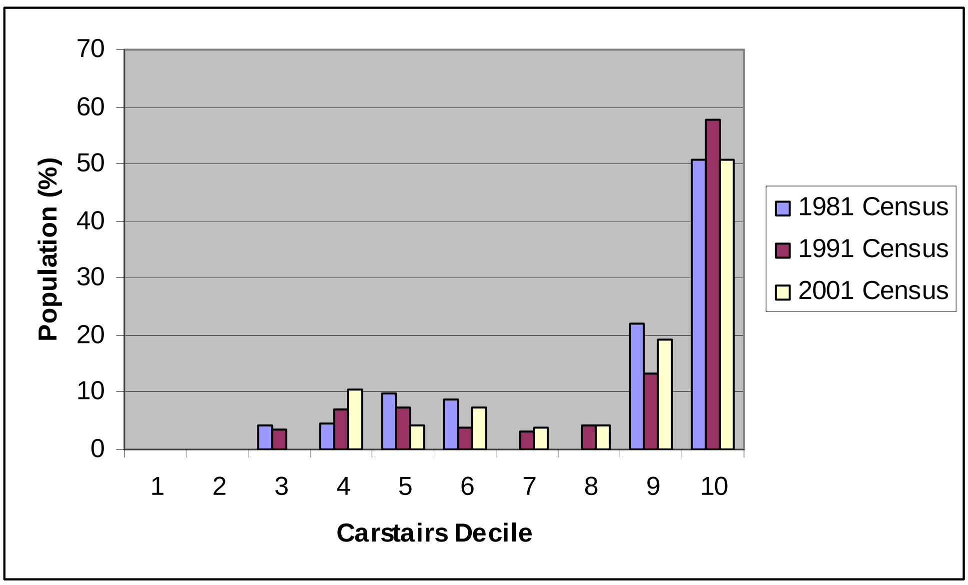


Figure 41: Carstairs Deprivation profile for Liverpool, 1981- 2001

After Glasgow, Liverpool had the largest portion of its residents living in wards that were in the most deprived tenth of all UK wards. In 1981 and 2001, approximately 50% of Liverpool's population lived in the most deprived decile, with a further 18% in decile 9. Liverpool had no wards that were in the two most affluent deciles, although this does not necessarily lead to the conclusion that Liverpool lacked any affluent residents (for reasons explained below). The change in the number of residents in decile 10 over the time period was due to one ward which was classified in decile 9 in 1981 being classified into decile 10 in 1991 and then back into decile 10 for the 2001 census. It is, therefore, unwise to make judgements about whether Liverpool became more affluent or deprived between 1981 and 2001 according to this measure.

The basic census units for which data was made available in England and Wales were wards. Wards have higher average populations than their Scottish equivalents postcode sectors. Liverpool had 32 wards at the time of the 2001 census while Glasgow had 104 postcode sectors. The 'resolution' of deprivation profiles for cities in England is not as fine as for cities in Scotland. Wards encompass larger areas than postcode sectors and are therefore less homogenous in the social makeup of the local population and material quality of housing. As a result, it is common for deprivation profiles of cities in England to have gaps where there appears to be no population in a particular decile. If the unit of geography was smaller, it seems probable that in Liverpool (a city of 440,000 residents) there would be some residents who lived in areas that were typical of deciles 1 and 2. As mentioned in the Literature Review, the English Index of Multiple Deprivation[130] uses smaller units than wards but these units do not map well to the geographical units at which mortality data were released.

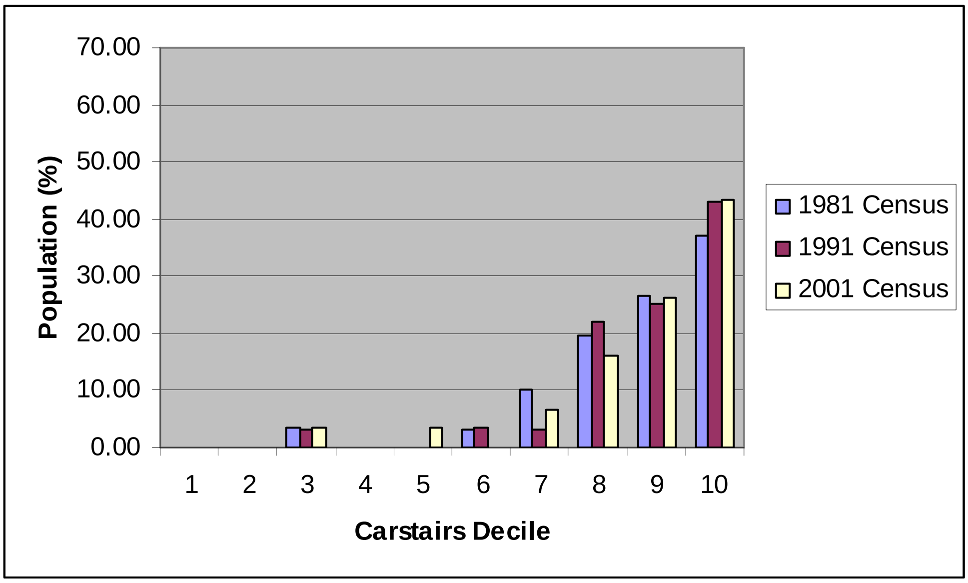


Figure 42 Carstairs Deprivation profile for Manchester, 1981-2001

Manchester was another city with a large component of its population in the most deprived deciles of the Carstairs distribution and with just one ward with a population of about 15,000 classed into decile 3.

Most of the other large cities outside of London showed similar patterns of deprivation to Glasgow, Liverpool and Manchester with comparatively few residents in affluent deciles and larger numbers of residents in deciles 7, 8, 9 and 10, although Glasgow, Liverpool and Manchester stand out as having very high numbers of residents in the most deprived deciles. However, there were two cities that did not conform to the pattern of Glasgow, Liverpool and Manchester. Instead, the cities of Edinburgh and Bristol had different deprivation profiles compared with most other cities. Edinburgh's deprivation profile is shown in Figure 43 below while the profile for Bristol is displayed in the appendix.

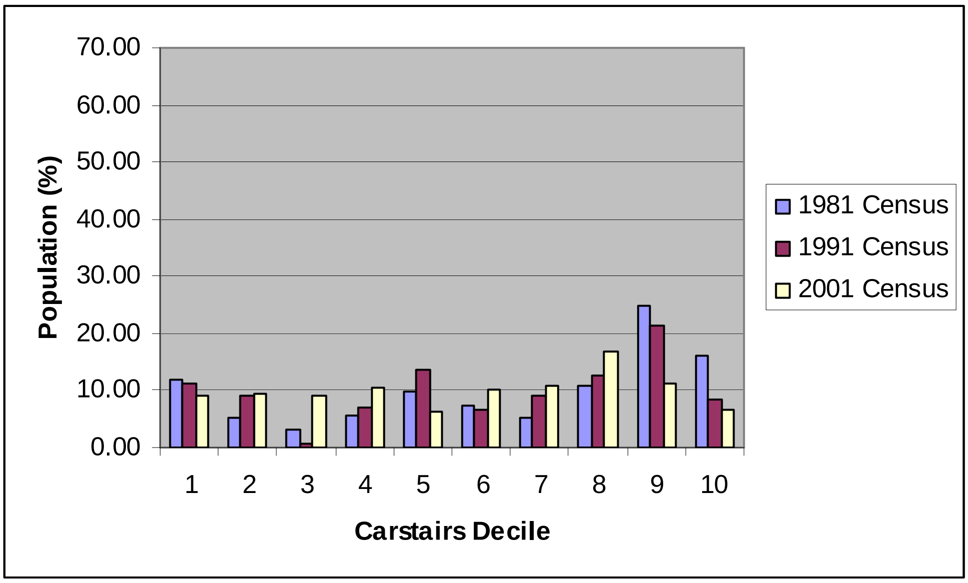


Figure 43: Carstairs deprivation profile for Edinburgh, 1981-2001

Edinburgh was the only city to have substantial numbers of residents in the most affluent Carstairs deciles at any of the censuses. This city lost residents in the most affluent decile between 1981 and 2001 but during the same period the proportion of Edinburgh residents in the two most deprived Carstairs deciles dropped substantially. In 1981, nearly 25% of Edinburgh residents lived in decile 9 postcode sectors but by 2001, this figure fell to just over 10%. Edinburgh gained residents in deciles 6, 7 and 8.

Deprivation profiles for the other large cities (Birmingham, Bradford, Bristol, Coventry, Leeds, Leicester, Newcastle, Sheffield and Sunderland) and some conurbations (deprivation profiles of conurbations are presented later in this chapter) in the UK will not be discussed in detail here. However, they are included in the Appendix at the back of this thesis.

8.2 Excess mortality and deprivation in Glasgow and other cities in the UK

The following results from indirect standardisation of death rates answer the following research questions as similar methods were adopted to answer them both:

a) What is meant by excess mortality and what is the size and nature of Glasgow's excess mortality when compared with comparable cities in the UKA?

b) How much of this excess mortality can be attributed to the deprivation as measured by the Carstairs index of deprivation?

8.2.1 Indirect standardisation of death rates

Death rates in various cities and conurbations were compared using the indirect standardisation method. All figures are displayed with 95% confidence intervals for each calculated standardised mortality ratio.

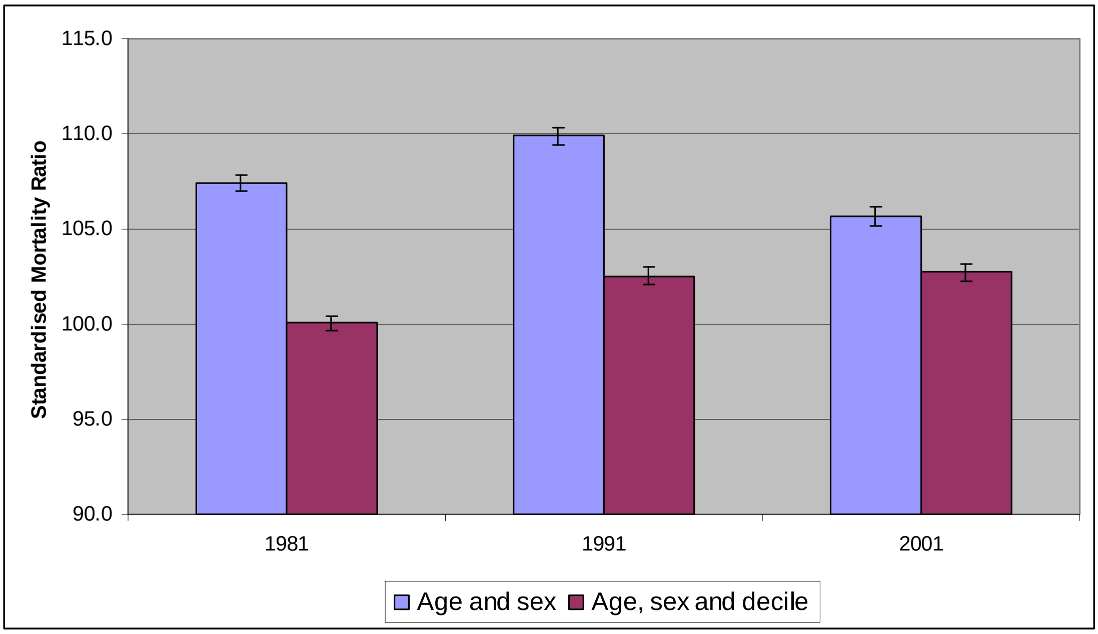


Figure 44: Standardised mortality ratios with adjustment for age and sex and also age, sex and Carstairs deprivation decile, *All cities* 1981-2001

Strictly speaking, SMRs for a particular location are not completely comparable over time. The composition of the underlying population will change over time due to local residents dying; in-migration of new residents and out-migration of other residents. The health status of those individuals departing and arriving in the area are unlikely to be similar to the majority of the local population. However, such SMRs do provide as useful an indicator as any method of the general trend in health in a particular place over time.

Compared with the UK as a whole, large cities had higher mortality rates at all three census time points. In 1981, the age and sex adjusted SMR for the population of thirteen large cities (in order of population size, they were: Birmingham, Leeds, Glasgow, Sheffield, Edinburgh, Liverpool, Manchester, Bradford, Bristol, Coventry, Sunderland, Leicester and Newcastle upon Tyne) was 107.4 ± 0.4. This means that the death rate in cities (after adjusting for age group and sex) was 7.4% higher than the death rate in the whole of the UK. In 1991, the age and sex adjusted SMR grew slightly to 109.9 ± 0.5 but the figure then fell again to 105.7 ± 0.5 in 2001. This was significantly lower than both the 1981 and 1991 figures.

After adjustment for Carstairs deprivation decile, the SMR in cities fell significantly at each census time point. In 1981, the SMR was 100 ± 0.4, indicating that after adjusting for deprivation, mortality rates in large UK cities were no different to the national average. In 1991 and 2001, there was still a slight excess mortality in cities after adjusting for Carstairs decile although the great majority of the excess seen after adjusting for age group and sex only was eliminated.

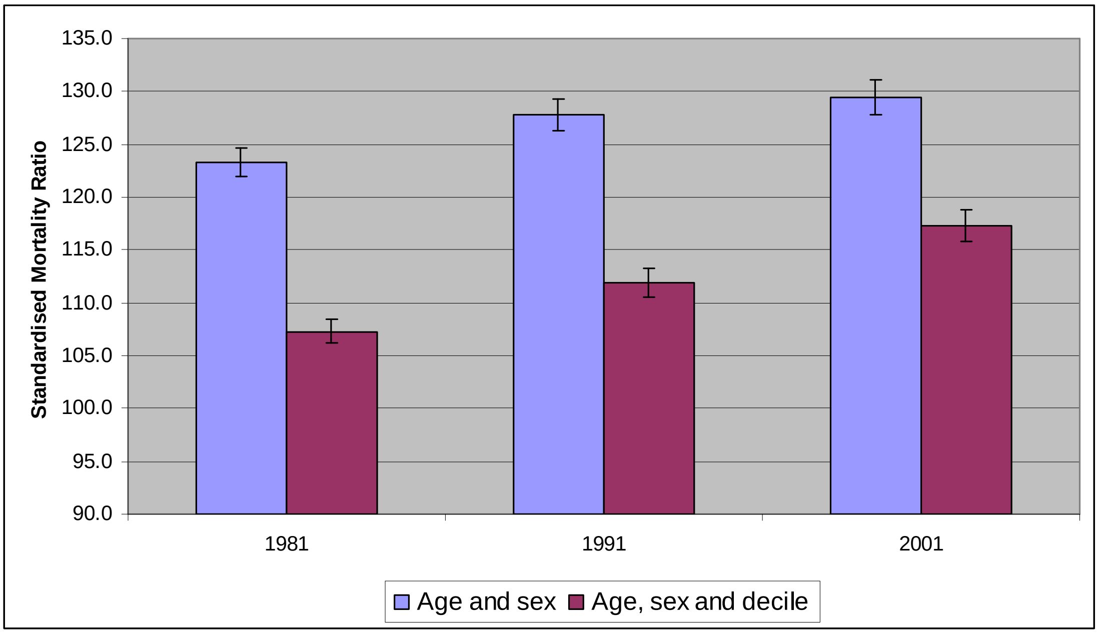


Figure 45: Standardised mortality ratios with adjustment for age and sex and also age, sex and Carstairs deprivation decile, Glasgow 1981-2001

Age and sex adjusted SMR for Glasgow in 1981 was 123 ± 1.3. This represents an excess mortality of 23% compared to the UK as a whole at that time. By 1991, this figure had risen to 127 ± 1.5 and by 2001, it was 129.5 ± 1.7. This demonstrates that Glasgow already had a far higher death rate than the UK average in 1981 and that this gap actually grew in relative terms until 2001.

Adjustment for Carstairs deprivation decile significantly reduced the magnitude of the SMR in Glasgow at all three time points. In 1981, the age, sex and deprivation decile adjusted SMR was 107 ± 1.3. In 1991, it was 112 ± 1.5 and in 2001 it was 117 ±1.7.

Standardised mortality ratios for Glasgow did not follow the pattern of 'typical' UK cities in this period: age and sex adjusted SMR increased significantly between 1981 and 2001 and age, sex and Carstairs decile adjusted SMR also increased significantly.

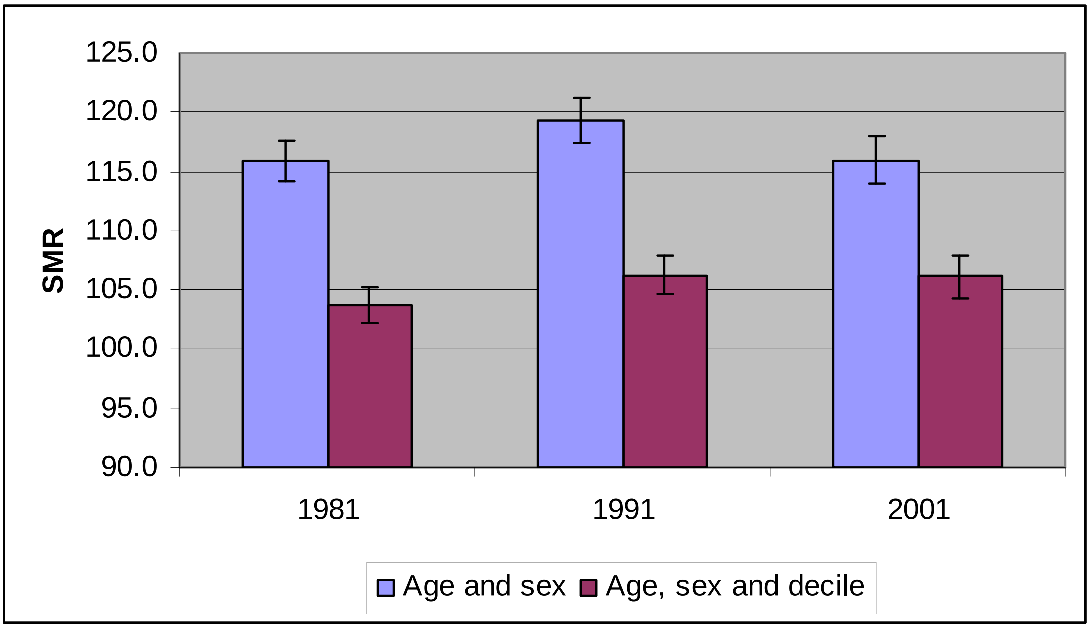


Figure 46: Standardised mortality ratios with adjustment for age and sex and also age, sex and Carstairs deprivation decile, Manchester 1981-2001

The age and sex adjusted SMR in Manchester did not change significantly between 1981 and 2001. Adjusting Manchester's SMR for Carstairs deprivation decile significantly reduced the magnitude of the excess mortality at all three time points.

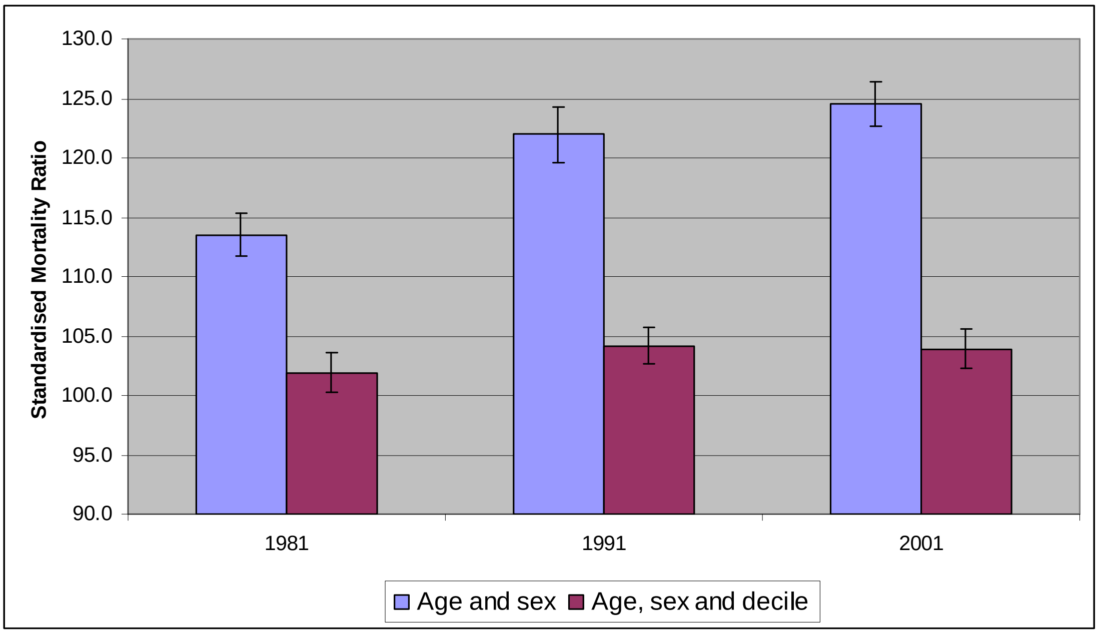


Figure 47: Standardised mortality ratios with adjustment for age and sex and also age, sex and Carstairs deprivation decile, Liverpool 1981-2001

Liverpool had the second highest age and sex adjusted SMR of UK cities at all three time points. This SMR rose significantly from 113.5 ± 1.8 in 1981 to 124.5 ± 1.9 in 2001. This was a steeper rise than observed for Glasgow in the same time period.

Adjusting SMR for local deprivation status appeared to make a bigger difference to the magnitude of SMR in Liverpool compared with Glasgow and Manchester. The age, sex and decile adjusted SMR in Liverpool did not rise significantly between 1981 and 2001 and reached its highest value in 1991 (104.2 ± 1.5). Deprivation explained more of the excess mortality in Liverpool at all three census time points than in either of Manchester or Glasgow.

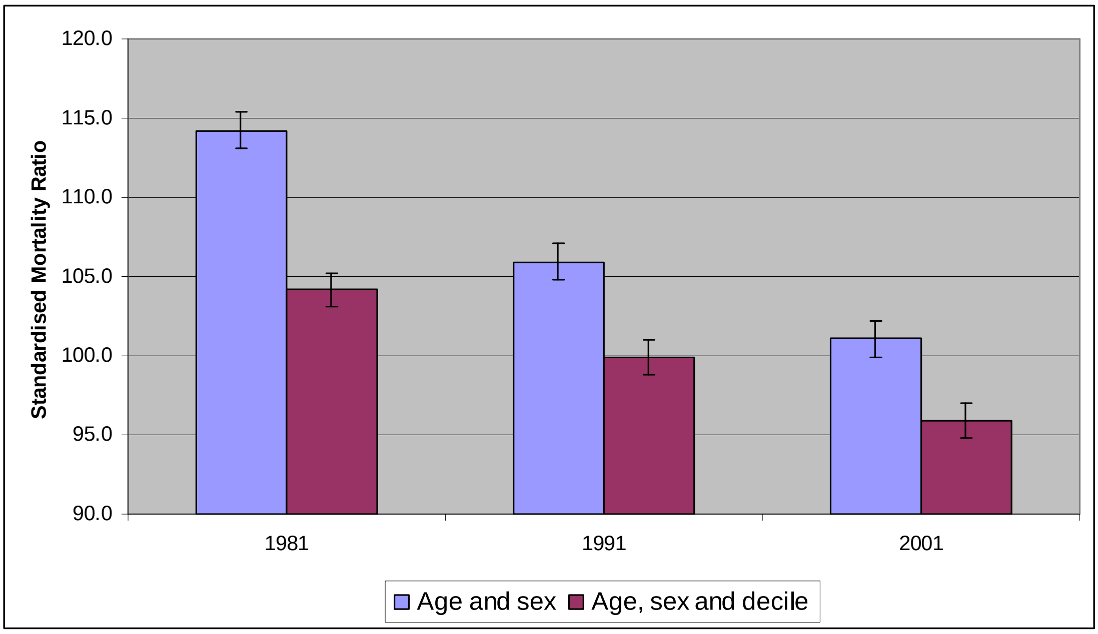


Figure 48: Standardised mortality ratios with adjustment for age and sex and also age, sex and Carstairs deprivation decile, Birmingham 1981-2001

Birmingham had an age and sex adjusted SMR of 114.2 ± 1.2 in 1981. Birmingham's SMR fell significantly to 105.9 ± 1.1 in 1991 and then fell again to 101.1 ± 1.2 in 2001, indicating that Birmingham did not have a significant excess mortality relative to the UK as a whole in 2001. Birmingham, along with cities such as Manchester, Liverpool and Glasgow, is described as a post-industrial city[148]. Unlike the other post-industrial cities, Birmingham's SMR fell between 1981 and 2001.

The age, sex and decile adjusted SMR in Birmingham also fell during this period. By 2001, this SMR was 95.9 ± 1.2, indicating that when allowing for deprivation factors, death rates in Birmingham were significantly lower than the national average. This contrasts with *All cities*, Glasgow, Liverpool and Manchester.

The SMR results for the other large cities not already mentioned will not be discussed in detail here. However, the following two summary figures do include the data from these cities. First, Figure 49 summarises age and sex adjusted SMR trends in large cities and Figure 50 summarise the SMR figures after adjusting for age, sex and decile. For greater clarity, the lines corresponding to Glasgow, Liverpool, Manchester and *All cities* have been drawn more heavily in the figures that appear below.

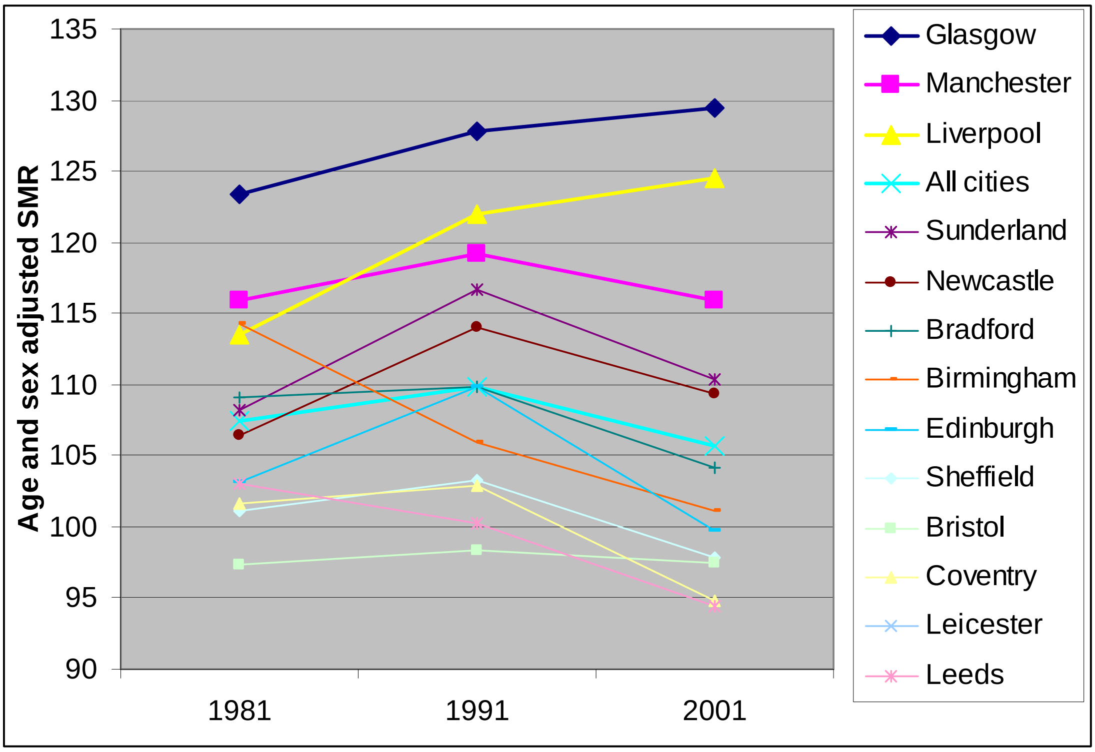


Figure 49: Summary of age and sex adjusted SMR results for large UK cites between 1981 and 2001 with Glasgow, Liverpool, Manchester and *All cities* data highlighted

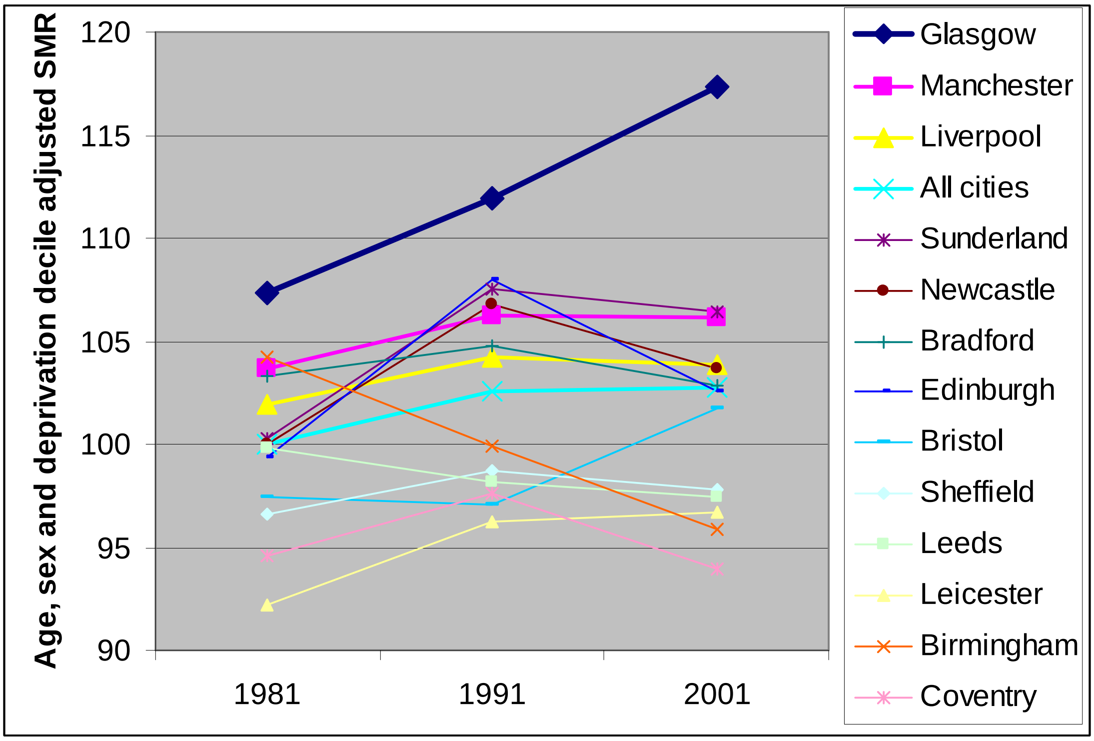


Figure 50: Summary of age, sex and Carstairs deprivation decile adjusted SMR results for large UK cites between 1981 and 2001 with Glasgow, Liverpool, Manchester and *All cities* data highlighted.

Figure 49 indicates that when adjusting death rates for age and sex, the SMRs of Glasgow, Liverpool and Manchester exceeded those of any other city in 1991 and 2001. In 1981, Manchester and Liverpool's SMRs were not significantly higher than that of the next worst city (Sunderland) but between 1981 and 1991, Sunderland's death rate fell relative to the other cities while Glasgow, Liverpool and Manchester's all grew. In general, SMRs in cities fell, but in Glasgow and Liverpool, SMRs increased and in Manchester, SMRs remained constant. It is also notable that five cities (Leeds, Coventry, Bristol, Sheffield and Edinburgh) had age and sex adjusted SMRs that were less than or equal to 100 in 2001.

Figure 50 shows that adjustment for deprivation decile reduced the magnitude of SMR in most of the 13 cities. Adjusting for deprivation in Liverpool and Manchester reduced the SMRs in these cities by a sufficiently large amount that their death rates were not significantly different from those of several other cities. This was not the case for Glasgow where death rates remained considerably higher than in other cities even after adjustment for Carstairs deprivation decile. Two cities (Bristol and Edinburgh) had SMRs that rose after adjusting for deprivation decile in 2001. These two cities had the least typical deprivation profiles: they had substantial numbers of residents in the affluent deciles and comparatively few in the most deprived deciles.

8.2.2 Summary points – indirect standardisation

Results obtained using the indirect standardisation method established that Glasgow had excess mortality relative to the UK as a whole in 1981 and that this excess grew until 2001. Certain other cities also had large amounts of excess mortality in 1981 and Liverpool and Manchester were notable for having significantly higher excess mortality than all other cities (bar Glasgow) across the time period studied.

SMRs in most cities were reduced when adjustment was made for deprivation decile in addition to age and sex. The largest reduction in SMR was observed for Liverpool. When adjusting for age and sex only, Liverpool had the second highest SMR of the 13 cities chosen for comparison but when deprivation decile was added to the adjustment, Liverpool had the fifth highest SMR. Glasgow's SMR, however, remained as the highest among the 13 cities analysed even when adjusting for Carstairs decile. This is a surprising result: out of all the cities, Glasgow had the largest portion of its residents living in the most deprived Carstairs deciles. Although Liverpool and Glasgow had broadly similar deprivation profiles, there was a much larger reduction in SMR when adjusting for deprivation status in Liverpool.

8.2.3 Age and sex specific death rates in cities

The next step in analysis was to identify those portions of city and conurbation populations that were most responsible for excess mortality. This was accomplished by using negative binomial regression models. Death rates in age and sex specific groups within each city and conurbation were compared with death rates across the same segments of the whole UK population. Indirect standardisation indicated that Glasgow, Liverpool and Manchester had the highest age and sex adjusted SMRs of the 13 UK cities chosen for analysis, therefore investigations into the population subgroups with the highest excess mortality focussed on these three cities and the *All citie*s amalgam of all 13 large cities.

There now follows a series of figures comparing age and sex specific mortality ratios in *All cities*, Glasgow, Liverpool and Manchester for each census time point. These figures illustrate which components of these cities' populations had the greatest excess mortality in 1981, 1991 and 2001 and also demonstrate longitudinal trends in mortality patterns.

When examining the figures that follow, it should be noted that for reasons of clarity, 95% confidence intervals will not shown. In age and sex specific categories, the absolute numbers of deaths are low in comparison with the total number of deaths in a whole city. As a result, confidence intervals for the SMRs are wide and when age specific data for several cities are presented on the same graph, confidence intervals overlap and become indistinct. In addition, there are very small numbers of deaths in the youngest age categories (0-4 years, 5-14 years, and 15-24 years). As a result, age specific mortality ratios for these age groups in cities are often very high or very low as a even a small number of extra deaths in one year will cause a substantially elevated mortality ratio. However, there were sufficient numbers of deaths in all other age and sex specific groups for meaningful conclusions to allow meaningful comparisons.

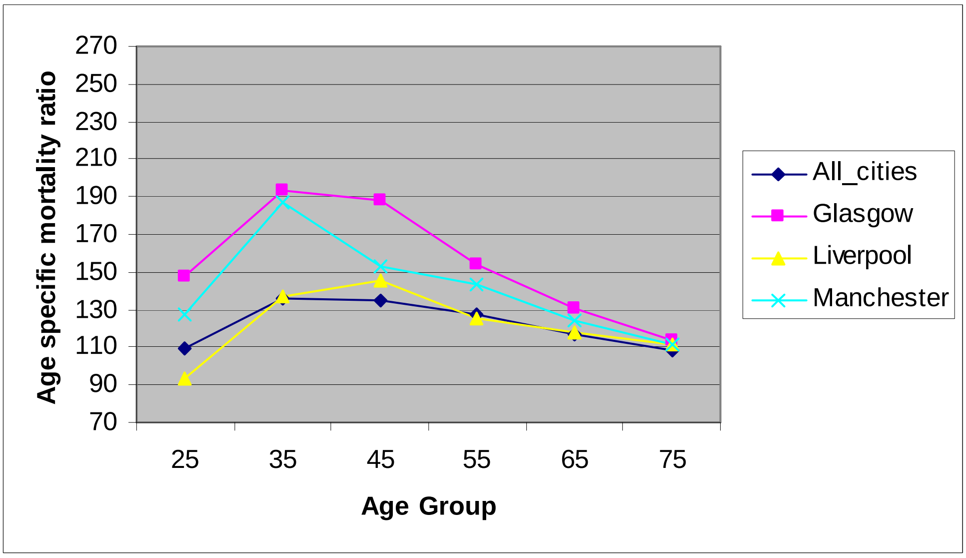


Figure 51: Age specific standardised mortality ratios for males in UK cities, 1981.

Figure 51 shows that in 1981, excess mortality among males in *All cities* became apparent in the age groups older than 25 years. The age group with the greatest excess relative to other males of the same age group was the 35-44 year old group where the SMR was 136.4 ± 7.3. Mortality ratios for males of working age and older in *All cities* were all significantly greater than 100 although excess mortality gradually reduced with each age group from 35-44 onwards.

In all working age groups, Glaswegian males had high levels of excess mortality in 1981. This was apparent in the 25-34 year old age group where the age specific mortality ratio was 148.2 ± 22.6. The highest age specific mortality ratio in Glasgow was among 35-44 year olds (193.0 ± 22.3) and even allowing for the wide confidence interval (due to the small number of deaths in this population group) this was still significantly higher than the mortality ratio for males of this age group in *All cities*. A similar figure was recorded for Glasgow men in the 45-54 year old age group and though the figures for the three oldest age groups were much lower, they were still elevated in comparison to the calculated mortality ratios for men of the same age in other cities.

In Manchester, the highest age specific mortality ratio was among males aged 35-44 and was similar to the equivalent figure in Glasgow. However, in 1981, Manchester did not have such large excess mortality in the 45-54 year old group as in Glasgow. Age specific mortality ratios among males in Liverpool more closely followed the pattern of *All cities*.

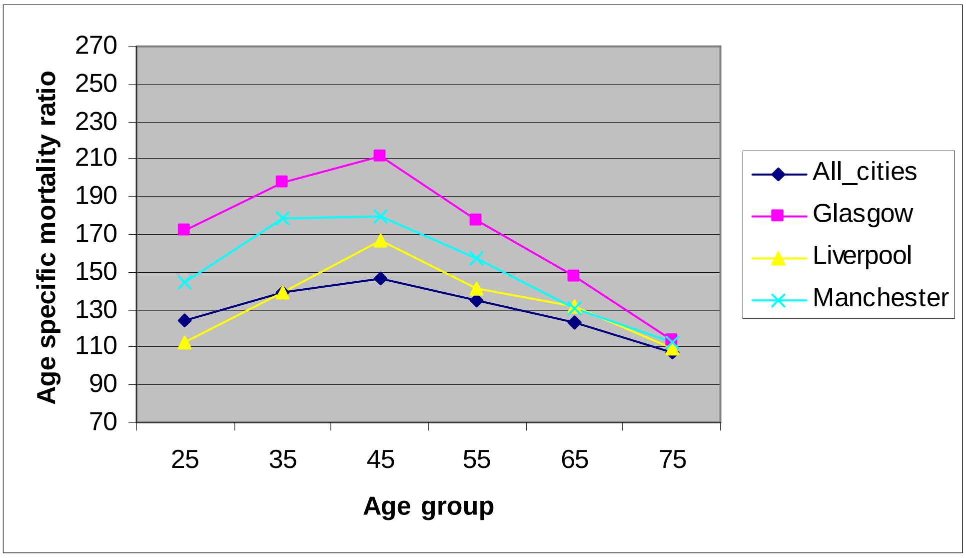


Figure 52: Age specific standardised mortality ratios for males in UK cities, 1991.

In 1991, the largest age specific mortality ratio among males in *All cities* was in the 45-54 year old group. The same group of individuals were in the 35-44 year old age group in 1981.

In Glasgow, all working age groups had excess mortality that was significantly higher than for *All cities*. The highest age specific rate in this city was in the 45-54 year old group, where the mortality ratio was 212.0 ± 19.1. The same group of men had the highest age specific mortality ratio in 1981 (when they were aged between 35 and 44) and it appears that this group of men in Glasgow made a large contribution to the city's overall poor population health. However, high age specific mortality ratios were recorded for other age groups of males in Glasgow at this time point too, notably among 25-34 year olds (172.1 ± 23.3) and 55-64 year olds (178.0 ± 11.8).

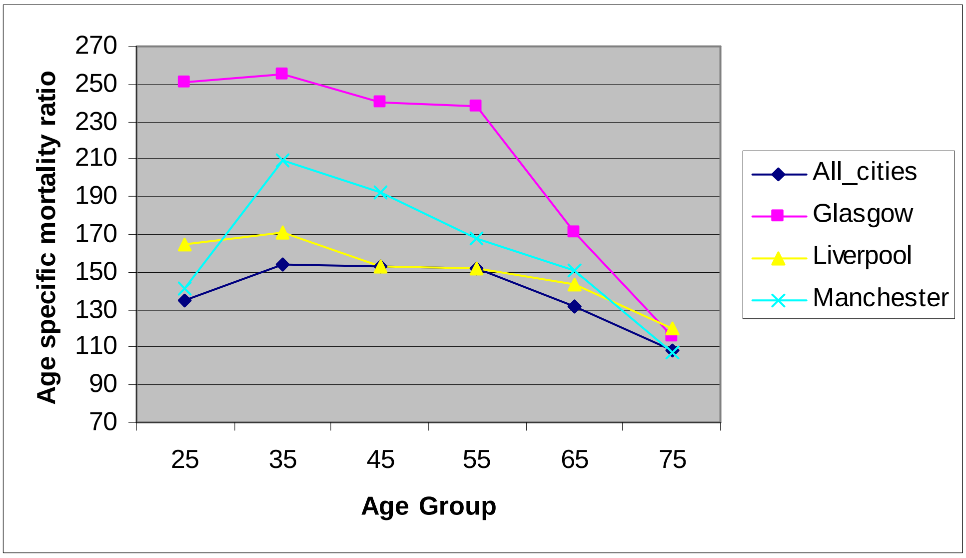


Figure 53: Age specific standardised mortality ratios for males in UK cities, 2001

Figure 53 shows that age specific mortality ratios for working age males in all locations (including *All cities*) had grown since 1981. This is better demonstrated by Figure 54 (below) which displays the age specific mortality ratios for *All cities* only over the period 1981 -2001. In *All cities*, over the time period studied, there was a trend for age specific mortality among working age males to increase with time. The same pattern was replicated on a more extreme scale in Glasgow. For example, the age specific mortality ratio for males aged 25-34 in 1981 was 148.2 ± 22.6 but by 2001 this figure was 251.1 ± 33.6. It is notable that there was not such a large rise in death rates among males of this age group in any of the other cities studied. In 1981 and 1991 very high excess mortality was most apparent among males of 35 years and older in Glasgow and other cities and this was still true in 2001 in all locations apart from Glasgow. Even though other cities had excess mortality among males of this age group, Glasgow's figures stand out.

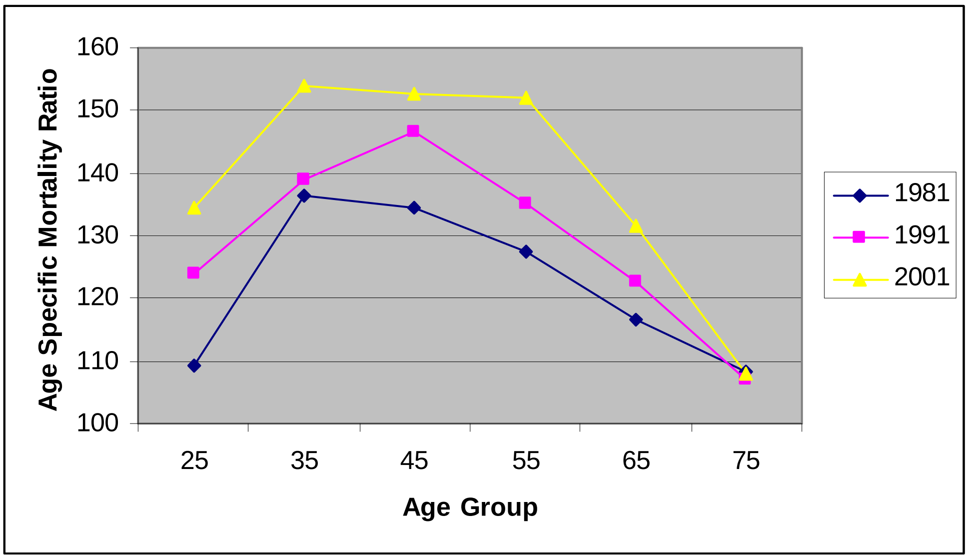


Figure 54: Age specific standardised mortality ratios for males in *All cities* 1981-2001

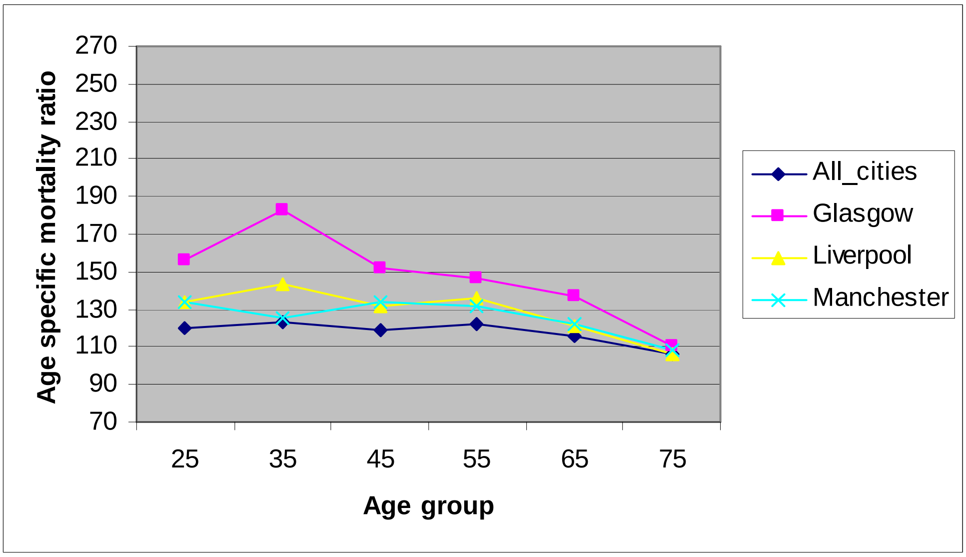


Figure 55: Age specific standardised mortality ratios for females in UK cities, 1981

Relative to women of the same age group across the whole of the UK, females of working age in *All cities* had excess mortality in 1981. Slightly higher figures were recorded in Liverpool and Manchester but not significantly so. In Glasgow, however, women aged 25-34 (156.5 ± 28.6), 35-44 (182.4 ± 22.7) and 45-54 (151.9 ± 12.8) had significantly higher mortality ratios than those of similar age groups in *All cities*.

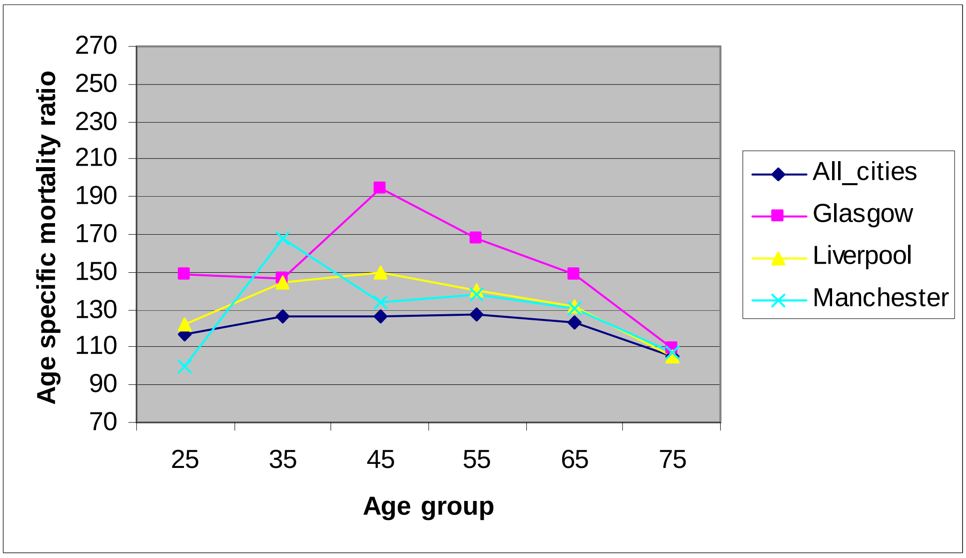


Figure 56: Age specific standardised mortality ratios for females in UK cities, 1991

In 1991, age specific death rates for females of working age in *All cities* were all higher than the 1981 figures. The rise in female age specific mortality ratios in *All cities* was mirrored in Glasgow, Liverpool and Manchester with females aged 35-44 in Manchester rising from 125.3 ± 24.5 in 1981 to 168.0 ± 30.1 in 1991. The equivalent figure for females in Glasgow age 35-44 did not change significantly between 1981 and 1991. This is in contrast to the findings for Glasgow males of the same age.

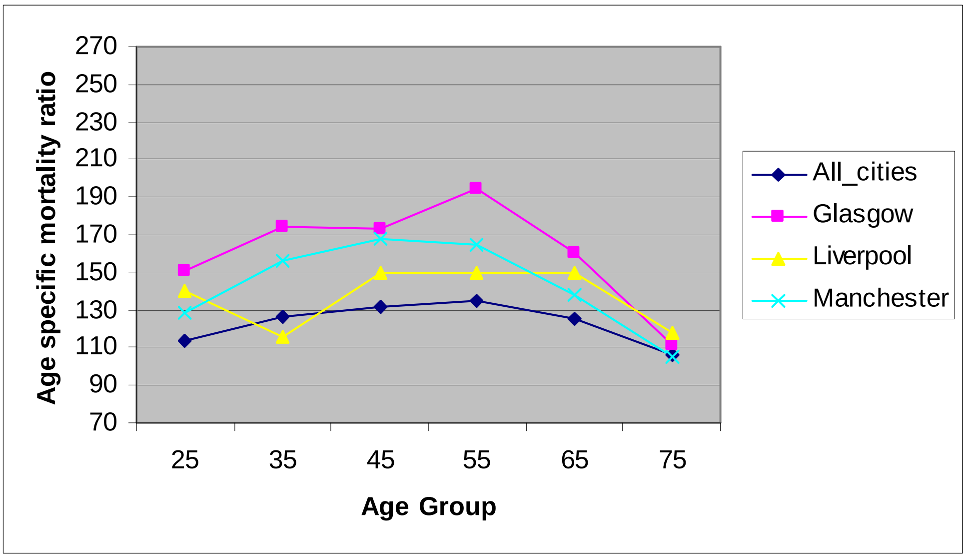


Figure 57: Age specific standardised mortality ratios for females in UK cities, 2001

As shown in Figure 57, in all working age groups, the SMR in Glasgow was higher than in comparator cities. SMR in Glasgow was significantly higher than in *All* *cities* in the 35-44, 45-54 and 55-64 year old age groups. There was also a significant difference in the 65-74 year old age group. In 1991, there was no significant difference in SMR between Glasgow and *All cities* in the 55-64 and 65-74 year age groups.

The three previous figures provide some evidence for a particularly unhealthy group of females in Glasgow. In 1981, the group with the highest age specific SMR was the 35-44 year olds (182.4 ± 22.7), in 1991 this same population group were aged 45-54 and had the second highest SMR in Glasgow.

As observed at the other census time points, age specific mortality ratios for females in Liverpool were closer in value to those of *All cities* than was observed for the same values in Glasgow and Manchester. This is an interesting finding as the age and sex adjusted SMR for the whole population of the city of Liverpool was higher that of Manchester in both 1991 and 2001 (see Figure 47 of this section). One explanation could be that Liverpool had a greater proportion of its working age population living in deprived areas than Manchester (this is borne out by the Carstairs deprivation profiles for Liverpool and Manchester). Indeed, adjustment for Carstairs deprivation decile reduced the SMR in Liverpool to a figure lower than the equivalent for Manchester at all three census time points.

8.3 What effect do different definitions of geography, deprivation and health outcome have on the size of this residue?

8.3.1 Geography

The next issue of interest was to identify the extent to which excess mortality in Glasgow was limited to the area within the Glasgow City Council boundary or if the rest of the Clydeside conurbation also suffered from having higher than average mortality rates. Mortality data from this conurbation would then be compared with those around other UK cities, especially those cities with high mortality rates. Before examining death rates in conurbations, the deprivation status of these entities was compared.

8.3.1.1 Deprivation profiles – conurbations

Glasgow is not unique among British cities in having affluent suburban areas in neighbouring local authority areas. However, Glasgow is also surrounded by a number of towns that have their own reputations for deprivation, crime and other social problems. There is a recognisable conurbation stretching from Greenock in the West to Coatbridge and Airdrie in the East (described in detail in the Methods chapter). The deprivation status of this conurbatio*n* merits comparison with the conurbations that surround other UK cities.

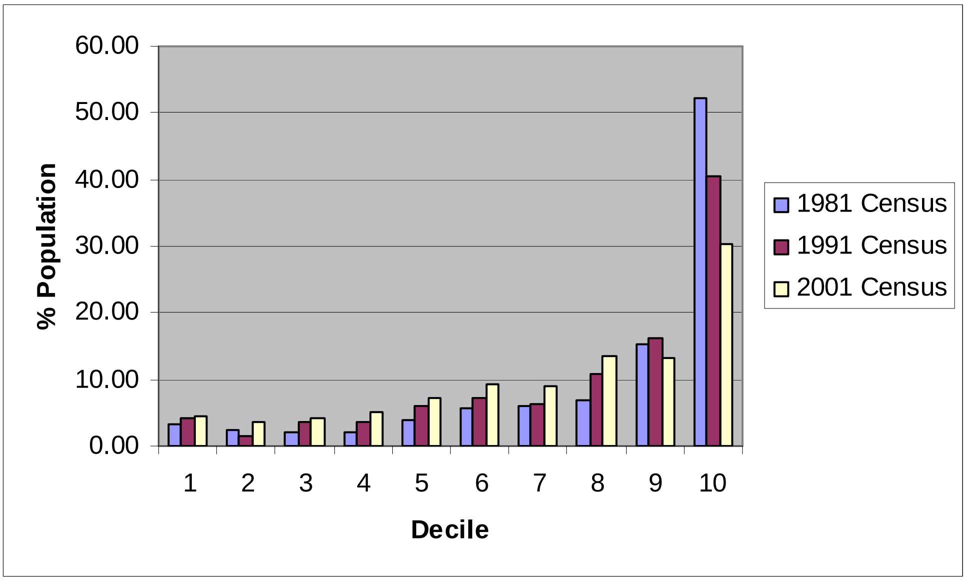


Figure 58: Carstairs deprivation profiles for Clydeside, 1981-2001

The deprivation profile for Clydeside in the period 1981-2001 is noteworthy. This conurbation had approximately 1.8 million residents in 1981. Of these, more than half lived in postcode sectors that were in the most deprived tenth of all UK areas. While the Glasgow City area contributed significantly to this figure, it does show that in 1981, severe deprivation was widespread throughout this large conurbation and not confined to inner city areas.

The second noteworthy feature of the deprivation profile history of the Clydeside conurbation is its large change over time. In 2001, the proportion of Clydeside residents in decile 10 areas was approximately 30%. This was accompanied by a rise in the relative population of deciles 1-8 compared with 1981 figures. No other urban region, be it a city or conurbation, showed such a large change in its deprivation status in the same time. The wholescale recent change in the deprivation status of the towns and suburbs around Glasgow is, perhaps, not always properly recognised. In real terms, Clydeside lost more than 450,000 residents in the most deprived Carstairs decile between 1981 and 2001. Some of the reasons for this change and the growing disparity in deprivation status between the Clydeside conurbation and Glasgow City will be analysed in the discussion section.

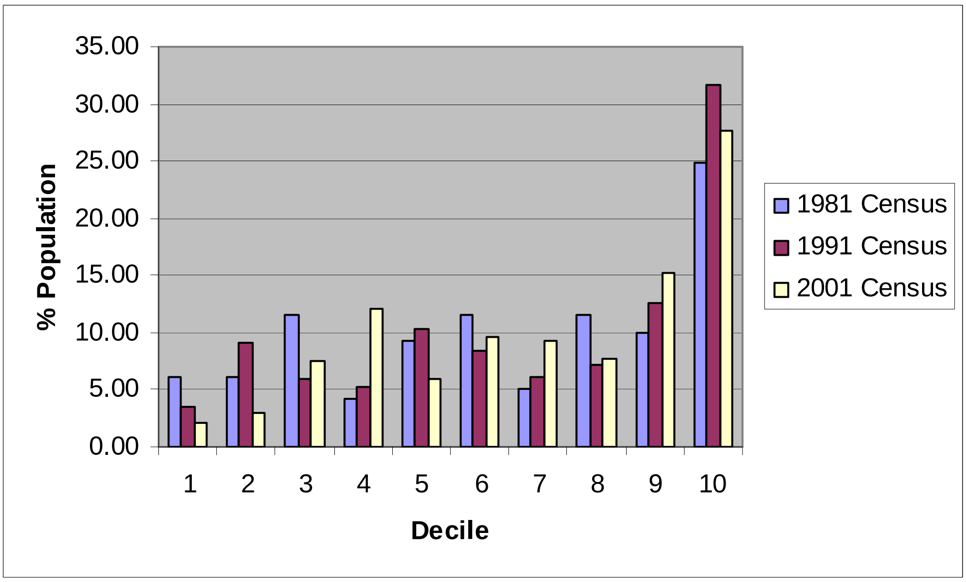


Figure 59: Carstairs deprivation profiles for Merseyside conurbation, 1981-2001

Liverpool was the second most deprived city but the conurbation that was formerly comprised the Merseyside Metropolitan County area was considerably more affluent than the city at its core. The shape of the deprivation profile for Merseyside changed between 1981 and 2001, but not in the same manner as Clydeside. Merseyside lost residents in the three most affluent deciles and had a net gain of residents in the two most deprived deciles. However, given the overall fall in Merseyside's population over this period (from 1.5 million to 1.3 million), the absolute number of residents in the most deprived deciles actually fell from more than 500,000 to 330,000. Thus, population loss from the most deprived areas accounted for the majority of the overall population loss across the whole conurbation.

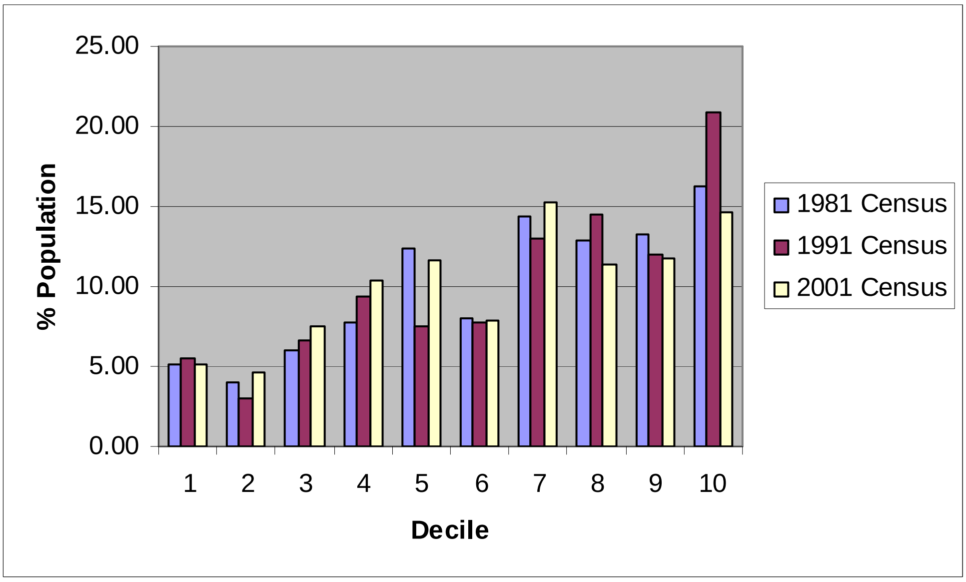


Figure 60: Carstairs deprivation profiles for Greater Manchester, 1981-2001

For the purposes of this analysis, the Greater Manchester conurbation was defined as being the same area as the former Greater Manchester Metropolitan County. The population of this large urban area grew slightly from 2.3 million in 1981 to 2.4 million in 2001. The area did not gain substantial numbers in the two most affluent deciles but did see a rise in the proportion of residents in deciles 4 and 5. This was accompanied by a slight drop in decile 10 residents from 16.5% in 1981 to 14% in 2001. The deprivation profile for the conurbation of Greater Manchester contrasted with the deprivation profile of Manchester City itself. Greater Manchester's profile did, in turn, differ from those of Clydeside and Merseyside in not having such a pronounced gradient from affluence to deprivation.

Another conurbation of interest was that of Tyneside. This was defined as being the areas that were previously part of the Metropolitan County of Tyneside. Tyneside has a similar social history to that of the Clydeside area: heavy industries dominated by shipbuilding that declined from the start of the 20th Century but very rapidly following the Second World War. However, since 1981, the pattern of deprivation in this region has been markedly different to that of Clydeside.

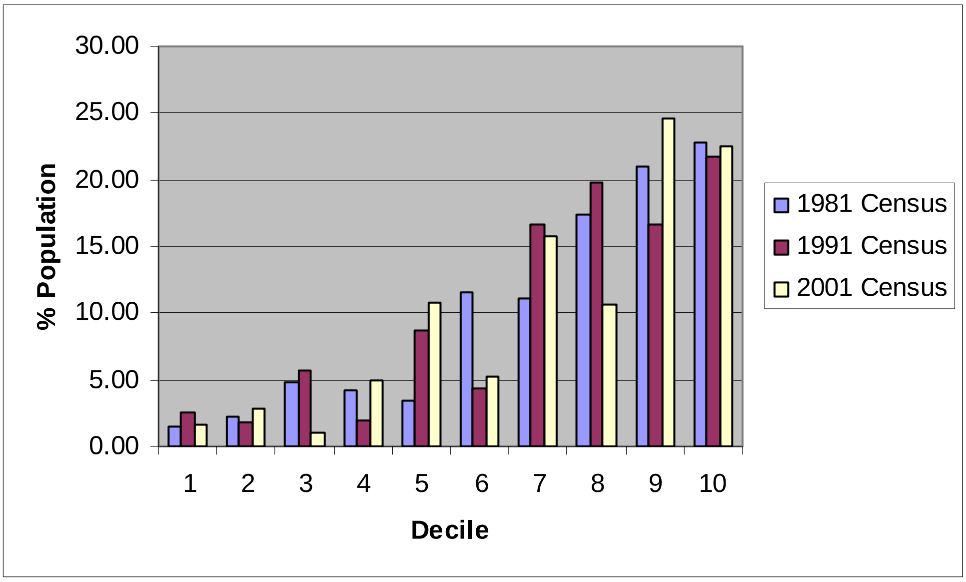


Figure 61: Carstairs deprivation profiles for Tyneside conurbation, 1981-2001

Clydeside had more than 50% of its residents in decile 10 in 1981, Tyneside had less than half this figure. However, the proportion of Tyneside residents in this decile remained constant between 1981 and 2001 while Clydeside's figure fell from 50% to 30%.

8.3.1.2 Indirect standardisation of death rates - conurbations

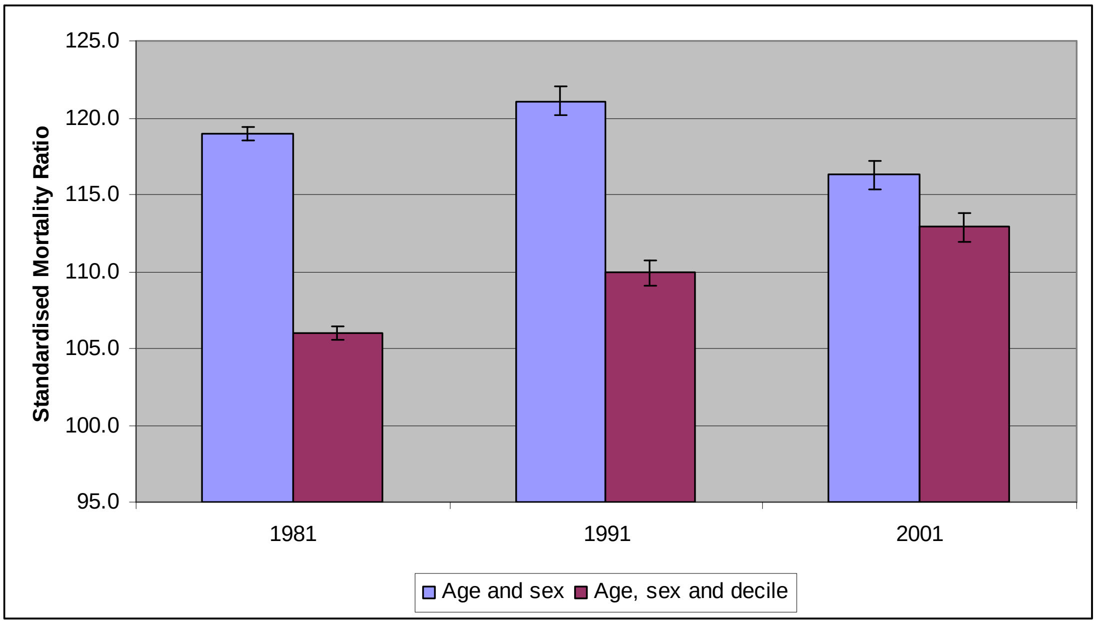


Figure 62: Standardised mortality ratios with adjustment for age and sex and also age, sex and Carstairs deprivation decile, Clydeside conurbation 1981-2001

Figure 62 shows that Clydeside had large levels of excess mortality at each census time point. In 1981, the age and sex adjusted SMR was 119 ± 0.4, it had risen to more than 122 ± 0.9 in 1991 but fell back to 116.3 ± 0.9 by 2001. In Glasgow City itself, the 2001 figure was 129.5 ± 1.7 so the wider conurbation enjoyed considerably better population health (by this measure) than the city at its core. However, the whole region of 1.7 million people still fared very poorly in comparison with the UK as a whole.

The Carstairs deprivation profile for the Clydeside conurbation (Figure 58 of this chapter) indicates that the area became considerably more affluent over the time period of interest. Given the disparity in death rates between affluent and deprived areas, it might be reasonable to expect a greater improvement in the age and sex adjusted SMR of the Clydeside conurbation. This did not happen, and the reduction in the SMR was rather small though still significant.

When adjusting for age, sex and deprivation decile, the figures for the Clydeside conurbation mirror those for Glasgow City. In 1981, most of the excess mortality on Clydeside was explained by adjusting for Carstairs decile but by 2001, the difference between the two SMR figures was much smaller.

In addition to calculating the SMR for the Clydeside conurbation, I also created an intermediate definition of 'Glasgow' which contained Glasgow City plus the neighbouring local authorities of Renfrewshire, East Renfrewshire and East Dunbartonshire. In 2001, this area had an age and sex adjusted SMR of 118.5±0.6 and a Carstairs decile adjusted SMR of 114.6±0.6. Both of these figures were slightly lower than for the entire Clydeside conurbation, but East Renfrewshire and East Dunbartonshire are two very affluent council areas with high life expectancy. It does demonstrate, however, that the size of the Glasgow effect does depend on how 'Glasgow' is defined.

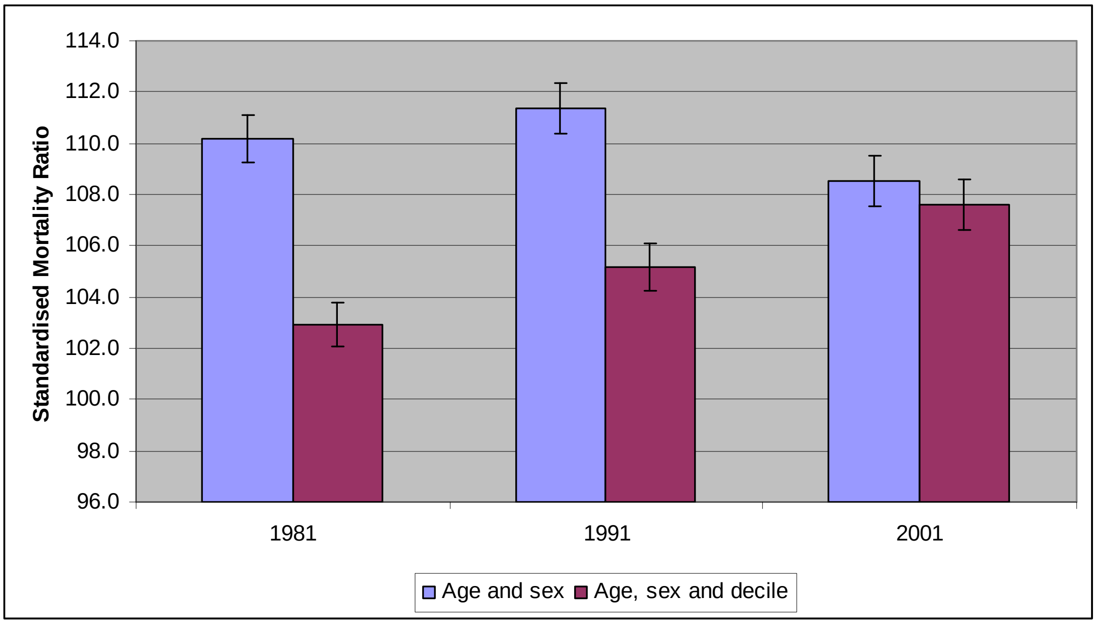


Figure 63: Standardised mortality ratios with adjustment for age and sex and also age, sex and Carstairs deprivation decile, Merseyside conurbation 1981-2001

Figure 63 shows that Merseyside had significant excess mortality at all three time points and the age and sex adjusted SMR did not change significantly between 1981 and 2001. Age, sex and decile adjusted SMR on Merseyside showed a similar pattern to Clydeside and steadily increased with time. By 2001, there was no significant difference between the two calculated SMRs for this region, although the excess mortality was small.

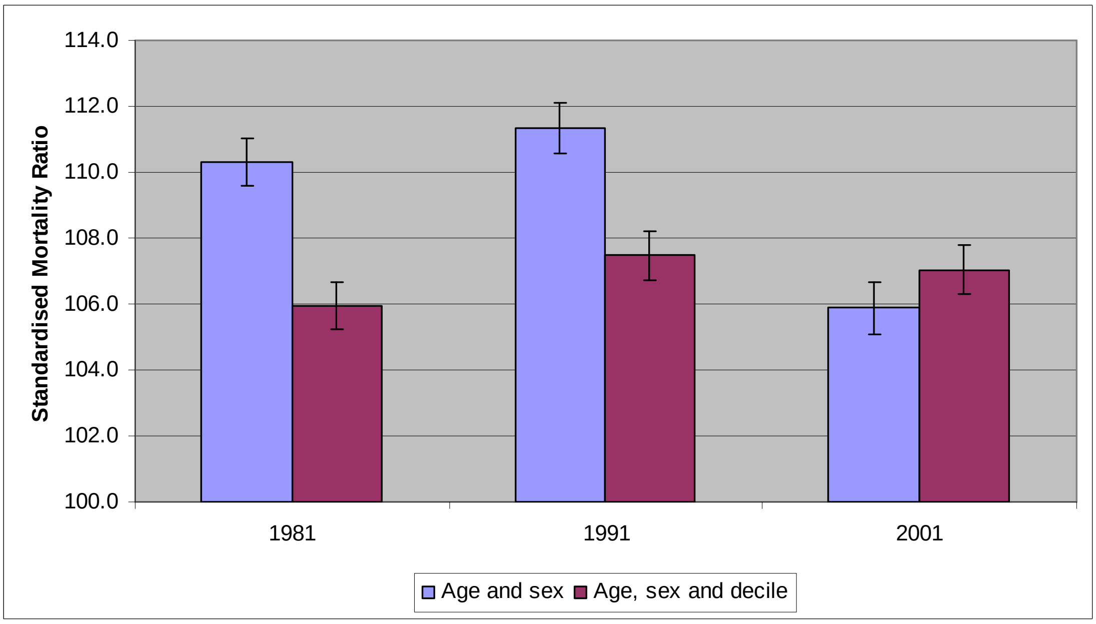


Figure 64: Standardised mortality ratios with adjustment for age and sex and also age, sex and Carstairs deprivation decile, Greater Manchester conurbation 1981-2001

Figure 64 shows that age and sex adjusted SMR in Greater Manchester fell significantly from 110.3 ± 0.7 in 1981 to 105.9 ± 0.8 in 2001. There was no significant change in age, sex and decile adjusted SMR between 1981 and 2001, although in 2001, the decile adjusted SMR was higher than the SMR with adjustment for age and sex only. Both Greater Manchester and Merseyside had lower SMRs than Clydeside at all three time points, even after allowing for deprivation factors.

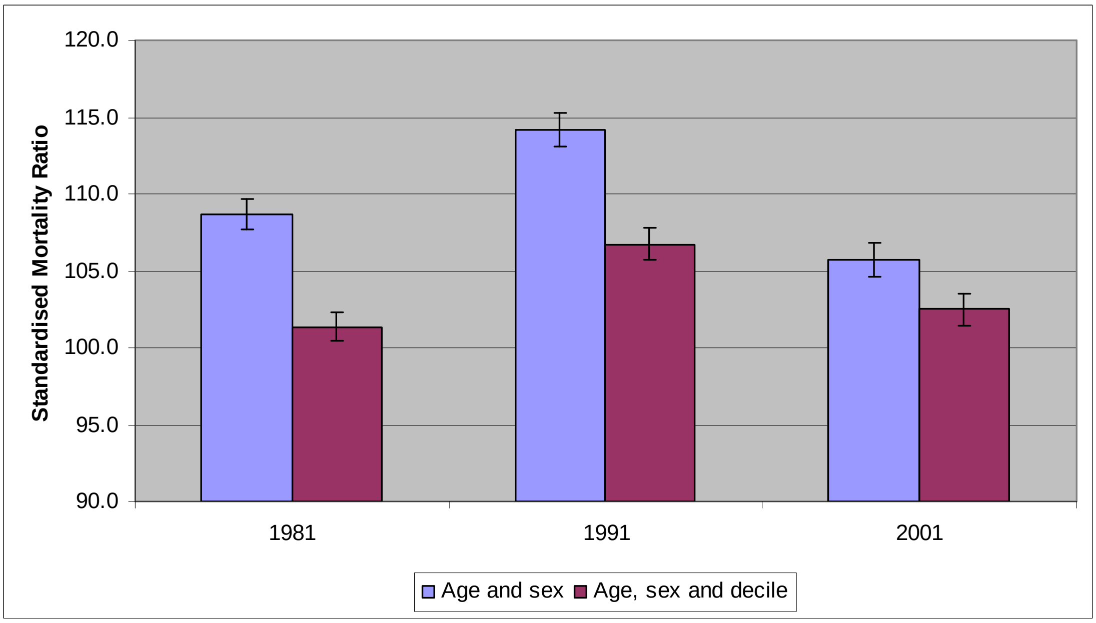


Figure 65: Standardised mortality ratios with adjustment for age and sex and also age, sex and Carstairs deprivation decile, Tyneside conurbation 1981-2001

Tyneside is a conurbation with a large proportion of its population living in deprived wards: in 2001, more than 40% of the local population lived in wards that were categorised into decile 9 or decile 10 of the Carstairs distribution. This area had significant excess mortality when adjusting for age group and sex, with a peak SMR of 114.2 ± 1.1 in 1991. In 2001, age and sex adjusted excess mortality in this area was much smaller.

When adjusting standardised mortality ratios for deprivation decile, the excess mortality on Tyneside was significantly diminished at all three time points. In 2001, adjustment for age, sex and decile explained less of the excess mortality on Tyneside than in previous years.

An additional issue of interest was to identify the extent to which Glasgow City itself was responsible for the excess mortality of the Clydeside conurbation. In 2001, Glasgow was home to roughly one third of this conurbation's population and it is conceivable that the very large excess mortality in this city contributed to the excess mortality measured for the Clydeside conurbation.

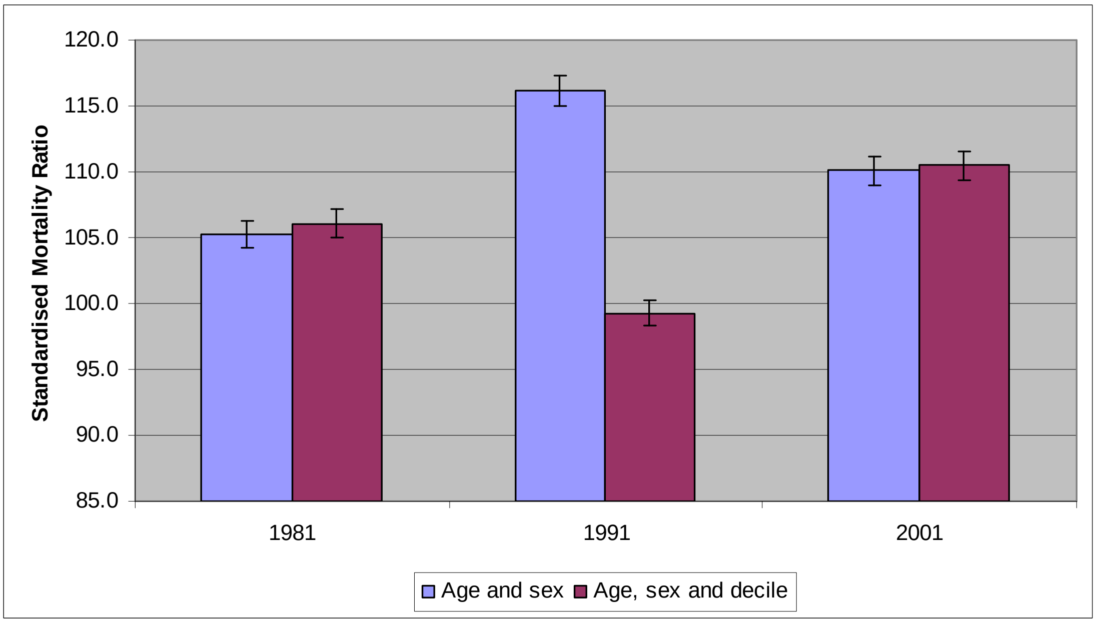


Figure 66: Standardised mortality ratios with adjustment for age and sex and also age, sex and Carstairs deprivation decile, Clydeside conurbation (excluding Glasgow City) 1981-2001

Figure 66 shows that in 1981, after adjusting for age group and sex, there was a relatively small excess mortality in the non-Glasgow portion of the Clydeside conurbation. In 1991, the age and sex SMR had jumped to 116.2 ± 1.2 and then in 2001 this SMR had a value of 110.1 ± 1.1. Adjustment for age, sex and decile accounted for all of the excess mortality in the area surrounding Glasgow in1991 only.

Individual charts of SMR data for the other major conurbations will not be discussed here but the two figures that appear below summarise SMR data for all the conurbations chosen for comparison in this study.

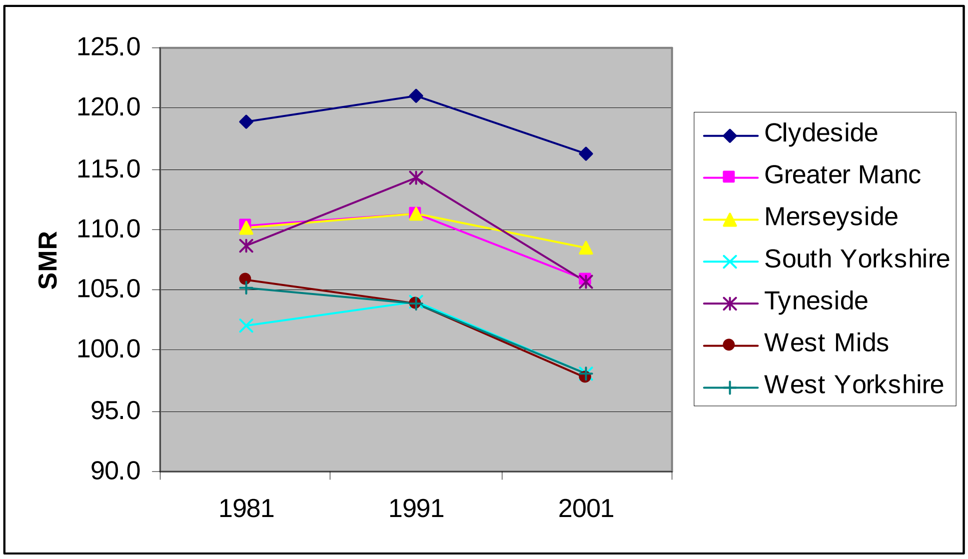


Figure 67: Summary of age and sex adjusted SMRs for UK conurbations between 1981 and 2001

Figure 67 Indicates that Clydeside consistently had the highest age and sex adjusted SMR over the time period studied. SMRs for all conurbations fell between 1981 and 2001, with the West Midlands showing the greatest fall. In 2001, two conurbations (West Midlands and South Yorkshire) had age and sex adjusted SMRs that were less than 100. Conurbations all had lower SMRs than the city at their respective cores: this is unsurprising since deprivation profiles indicate that in most conurbations, affluent areas are located outwith core city boundaries.

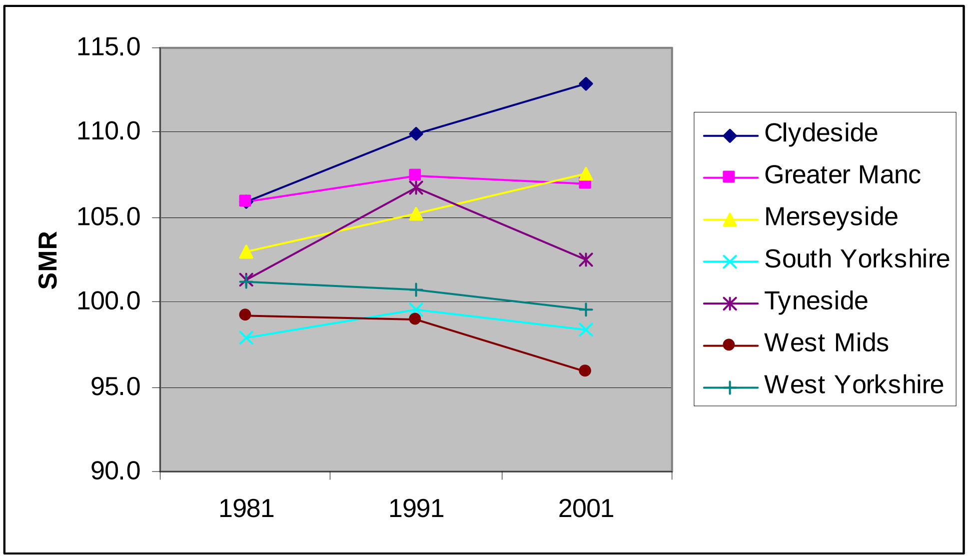


Figure 68: Summary of age, sex and Carstairs deprivation decile adjusted SMRs for UK conurbations between 1981 and 2001

Figure 68 shows that after adjusting for Carstairs deprivation decile, SMRs in all conurbations fell at all three time points. In general, the reduction in SMRs for conurbations when adjusting for Carstairs decile was not as large as the reduction observed when looking at SMR in cities. This is because conurbations had lower age and sex SMRs in the first place and because conurbations have lower levels of deprivation.

8.3.2 Different definitions of deprivation

8.3.2.1 Composition of the Carstairs index

One hypothesis to explain the residue of unexplained excess mortality in Glasgow after adjusting for Carstairs deprivation decile is that variations in the level of deprivation among decile 10 areas are disguised by classifying all these areas into the same category. This is highlighted by a boxplot of Carstairs z-score by Carstairs decile.

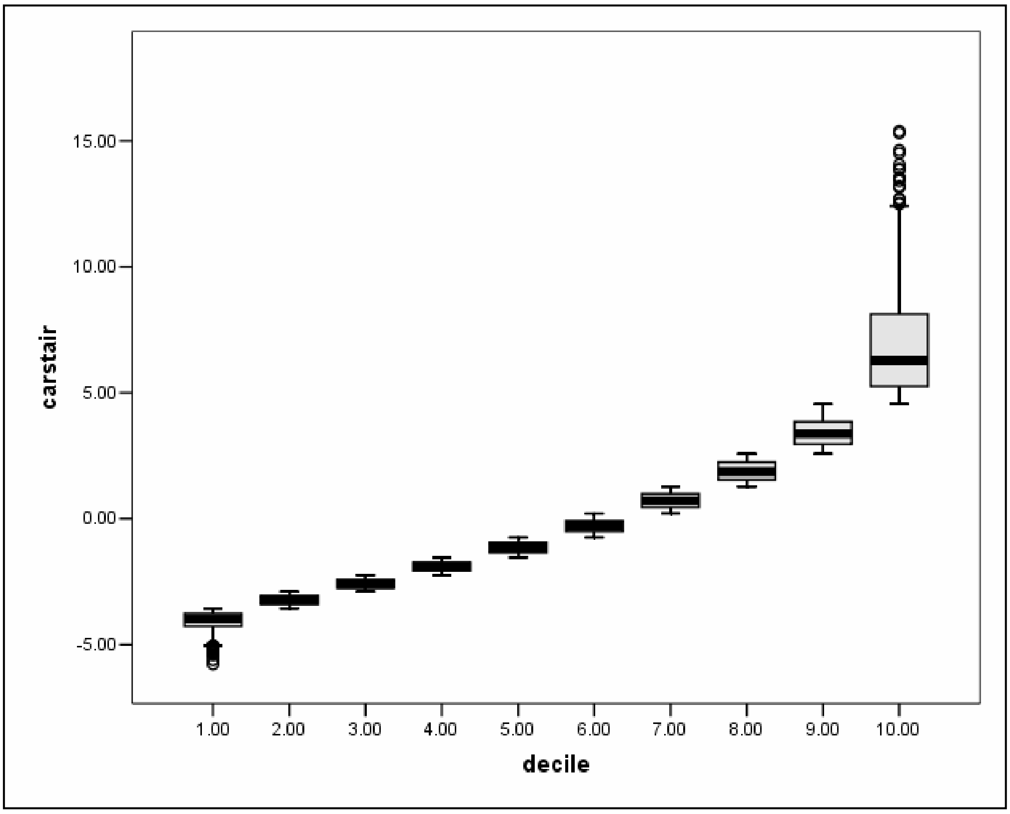


Figure 69: Boxplot of Carstairs z-score by Carstairs decile, 2001

Figure 69 shows that Carstairs z-scores were relatively homogenous in deciles 1-9. However, the box on the right hand side, corresponding to decile 10 has the greatest inter-quartile range of any of the ten categories and has a pronounced tail. Compared with the other deciles, not all small areas classified into decile 10 were equally deprived. Given the relationship between all-cause mortality and deprivation, it was necessary to create a method of adjusting death rates that would take account of this tail in decile 10. This was particularly pertinent to Glasgow since it was the city with the greatest proportion of residents living in decile 10 areas.

The following results compare the SMRs for cities (calculated using negative binomial regression models) when making the following adjustments:

- Age group, sex and Carstairs z-score
- Age group, sex and lack of car ownership
- Age group, sex and unemployment

- Age group, sex and social class

- Age group, sex and overcrowding

These results address two aims. The first is identify the extent to which there is a difference in calculated SMR when adjusting for a categorical deprivation variable (Carstairs decile) and a 'continuous' deprivation variable (Carstairs z-score).

The second aim was to investigate the four component variables of the Carstairs deprivation score and how they performed as covariates in regression models of death rates.

There are is a caveat to this method that should be considered here. First, it may be the case that in highly deprived areas (such as in decile 10) that the relationship between deprivation and mortality is weak or non-linear. In other words, beyond a certain level of deprivation, does mortality increase as rapidly? The negative binomial models used in this project assume that there is a consistent 'linear' relationship between mortality and deprivation.

Figure 70 shows that overcrowded households became less commonplace between 1981 and 2001. This was due to population decline in certain cities (where the greatest concentrations of overcrowding can be found) an increase in the number of households (due to factors such as new housebuilding and social phenomena such as single living and re-partnering). In Table 10, displayed immediately beneath Figure 70, it can be seen that the mean percentage of overcrowded households fell significantly between 1981 and 2001. Moreover, the standard deviation around this mean was also reduced in the same period indicating that there were fewer areas with very high levels of overcrowding in 2001. While the standardised z-scores for overcrowding did not change over the time period (a z-score distribution, by definition, has a mean of 0 and a standard deviation of 1, no matter the distribution of the variable being standardised) a single unit change in the 1981 z-score for overcrowding represented a greater change in the absolute score for overcrowding than did a single unit change in 2001. As a result, it might be expected that the standardised score for the overcrowding variable would explain less of the excess mortality in cities in 2001 than it did in 1981. This may in turn explain why Carstairs decile was increasingly unable to explain excess mortality in UK cities (especially Glasgow) at each census time point.

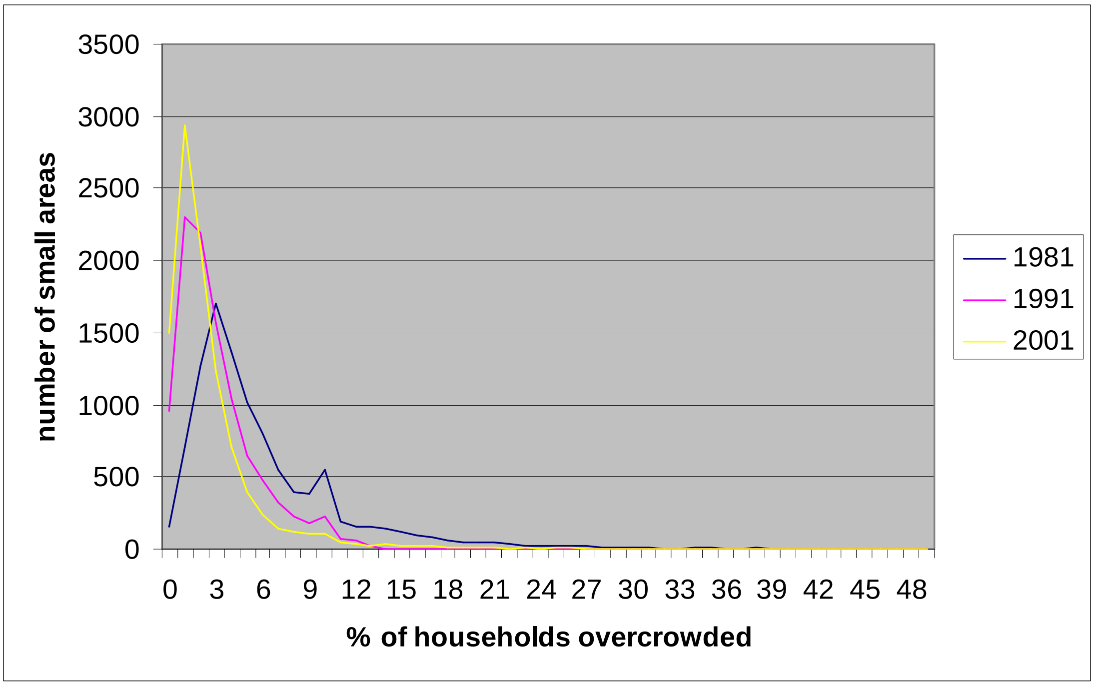


Figure 70: Percentage of households in each postcode sector or ward overcrowded, 1981-2001

Table 10: Summary statistics for overcrowding variable, 1981-2001

Year	Number of Small Areas	Mean percentage of households overcrowded	Standard deviation
1981	10,288	8.96	5.64
1991	10,512	3.92*	3.61
2001	9,860	3.15*†	3.42

†significantly different from 1991 value (one way ANOVA with Tukey's post hoc tests)

Between 1981 and 2001, there was also significant change in the no_car variable. Figure 71 and Table 2 both indicate that the bell curve for the distribution of non-standardised scores for this variable moved to the left (indicating that the mean percentage of households without access to a car or van in each small area was reduced) and was also centrally compressed (indicating a reduced standard deviation due to reduced numbers of areas with very high numbers of households without a car).

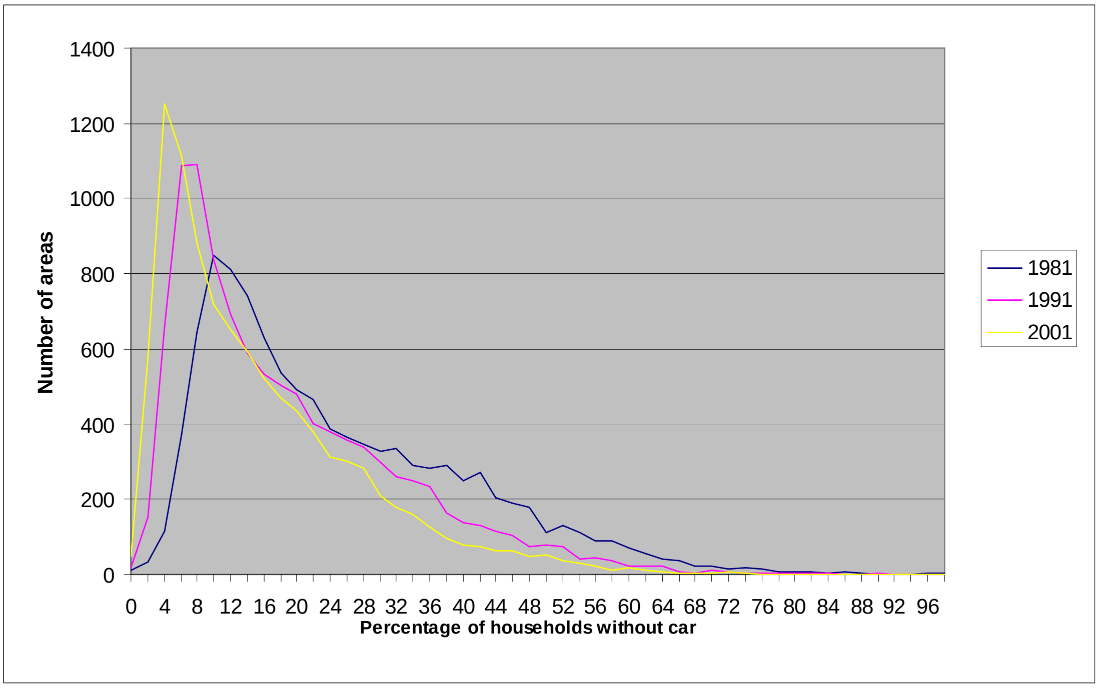


Figure 71: Percentage of households in each postcode sector or ward without access to a car or van, 1981-2001

Table 11: Summary statistics for no car variable, 1981-2001

Year	Number of Small Areas	Mean percentage of households without access to car or van	Standard deviation
1981	10,288	25.83	15.60
1991	10,512	20.60*	14.43
2001	9,860	16.48*†	12.27

***significantly different from 1981 value (one way ANOVA with Tukey's post hoc tests)**
† significantly different from 1991 value (one way ANOVA with Tukey's post hoc tests)

Figure 71 and Table 11 show that there was a significant reduction in the mean percentage of households without a car or van between 1981 and 1991 and again between 1991 and 2001. However, Figure 71 also demonstrates that in 2001 there were still many areas that had very low levels of car ownership: there were more than 200 postcode sectors and wards where at least 50% of households did not have access to a car or van, although this figure was more than 850 in 1981.

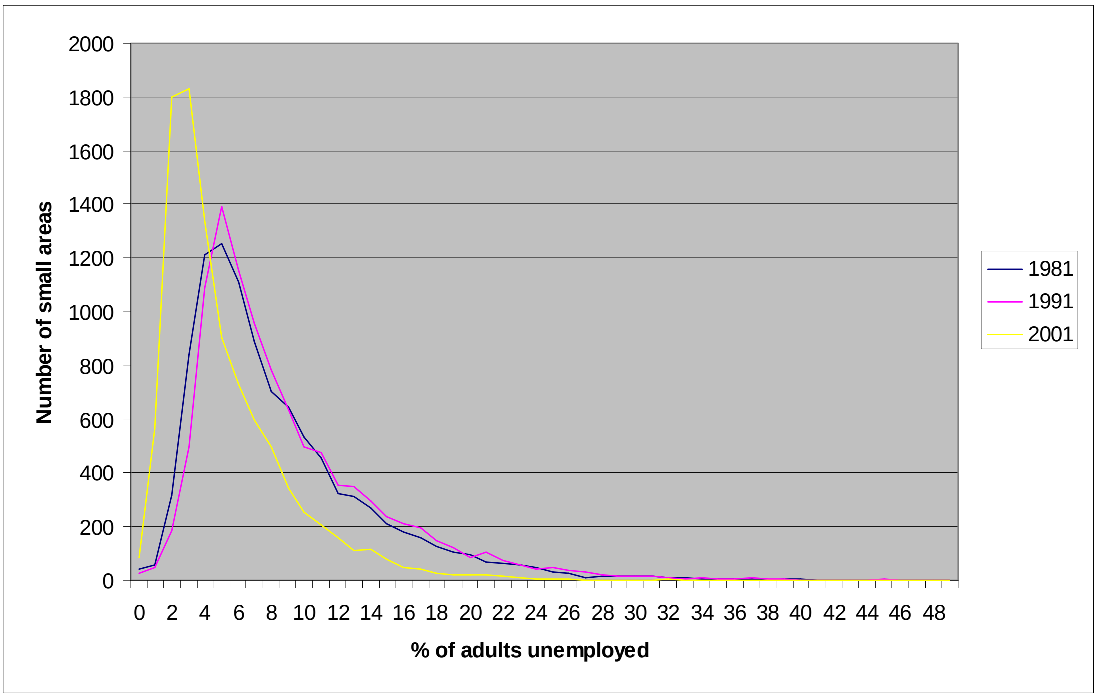


Figure 72: Percentage of working age men unemployed at time of census in each small area, 1981-2001

Table 12: Summary statistics for unemployment variable, 1981-2001.

Year	Number of Small Areas	Mean percentage of unemployed mean in each small area	Standard deviation
1981	10,288	8.96	5.64
1991	10,512	9.86*	6.30
2001	9,860	5.66*†	3.87

***significantly different from 1981 value (one way ANOVA with Tukey's post hoc tests)**
†significantly different from 1991 value (one way ANOVA with Tukey's post hoc tests)

The overall time trend for the proportion of working-aged males who were unemployed at the time of each census is shown in Table 12 and Figure 72 (above). This deprivation variable is similar to the other three Carstairs variables in that there was a significant improvement between 1981 and 2001. However, between 1981 and 1991, the mean percentage of unemployed males rose significantly. Of all the Carstairs variables, unemployment is perhaps most susceptible to short term change. Closure of a large factory, for example, may adversely affect the employment statistics in two or three small areas and during years of economic recession unemployment figures rise across the country. In addition, many long-term unemployed people become incapacity benefit claimants and while they are no longer unemployed in the technical sense they are still economically inactive and subject to the financial and social constraints associated with unemployment. It is unsafe to suggest if the apparent long-term trend in unemployment between 1981 and 2001 represents genuine improvement from these measures alone.

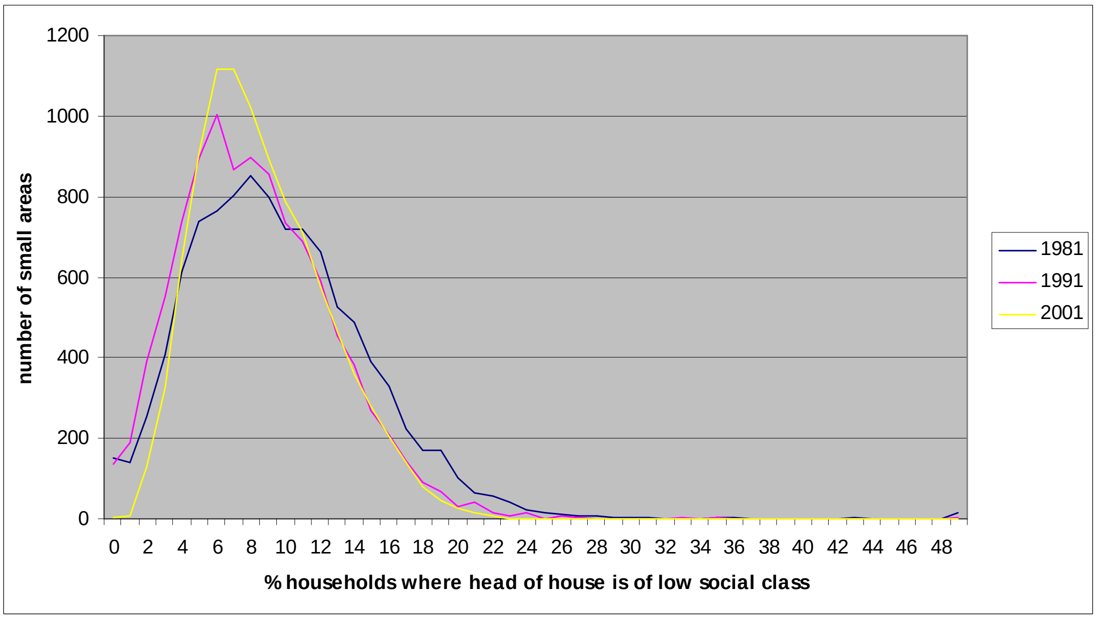


Figure 73: Percentage of households heads in low social class, 1981-2001

Table 13: Summary statistics for low social class variable, 1981-2001.

Year	Number of Small Areas	Mean percentage of household heads in low social class	Standard deviation
1981	10,288	20.2	10.52
1991	10,512	17.97*	9.06
2001	9,860	18.43*†	7.41

***significantly different from 1981 value (one way ANOVA with Tukey's post hoc tests)**
†significantly different from 1991 value (one way ANOVA with Tukey's post hoc tests)

Figure 73 and Table 13 show that the mean value for the percentage of the local population where the head of the household was in low in each small area fell significantly between 1981 and 2001, although there was a small but significant rise between 1991 and 2001.

In summary, these tables and graphs indicate that throughout the UK, there was improvement in all of these Carstairs variables. More people had access to cars, fewer were classed as unemployed or of low social class and there were fewer people living in overcrowded houses. It was therefore of interest to see if any of these individual variables were more capable at explaining excess mortality in cities than the combined Carstairs score and also to see if the same variables that best explained excess mortality in 1981 also did so in 2001. The four tables presented in this sub-section also show that the scores for the component variables are non-normally distributed. They are skewed and seem to show kurtosis. This would appear to call into question the validity of standardising these scores to create z-scores. However, a pragmatic approach was taken as I could find no published work calling into question the validity of the Carstairs score from this point of view.

8.3.2.2 Comparison of SMRs for cities and conurbations with adjustment for Carstairs component variables

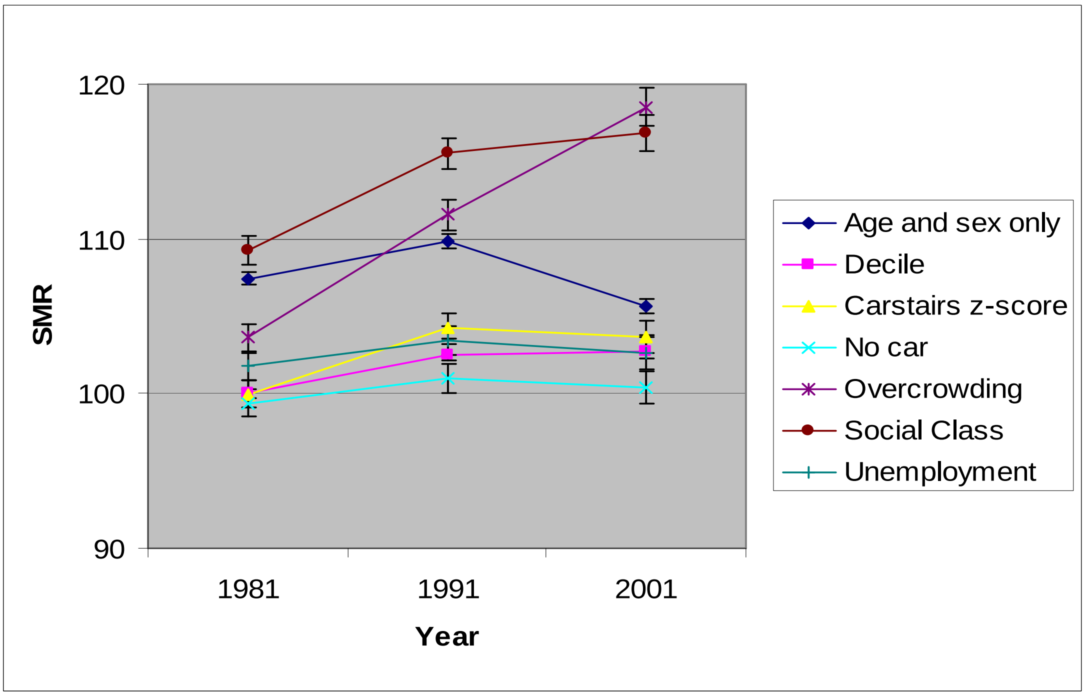


Figure 74: SMR for *All cities* with various adjustments in addition to age group and sex, 1981 to 2001.

In Figure 74 above, the results for indirect standardisation of death rates adjusting for age and sex only (dark blue line) and age, sex and Carstairs decile (pink line) are repeated and compared with various SMRs calculated by negative binomial regression models.

There was no significant difference between SMR adjusting for Carstairs decile (calculated by indirect standardisation) and the SMR adjusting for Carstairs z-score (calculated by negative binomial regression) in either 1981 or 2001 and a marginal difference in 1991. Certain Carstairs variables performed better than others when used as covariates in regression models of death rates. The model containing the no car covariate (pale blue line) had the lowest SMR at all three time points although it was not significantly lower than the result for the Carstairs z-score model in 1981. It should be noted that at all three time points, when adjusting for age, sex and no car, the SMR for *All cities* was not significantly higher than 100 meaning that all excess mortality in this amalgam was explained by the no car variable. Unemployment explained slightly less excess mortality in *All cities* than no car at all time points. In 1981, the SMR calculated by the model with overcrowding (103.6±0.9) as a covariate was significantly higher than that using no car (99.3±0.9) but the difference in calculated SMR for these two variables grew substantially by 1991 and 2001: this pattern was observed in several other cities. In 2001, the model containing overcrowding as a covariate performed least well at explaining excess mortality in cities with the exception of the age and sex only model.

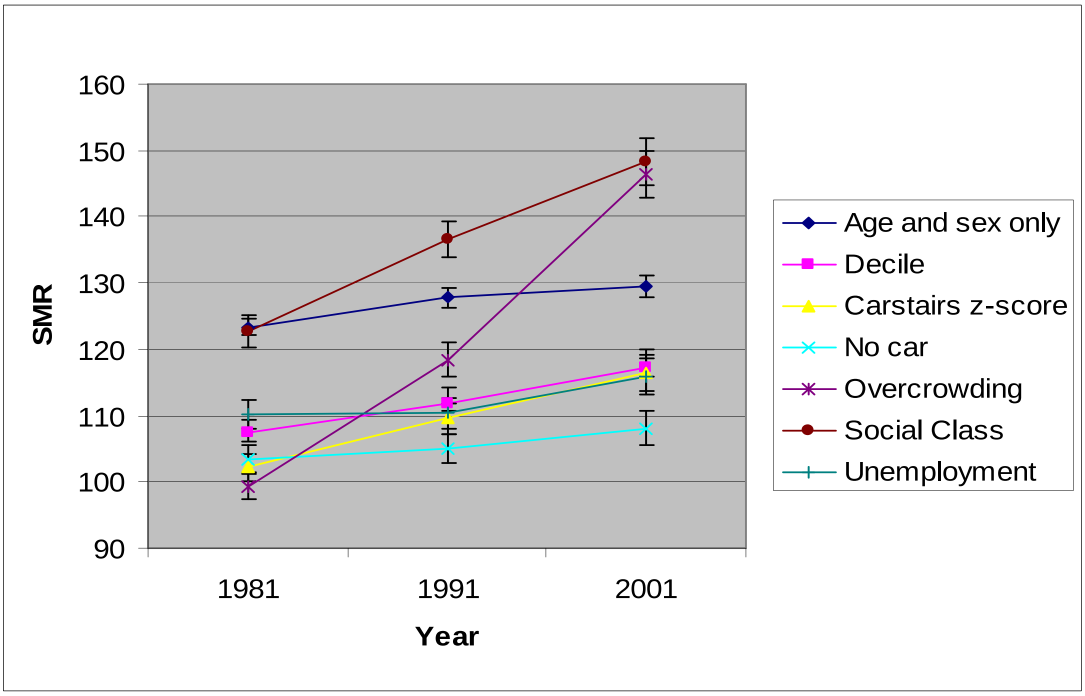


Figure 75: SMR for Glasgow with various adjustments in addition to age group and sex, 1981 to 2001.

In Glasgow, there was no significant difference in calculated SMR between the models with Carstairs decile and Carstairs z-score as covariates at all three time points. This would seem to rule out the 'tail' effect that I presented at the start of this section contributing to the excess mortality in Glasgow.

The behaviour of the overcrowding variable is notable because that model produced the lowest SMR for Glasgow in 1981 (99.3±2.0) and also explained all of the excess mortality in the city at that time. In 2001, however, the model with overcrowding as a covariate had an SMR that was not significantly lower than that with social class. Over the same time period, the SMR produced when adjusting for no car did not change significantly (although it did rise) and in 2001 the SMR for this model was 108.2 ± 2.6. This model was therefore able to explain most of the excess mortality in Glasgow at that time.

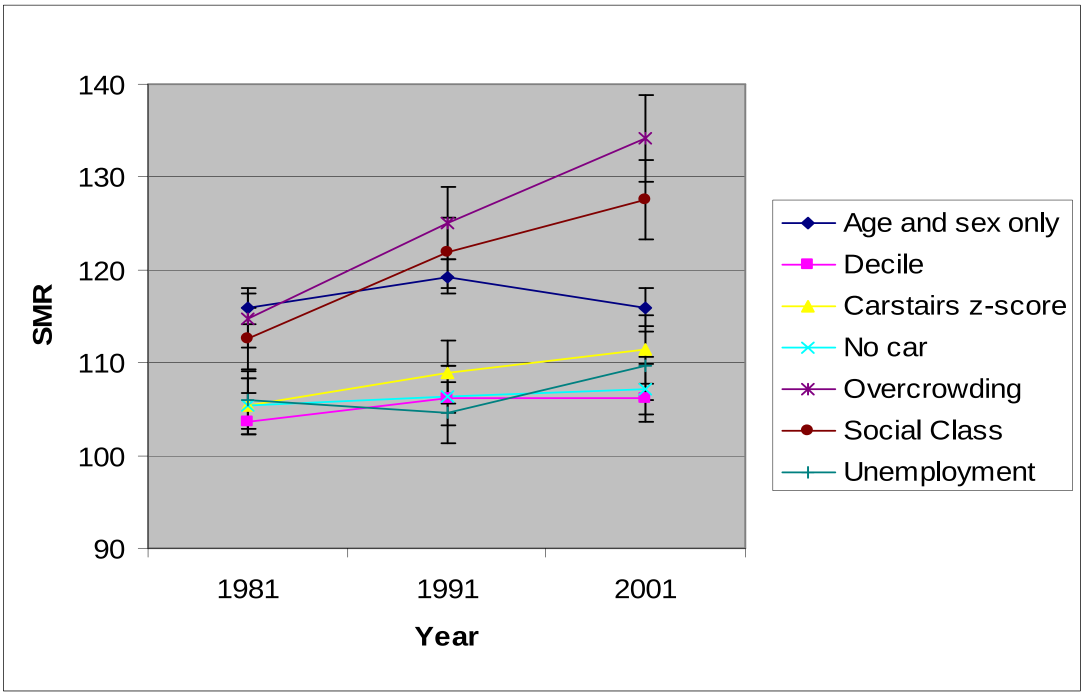


Figure 76: SMR for Manchester with various adjustments in addition to age group and sex, 1981 to 2001.

In Manchester, there was no significant difference between the SMRs produced by indirect standardisation for Carstairs decile and those produced by a regression models adjusting for Carstairs z-score in either 1981 or 1991. However, in 2001, the SMR adjusting for Carstairs z-score was significantly higher than the decile adjusted SMR. As in Glasgow, the social class variable performed poorly in explaining the excess mortality in Manchester although it is also notable that the overcrowding model consistently produced the highest SMR of any of the four Carstairs variables.

In 2001, the lowest SMR for Manchester was produced by the model that included the no car variable as a covariate although this was not significantly lower than the SMR produced by the model that included unemployment or Carstairs decile.

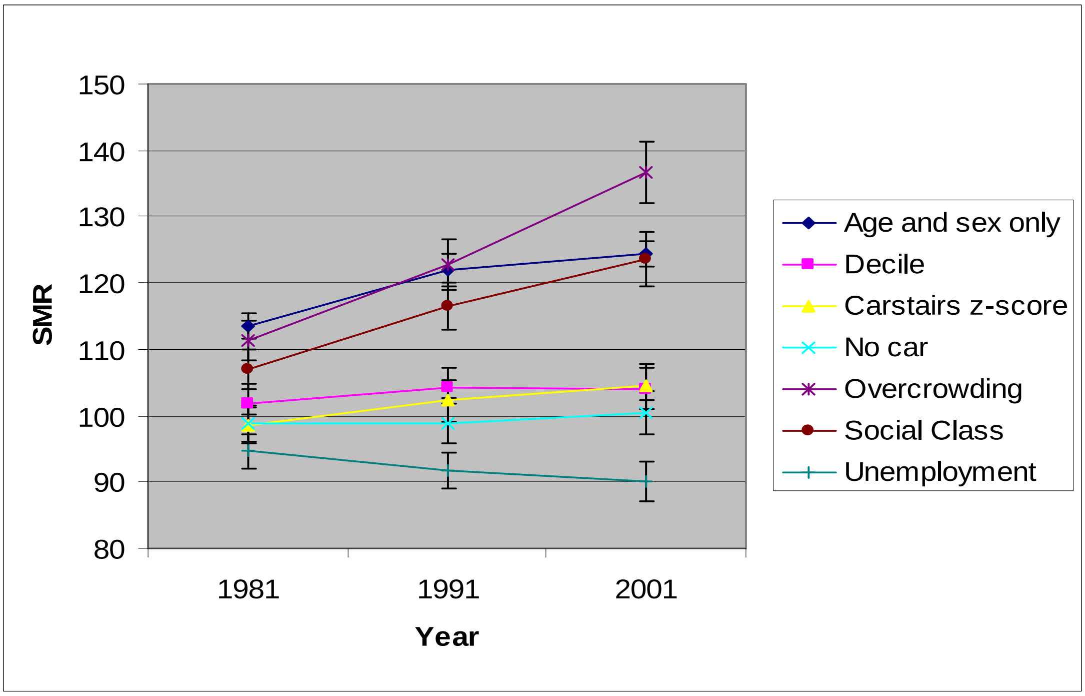


Figure 77: SMR for Liverpool with various adjustments in addition to age group and sex, 1981 to 2001

In Liverpool, there were no significant differences between the SMRs with adjustment for Carstairs decile and those with adjustment for Carstairs z-score at any time point. Most of Liverpool's excess mortality was explained by either Carstairs decile or Carstairs z-score in 2001.

As in Manchester and Glasgow, models including social class and overcrowding performed poorly in comparison to those that included unemployment and lack of car ownership. Perhaps the most notable feature of Figure 77 is that it indicates that after adjusting for area unemployment, the SMR in Liverpool was significantly lower than the UK as a whole.

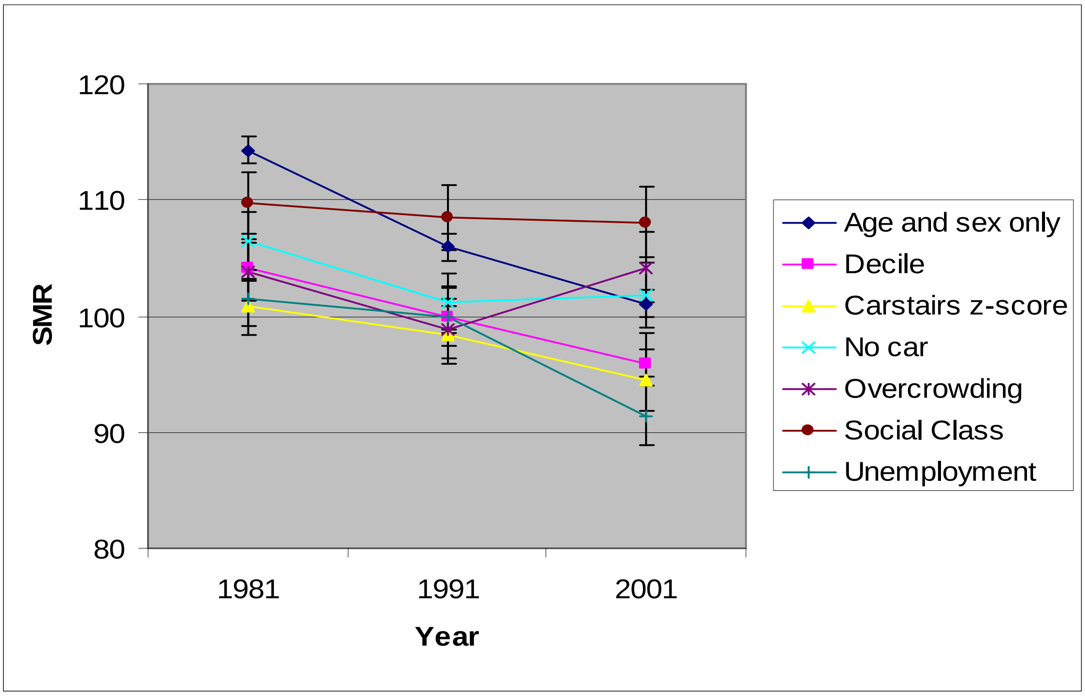


Figure 78: SMR for Birmingham with various adjustments in addition to age group and sex, 1981 to 2001.

In Birmingham, the best performing model in 2001 was the one that included unemployment as a covariate. However, the SMR that resulted from this model was not significantly lower than the SMR calculated with adjustment for Carstairs z-score.

At the earlier time points, Carstairs z-score was the best performing covariate in models although in 1991 the SMRs for several models were not significantly higher or lower than 100.

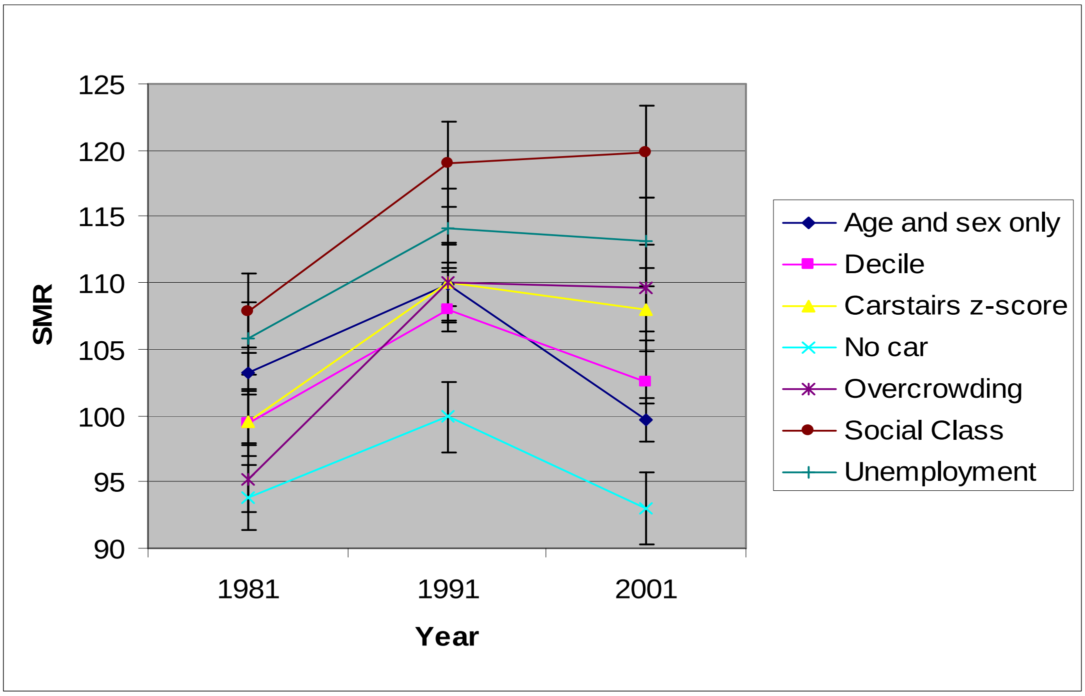


Figure 79: SMR for Edinburgh with various adjustments in addition to age group and sex, 1981 to 2001.

Despite being the most affluent city in the UK according to the Carstairs deprivation profiles, Edinburgh still had significant levels of excess mortality in 1981, 1991 and 2001. In 1981, all of the excess was explained by Carstairs decile and Carstairs z-score, while adjustment for overcrowding and lack of car ownership reduced Edinburgh's SMR to significantly less than 100. In 1991 and 2001, only the model with the no car covariate explained all of the excess mortality in Edinburgh.

It is difficult to display a single figure summarising results of this kind for all the cities in the UK. Instead, individual figures for the cities not discussed in this section (Bradford, Bristol, Coventry, Leeds, Leicester, Newcastle upon Tyne, Sheffield and Sunderland) are displayed in the Appendix at the back of this thesis.

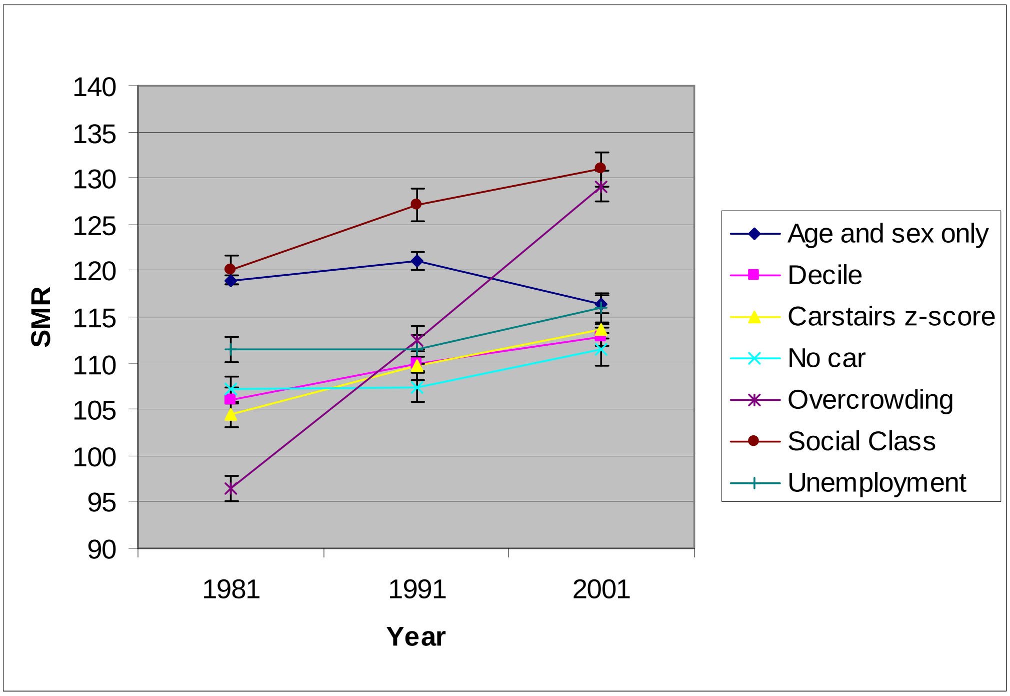


Figure 80: SMR for Clydeside with various adjustments in addition to age group and sex, 1981 to 2001

In 1981, adjustment for overcrowding explained all of the excess mortality in the Clydeside conurbation (and indeed reduced the area's SMR to significantly less than 100). No other model explained all of the excess mortality in Clydeside at any time. As observed for the Glasgow City area, the overcrowding variable was associated with the lowest calculated SMR for Clydeside in 1981 (when it explained all of the excess mortality in Clydeside) but by 2001 the model that included overcrowding as a covariate was unable to explain any excess mortality in Clydeside and indeed resulted in an SMR that was even higher than that calculated when indirectly standardising death rates for age group and sex.

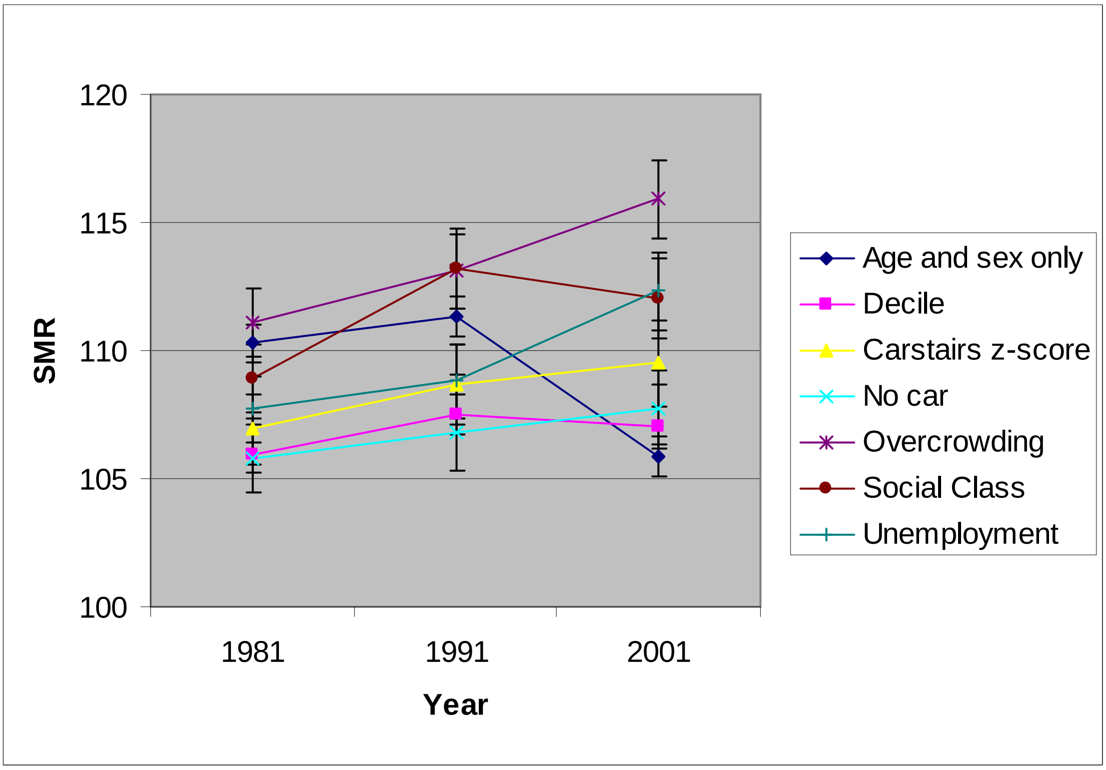


Figure 81: SMR for Greater Manchester with various adjustments in addition to age group and sex, 1981 to 2001

No regression model of death rates in Greater Manchester was able to explain all of that conurbation's excess mortality at any time point. The best performing covariate was no car, although this did not produce an SMR that was significantly lower than adjusting for Carstairs decile or Carstairs z-score. Although there was an upward trend in the SMR produced by the no car model, this rise was not statistically significant.

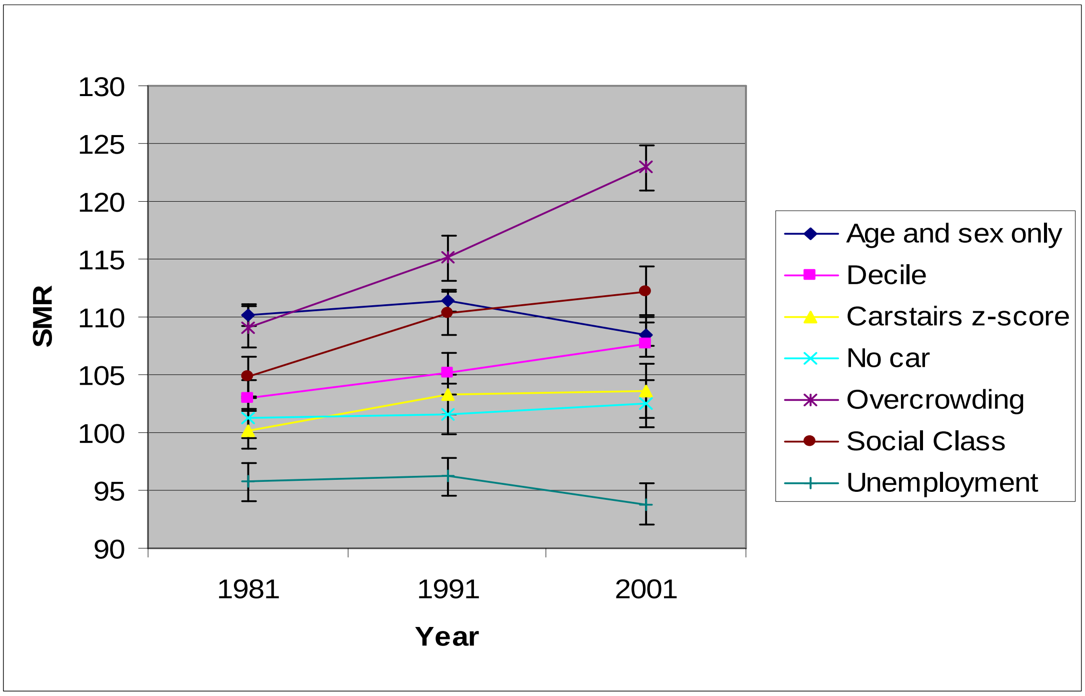


Figure 82: SMR for Merseyside with various adjustments in addition to age group and sex, 1981 to 2001

In both 1981 and 1991, unemployment and lack of car ownership explained all of the excess mortality in the Merseyside conurbation. In addition, adjustment for Carstairs z-score resulted in an SMR not significantly higher than 100 in 1981 only. Unlike in Clydeside, the SMR when adjusting for overcrowding was always significantly higher than 100 in Merseyside and by 2001 the overcrowding SMR was actually higher then when adjusting for age group and sex only. Merseyside was the only conurbation where adjustment for the unemployment variable resulted in the lowest SMR

9 Discussion

9.1 Introduction to discussion chapter

In this chapter I begin by repeating what I consider to be the central findings of my research and how these findings relate to the research questions that I set myself at the start of this piece of work. Then I will discuss the findings laid out in Chapter 8. I will comment on the limitations and strengths of the methods I adopted and where I do identify caveats, I will offer suggestions as to whether they will have significant or minor impact on the magnitude of the ‘Glasgow effect’ as I have defined it. I will present a number of hypotheses to explain the Glasgow effect drawing as far as possible upon my own findings to discuss these hypotheses and, in each case, concluding with suggestions for further research and implications for public health or even economic policy. I complete this chapter by offering a set of overall conclusions and some personal reflections on the implications of my work and the research process in general.

9.2 Main Findings

Before discussing the findings of this study in detail, I shall briefly reiterate what I consider to be the main findings. The following information has appeared already Chapter 8 but the current section highlights those Figures that I think are most important and shed most light on the central issues, namely, the extent to which the Glasgow conurbation suffers from excess mortality and the degree to which this can be explained by deprivation. The reader comfortable with the results presented in Chapter 8, can move on to section 9.3.

The first important finding of this study concerns the relative deprivation status of Glasgow and the Clydeside conurbation. Glasgow City’s deprivation status is best understood when comparing it with the amalgam of ‘*All cities*’. The population composition of the ‘*All cities*’ entity can be considered typical of the UK urban population. Any single city which deviates substantially in its relative composition from that of ‘*All cities*’ can be considered unusual or atypical. Although no single city exactly reflects the population composition of ‘*All cities*’, most are similar enough that outliers can be easily identified. In terms of deprivation status, Glasgow deviates considerably from the typical pattern of UK cities as Figure 83 shows.

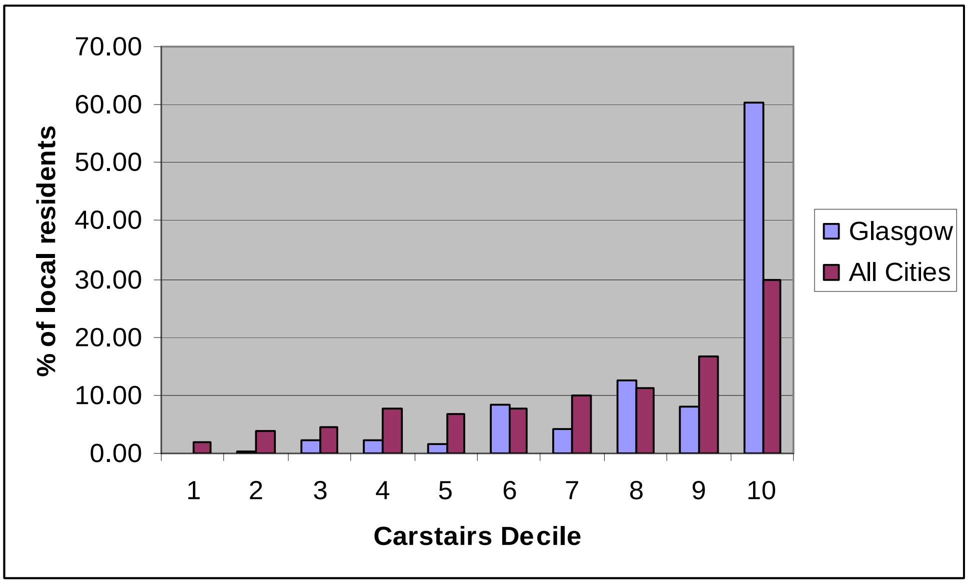


Figure 83: Comparison of deprivation status of Glasgow and *All cities*, 2001 Census

The second important finding concerns standardised mortality ratios in UK cities between 1981 and 2001 and is highlighted by Figure 84.

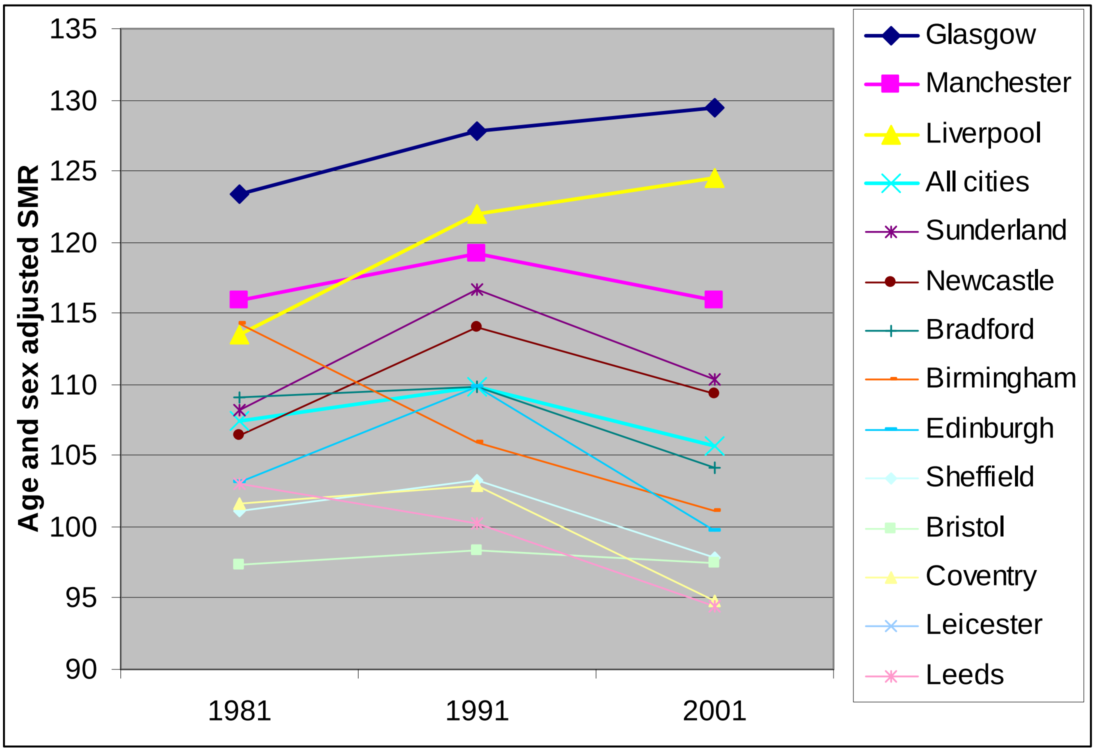


Figure 84: Summary of age and sex adjusted SMR results for large UK cites between 1981 and 2001 with Glasgow, Liverpool, Manchester and *All cities* data highlighted through use of heavier line. (100 = mortality ratio for the whole of the UK at the time of each Census)

Glasgow, Liverpool and Manchester stand out among large UK cities for having the highest SMRs at all three Census time points and although error bars have not been included on the above figure, these three cities all had SMRs significantly higher than the next worst city in both 1991 and 2001. Glasgow and Liverpool had SMRs that increased between 1981 and 2001. In population health terms, these two cities were a long way behind the norm in 1981 and fell further behind by 2001. The data for *All cities*, where SMR was consistently in excess of 105, indicates that the urban population of the UK generally had higher mortality than the population living in non-urban areas. Some cities, however, experienced population health that was not only better than average for cities but also better than average for the whole of the UK. In particular the SMR in Bristol was less than 100 at each time point. In 2001 Bristol was joined by Coventry, Sheffield and Leeds in having SMRs significantly better than the UK average.

Figure 85 is similar in nature to Figure 84 but includes adjustment for Carstairs deprivation decile.

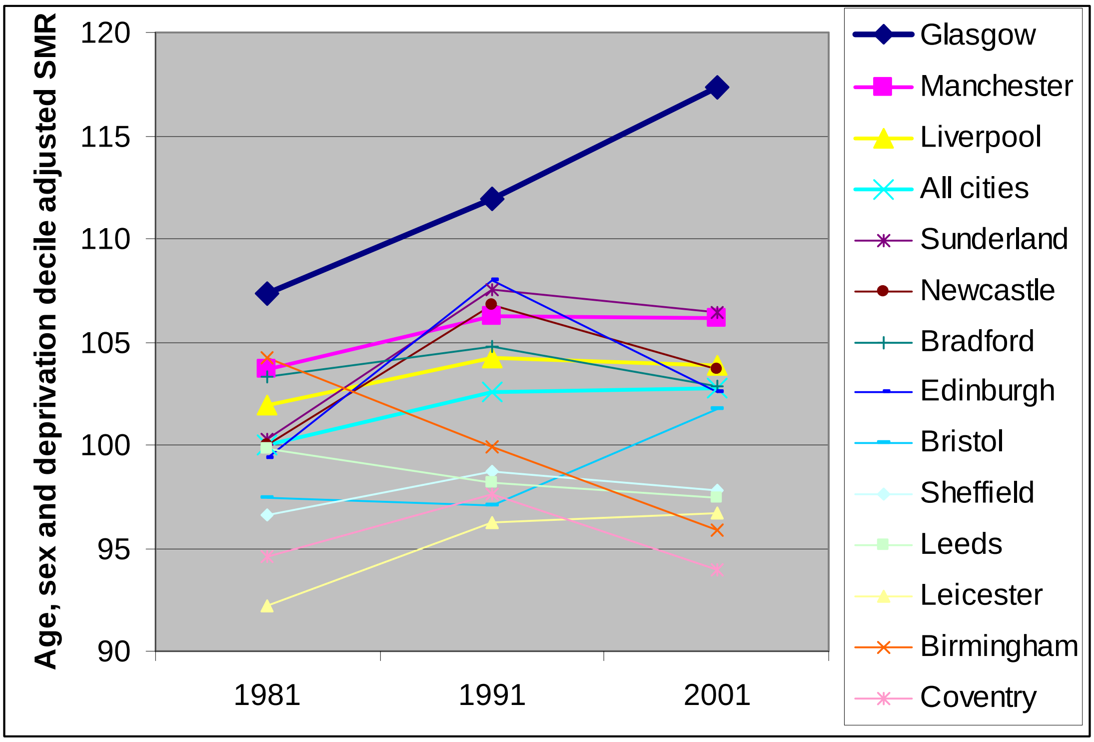


Figure 85: Summary of age, sex and Carstairs deprivation decile adjusted SMR results for large UK cities between 1981 and 2001 with Glasgow, Liverpool, Manchester and *All cities* data highlighted. (100 = mortality ratio for the whole of the UK at the time of each Census)

In general, adjustment for Carstairs deprivation decile resulted in the SMR for cities being reduced compared to the rates following adjustment for age group and sex only. Following adjustment, the SMRs of Liverpool and Manchester were reduced sufficiently at all timepoints to no longer be significantly different from several other cities. On the other hand, age, sex and deprivation decile adjusted SMRs in Glasgow remained much higher than in all other UK large cities (although adjustment for deprivation did result in a significant reduction compared to adjustment for age and sex only) and continued to rise between 1981 and 2001.

In Box 1, below, there is a short summary of the key findings as they relate to the research questions set out earlier in this thesis.

Box 1: Summary of answers to research questions

1. What is meant by excess mortality and what is the size and nature of Glasgow's excess mortality when compared with comparable cities in the UK?

    - Excess mortality is when the SMR of a particular population is significantly higher than for the whole of the UK.
    - Excess mortality in Glasgow grew between 1981 and 2001. Glasgow had the largest excess of any city in 1981, 1991 and 2001, when the SMR in Glasgow was 123, 127 and 129 respectively. Most, though not all, large cities had excess mortality compared to the whole of the UK.

2. How much of this excess mortality (as defined by the previous question) can be attributed to deprivation as measured by the Carstairs index of deprivation?

    - The magnitude of excess mortality in Glasgow was signinficantly diminished. SMRs for Glasgow with adjustment for age, sex and deprivation decile at the three timepoints were: 107, 112 and 117.

3. What is the size and nature of any residue i.e. any excess mortality that is not explained by deprivation (as measured by the Carstairs Index of Deprivation)?

4. What do different definitions of geography and deprivation have on the size of this residue?

    - Excess mortality in the Clydeside conurbation compared to the whole of the UK was smaller than the excess recorded for Glasgow. However, there was still a residue of excess mortality in Clydeside after adjusting for Carstairs decile
    - Adjusting for Carstairs z-score (rather than decile) resulted in a signficantly lower SMR in Glasgow. The excess mortality in Glasgow was further diminished when adjustment was made for lack of car ownership.

9.3 Limitations of this study

9.3.1 All cause mortality data

This was a study of the population health of cities in the United Kingdom. Yet it uses a measure of population health, all cause mortality, that is in many ways not a measure of health at all. Using death data means that the broader health and quality of life measurements of those Glasgow citizens who are alive cannot be assessed. Recent work published by the Glasgow Centre for Population Health such as *Let Glasgow Flourish*[152],*The Aftershock of Deindustrialisation*[5] and the *Community Health Profiles*[212] seek to go beyond the use of death data in comparing the population health of areas. Although it would have been desirable to have taken a similarly holistic or broad approach here, this was not practically possible. In selecting a single measure, all cause mortality, I was able to compare the health outcome of specific populations within the UK with the rest of the country and was able to identify longitudinal trends in health.

I have confined the analysis to all-cause mortality data as this is what was needed to answer the research questions. In the next phase of this work there are potentially interesting analyses that could be undertaken, looking at mortality from specific causes. It may be that the poorest residents of Glasgow die from somewhat different causes to the poorest residents of other cities. If this were the case, it might in turn prompt a different direction or emphasis in public health protection and health promotion strategies. There is some evidence that, as recently as the 1990s, people in relatively deprived Glasgow died of the same causes as people in more affluent Edinburgh, only at an earlier age[265;266]. In more recent years the causes of death associated with deprivation have been changing such that alcohol and drugs related death, violence and suicide have become more important[267], while a very recent paper claimed that 32% of excess mortality among 15-54 year olds in Scotland could be attributed to deaths among drug users[268].

A limitation of the current thesis is that specific causes of mortality were not investigated. I was able to identify that young working aged men in Glasgow had particularly high mortality, even within the context of the city with the highest all cause mortality rate in the UK. Given the impact of high mortality within this age group on the city's average male life expectancy, there is merit in a further investigation of the specific causes of death among young men. This would add a great deal of contextual detail to the main results presented herewithin. Such research would answer questions such as: do causes of death such as alcohol-related mortality and drug abuse have the same relationship with deprivation as other causes of death such as cancer and heart disease that afflict older age groups? In turn, the answers to these questions would have addressed the fourth research question that I did set myself *"What is the size and **nature of this residue**?"* which has been partially answered by my investigations into age and sex specific all-cause mortality rates. However, the differential between the deprivation adjusted SMR in Glasgow and those calculated for other UK cities was not immediately apparent. Such investigations should of course be the focus of future research into why all cause mortality rates are so much greater in Glasgow than elsewhere.

An important point to make, however, is that this thesis was part of a larger body of work commissioned by the Glasgow Centre for Population Health. This piece of work highlights Glasgow's unique position (in health terms) within the UK. In using all cause mortality data, it does not give a complete picture of health in the city but should be taken as part of a linked programme of investigations which collectively build understanding of health in Glasgow and provide leads for researchers and policy makers alike.

9.3.2 Indirect standardisation

In this thesis, I used standardised mortality ratios, calculated by means of indirect standardisation to compare population health between cities. There are a number of limitations to this method that need to be addressed. The most obvious limitation is that indirect standardisation indicates relative differences between populations. Thus, we can say that in 2001, age and sex adjusted death rates in Glasgow were 28% higher than for the whole of the UK. However, this disguises what the absolute death rate was in Glasgow. SMRs are even more problematic when comparing the same area across time as the composition of both the local and the standard population change. Thus, absolute death rates in one area may fall, but its SMR relative to the death rate in the standard population may actually rise over a period of time – this is well illustrated by the case of Glasgow where the crude death rate in 1981 was 4,374 per 100,000 and in 2001 it had fallen to 3,984 per 100,000. However, an SMR is an easily interpreted, intuitive figure and areas with particularly poor health relative to the norm can be identified easily.

There are technical drawbacks to the use of indirect standardisation too. In contrast to the indirect method adopted in this thesis, the direct method of standardisation involves applying the age specific rates of the subject population to the age structure of the standard population. This is because it preserves consistency between populations i.e. if each age-specific rate in area A is greater than each of the corresponding age-specific rates in area B, then the directly standardised rate for area A will always be higher than that of area B, irrespective of the standard population used. Indirect standardisation does not necessarily preserve this consistency, and in extreme situations may give misleading results. Such a situation will occur when the age structures of the two populations in question are not similar or if the ratio of their age specific mortality rates fairly stable across the age groups. I have not tested to see if the age structure of the population in Glasgow was different to the age structure of other cities in the UK, although I have presented some data to indicate that there is a slightly different pattern to age and sex specific mortality rates in Glasgow to the pattern in Liverpool and Manchester, with mortality rates among young working aged men in Glasgow being significantly higher in 2001 than in men of the same age group in other cities. It is conceivable then, that the whole city SMR figure for Glasgow in 2001 is inflated because of the disproportionate number of deaths in the 20-24 and 25-29 age categories in comparison with the equivalent sub-groups in Manchester and Liverpool. However, I believe that even if such inflation were in operation it would have only a minor effect on the magnitude of the Glasgow effect as I have defined it.

9.3.3 Use of age and sex adjusted mortality rates

My results reveal significant differences in the patterning of death rates among men and women in cities. In the cities with the highest all cause mortality rates (Glasgow, Liverpool and Manchester), there was greater disparity between male and female death rates than in cities with lower age and sex adjusted SMRs such as Birmingham, Sheffield and Leeds. Despite this, in absolute terms, female death rates in Glasgow, Liverpool and Manchester were considerably higher than in any other city. Using age and sex adjusted SMRs has the effect of disguising variations in the magnitude of the excess mortality in Glasgow and other cities between the two sexes. In Chapter 8, I presented age group and sex specific mortality ratios for Glasgow, Liverpool and Manchester but did not present age adjusted mortality ratios for the entire male and female populations of these cities. Accordingly, I am not able to say whether excess mortality is most profound in the male or female segment of Glasgow's (or any other city's) population..

9.3.4 Deprivation data

This study relies heavily on the Carstairs index of deprivation. I will deal with the shortcomings of the Carstairs measure shortly but will first consider the more general limitations of deprivation indices.

In general, deprivation indices have a specific and limited purpose: they provide an account of the degree to which people lack key assets. They do not measure the (not necessarily material) assets that people actually possess. Such assets might be: family and other social networks; community facilities; quality of the local environment including schools, shops, green spaces; medical care provision and employment opportunities; quality of social housing stock; public transport provision and so on. The possession of or access to such assets or facilities may mitigate against some of the effects of material deprivation: the lack of such facilities may further exacerbate deprivation's effects. None of the deprivation measures that I examined earlier in the Literature Review included any domain which attempted to measure the presence of such assets. I did not have a measure of key assets. It is possible that there are some key assets that have a positive impact on the health of deprived communities. However, the findings of *Let Glasgow Flourish*[152] suggest that on almost all measured variables, deprived communities do worse.

I adopted the Carstairs measure for use in this thesis as it enabled comparisons of deprivation over time and between cities. In the forms of the Indices of Multiple Deprivation, there are newer, more recently formulated deprivation measures that have been created in light of recognition of the non-material aspects of deprivation. These measures are more comprehensive than the Carstairs measure and perhaps may be more relevant to the 'lived experience' of deprivation in 21st Century Britain. Crucially, however, they are not compiled in the same way and so they do not allow comparisons of deprivation between Scotland and England to be made.

The Carstairs index is an area-based measure of deprivation. Area based measures are constructed by counting the number of people within a predefined geographical area who meet a particular criterion - for example, the number of people who do not own a car. A limitation of this approach is that the area classification reflects the characteristics of the majority of people in the area, but will not accurately reflect the characteristics of every individual living there. Accordingly, people with larger incomes or better material circumstances can be classified as being ‘deprived’ if they live in a neighbourhood where the majority of people are less affluent. More pertinently for social policy makers, in areas classified as ‘affluent’ by deprivation indices there will be a (not necessarily small) minority of residents who satisfy the criteria for being deprived[269;270]. Social interventions devised with the purpose of alleviating deprivation must be designed not just to target areas where deprivation is common but also to identify and help those individuals who live in an area that might otherwise be ignored by such measures. I have taken care to use terminology such as ‘those living in the most deprived areas’ rather than ‘deprived people’ when discussing the health status of people living in Glasgow and other cities as I have not used any measure of deprivation relating to individuals.

While the likelihood is that an individual living in a Postcode sector classified in decile 10 of the Carstairs distribution will himself be materially deprived, it is by no means a certainty. Such problems are even more apparent when considering English cities where Carstairs deprivation data and mortality data were available at the ward level of geography. Some inner city wards in England have populations in excess of 10,000 and are likely to be highly heterogeneous. This is highlighted by the deprivation profiles for most English cities where it would appear that 0% of local residents live in an area classified within a particular Carstairs decile. Manchester, for example, appears to lack any residents in the two most affluent deciles. Postcode sectors encompass smaller populations (typically 3-5000) so the two Scottish cities in this study, Glasgow and Edinburgh, are not affected by this problem to the same extent. Nevertheless, even within one Postcode sector there can be substantial variation in the housing stock and type of people living in the area. Take, for example, the 'G51 4' Postcode sector, just South of the River Clyde. This encompasses the traditional tenements of Govan, recently built luxury flats adjacent to the new Clyde Arc bridge at Pacific Quay, high rise flats at Ibrox and the interwar council housing estate of Drumoyne which features terraced houses and 'four in a block' cottage flats. This Postcode sector is classified as being in decile 10 of the Carstairs distribution but is far from uniform and although the majority of residents are severely deprived according to Carstairs (and other) measures, it contains some pockets of relative affluence and some middling areas.

A further potential limitation of the Carstairs measure is that it is the unweighted aggregate of four standardised Census variables. This means that each of the four Carstairs variables is given equal importance in the construction of the index. Thus, living in an overcrowded house is implied to be just as detrimental to well-being as not having a car or being of low social class. This implication is questionable, especially where health is concerned. The more recent Indices of Multiple Deprivation assign weightings to their domains. The most recent Scottish Index of Multiple Deprivation used the weightings described in Table 14.

Table 14: Weightings assigned to domains in Scottish Index of Multiple Deprivation, 2006

SIMD Domain	Assigned Weighting
Income	12
Employment	12
Crime	2
Education	6
Health	6
Housing	1

Access	4

Thus, lack of income is deemed to be more important from the point of view of being associated with multiple deprivation than lack of access to services. Such an approach is endorsed by Gordon, who has suggested that weighting the components of deprivation measures allows funds to be directed to those who need them most[131].

In this study I have addressed the equal weighting of components within the Carstairs measure by testing the ability of each component variable to explain excess mortality in cities. In fact, this was the approach originally taken by Carstairs and Morris who selected several candidate variables when they constructed their index in the 1980s. They sought to find factors which could explain the excess mortality that they measured in Scotland at the time of the 1981 Census. They settled on four variables, deciding that the inclusion of more variables would not improve the index's ability to explain excess mortality. This reveals another potential shortcoming of the Carstairs measure: it is an *ad hoc* construction, created with the explicit intent of explaining poor health in Scotland and not intended as a deprivation measure to guide policy makers. Thus, using the Carstairs score to describe a small area, or a whole city, as deprived could be misleading. Instead, an area with a high Carstairs score might be more accurately described as having a population where factors associated with high levels of mortality are more common. Nevertheless, all the variables used to create the Carstairs index were later used in both the Scottish and English Indices of Multiple Deprivation. Furthermore, as an adjunct to the original *Scottish Effect* study, the researchers discovered a Pearson rank correlation of 0.897 between SIMD datazone scores that had been aggregated to Postcode sector level and Carstairs scores for the same areas in Scotland[5]. This finding indicates that even though Carstairs is not a measure of multiple deprivation it is a reasonable proxy measure.

The drawbacks of the Carstairs measure must be acknowledged when interpreting the results of this study. It is an area-based measure — whereas risks to health operate upon individuals, although local contextual effects are a determinant of health[271]. Carstairs data were available at different levels of geography in Scotland from those used in England. Problems of ecological fallacy mean that deprivation profiles for English cities in particular are not necessarily representative of the 'true' demographic make-up of those cities. This has particular implications when adjusting death rates in English cities by age group, sex and deprivation decile. The death rates of deprived residents might be standardised against rates of more affluent people while death rates of more affluent residents, misclassified into a ward which has a high overall level of deprivation, might be standardised against those of much more deprived people. Until Carstairs data are available for English Postcode sectors, this problem will remain unsolved.

9.3.5 Ability of the Carstrairs Index to explain mortality differentials over time

Figures 70 -74 in the results section show the frequency distribution of each of the Carstairs component variables over time. The distribution of three of these variables (overcrowding, unemployment and lack of car ownership) became more favourable between the time of the 1981 Census and the 2001 Census, while the distribution of the fourth variable, low social class, remained unchanged. In light of this information, it becomes reasonable to question whether the Carstairs measure is able to capture the concept of material deprivation, far less the more recently developed concept of multiple deprivation. The frequency of three indicators of deprivation was reduced and while it is reasonable to argue that the presence or absence of these items still points towards the existence of deprivation, it seems equally reasonable to suggest that their increasing scarcity implies that there must now exist other, variables that better indicate the presence of deprivation. It is unrealistic to argue that relative deprivation has become less of a problem as other measures such as the SIMD continue to suggest its presence on an extensive scale. A more plausible line of argument is that the Carstairs index is an increasingly inappropriate way to measure such a complex phenomenon as relative deprivation. To illustrate this idea, it is useful to return to the words of Peter Townsend that I quoted in the literature review chapter:

> "Deprivation takes many different forms in every known society. People can be said to be deprived if they lack the types of diet, clothing, housing, household facilities and fuel and environmental, educational, working and social conditions, activities and facilities which are customary, or at least widely encouraged and approved, in the societies to which they belong."[128(page 25)]

Townsend lists several ways in which deprivation can make itself manifest: diet, clothing, housing, environment conditions, working conditions, social conditions and facilities. The Carstairs indicator variables, at best, can be seen to measure housing, social conditions and working conditions and cannot be said to directly measure the other domains, although it is possible to see an indirect connection between, say, car ownership and items such as social conditions, social activities and working conditions. Carstairs and Morris concede that the variables they included in their index were proxy variables. Positive change in the distribution of these proxy variables could indicate that deprivation has become less commonplace but it seems more likely that the nature of deprivation itself has changed such that it no longer bears a close relationship with the proxy variables that Carstairs and Morris selected. This is an important point. According to Townsend's definition of deprivation, the Carstairs index is only partially able to quantify the extent and frequency of deprivation even when there was a close relationship between the indicators and deprivation itself. If, subsequently, the relationship between the indicators and the concept they are intended to measure deteriorates then the overall ability of the index to explain differentials in health is called into question.

In light of this, there are clear implications for the interpretation of the results within this thesis. I have suggested that the ability of Carstairs to explain mortality differentials has diminished over time and that this is particularly true for Glasgow and, to a lesser extent, for the Clydeside conurbation. It might be tempting to suggest that the relationship between deprivation and mortality in Glasgow and Clydeside is different to that in the rest of the country. However, Figures 70-74 show that deprivation *as measured by the Carstairs index only* became less commonplace over the period 1981-2001. Thus it should come as no great surprise that the ability of the Carstairs measure to explain geographical differentials in health is diminished and that, since Glasgow was the location with the greatest concentration of areas scoring highly on the Carstairs measure, the ability of Carstairs to adjust for high mortality locally should be most impaired. Without equivalent data for a second measure of deprivation it is difficult to quantify the extent to which the Glasgow effect (as I have defined it) is overstated due to the amelioration of the Carstairs indicator variables. However, the effect could be significant and, should another method of adjusting death rates for deprivation be used, the excess mortality found in Glasgow might be considerably diminished.

9.3.6 Issues of geography, inclusion and comparability

The basis upon which decisions were made about which cities to include and exclude also has some limitations. I selected cities primarily on the basis of population size (there were 11 UK cities with a comparable population to Glasgow according to the 2001 Census) and then on the basis of their social history (I included Newcastle upon Tyne in my analysis for this reason). I included a sufficient number in order to gain an understanding of any differences in deprivation status and health outcome between Glasgow and other cities in the UK. Because there was a subjective component to both these criteria, it might be possible to argue that I was missing out on useful comparative data by excluding cities such as Portsmouth, Cardiff, Middlesborough and Dundee.

The omission of London is perhaps more significant since it is by some distance the largest urban centre in the UK, has areas that have some of the worst population health in the UK and has population groups with particularly high levels of health need. I have described London as a ‘World City’ implying that it has more in common with cities such as Tokyo, New York and Paris than it does with the other cities in the UK. It has such a large population that calculating an SMR for the whole of London would be of as little use for the purposes of this study as an SMR for the whole of Scotland. London has such a diverse population with such extremes of wealth and deprivation that a whole city SMR would not give a clear indication of the whole city's population health in the manner that I suggest SMRs for the other cities do.

I described in the methods section how cities are functional entities that do not necessarily follow administrative boundaries. This necessitated the comparison of conurbations but the relationships between cities and their conurbations vary from place to place so it is difficult to judge whether I have been comparing like with like. The main settlement of the Clydeside conurbation is Glasgow and the surrounding towns are to a greater or lesser extent reliant on Glasgow for employment opportunities, educational institutions, retail and leisure facilities and so on. Conurbations are complex, ill-defined settlements. I have not examined whether the nature of the conurbation on Merseyside is similar to that of Clydeside or Greater Manchester - if they have 'dormitory' suburbs similar to Bearsden, Milngavie and Newton Mearns located immediately adjacent to the core city boundary; if the nearby towns have previously been independent entities that have become encompassed by the sprawl of the central city; or if the wholescale inner-city population transfer to nearby peripheral housing estates, suburbs and new towns happened to the same extent. Accordingly, the reader is encouraged to use caution when interpreting data relating to the conurbations as they have been defined to enable the comparison required by the current study. The boundaries I have selected do not reflect any current governmental or academic definitions.

That said, I had two intentions when comparing the health status of conurbations. First, I was interested in identifying the extent to which the exclusion of data from nearby affluent suburbs just outside the Glasgow City boundary from the city's health statistics leads to the picture of population health in Glasgow being misleadingly bleak. Accordingly, I wanted to identify if the same mechanism might operate in other cities in the UK. Second, Glasgow is not the only area in the West of Scotland with a reputation for poor population health. Inverclyde, West Dunbartonshire, Renfrewshire and Lanarkshire all have life expectancies which are considerably below the British average, and I wanted to establish if the relationship between material deprivation and excess mortality in the wider conurbation was similar to that within Glasgow itself.

The definitons of city and conurbation do matter but they do not fundamentally alter the conclusion that outwith core cities, the health of urban residents is demonstrably better. It is important to compare like with like. In future, those wishing to investigate why conurbations have better health than the cities at their core, and the magnitude of this difference, will require to develop a more consistent and rigorous definition of the relevant geographical boundaries than I have used here, and a better understanding of the nature of those conurbations (in historical, social and economic terms for example).

9.4 .Strengths of this study

In spite of these limitations, I believe that to a large extent I have been able to answer the research questions set out in Chapter 4. I have provided evidence that population health is indeed worse in Glasgow than it is in all other comparable cities in the UK. After adjustment for a measure of deprivation, Glasgow remains at the bottom of the 'league table' of health of UK cities. I make this assertion confidently because my data cover the whole population of the UK and use a measure of health that is regarded as a reliable indicator of overall population health.

I have already discussed the limitations of using death data as a measure of health and in the literature review in Chapter 2 I also discussed the advantages of using death data for a project of this kind. Death is unarguable and is recorded for every citizen when it occurs. Death data, therefore, are comprehensive and are available for every area of the country. Thus comparisons of health between areas based on mortality data are robust and reliable because there are no issues of sample size, bias or self-reporting errors. Mortality rates are accepted as valid measures of health when comparing different populations.

While the various regional public health observatories located around the UK are tasked with comparing population health in the regions and cities of the UK, I have gone beyond description and comparison of population health in cities and attempted to explain differences on the basis of the new analyses that I have undertaken. The results I have obtained concerning the relative deprivation status and mortality ratios of the 13 large UK cities will be thought-provoking for those with an interest in public health. Despite the issues of underbounding and overbounding leading to concerns about how comparable city and conurbation boundaries are, these boundaries do, to a large extent, represent recognisable, complete settlements. I have confidence that the general public will understand and relate to my findings concerning population health in different cities.

My results contain some good news for certain cities, especially Sheffield, Leeds and Edinburgh where in 2001, age and sex adjusted standardised mortality ratios were similar to or lower than the British average. In Birmingham, the SMR fell between 1981 and 2001 and the results for this city show that it is not necessary for cities with poor population health to remain in that situation. Current public health policy is focussed on local level inequalities in health between neighbourhoods, age groups, gender groups or ethnic groups. My results take a broader view and point to specific cities in the UK where population health is better or worse than others. My results bring new insights and understanding of how far behind other cities in the UK Glasgow is in health terms, and highlights cities where population health is better than might be expected.

Moreover, with respect to the relationship between excess mortality and deprivation, the Carstairs index has been shown in this study to be still capable of explaining a significant portion of excess mortality in *All cities*. In certain cities it is capable of explaining all of the excess mortality.

Above all, I have demonstrated that there is a Glasgow effect. Amongst British cities, all cause mortality ratios in Glasgow are exceptionally high after adjustment for age group, sex and a reasonably robust measure of deprivation. Glasgow is not the only city with a large residue of unexplained excess mortality as data for Manchester indicate. However the separation of Glasgow's SMR in 2001 from those in other cities suggests that the relationship between measured deprivation and mortality in Glasgow is different. The effect is not necessarily an urban effect, as data for *All cities* show.

9.5 Hypotheses to explain findings

9.5.1 General points

In the next section, I will set out a series of hypotheses to explain the Glasgow effect. Throughout this project, I have been part of a semi-formal group of researchers that has formed the 'Observatory Group' within the GCPH. In our regular meetings we discussed several hypotheses about why the Glasgow effect might exist. Several of these hypotheses were formalised and published in *The Aftershock of Deindustrialisation*[5]. Thus, while some of the headings in this section have appeared in other published documents, the discussion points pertaining to them are, unless stated otherwise, entirely of my own formulation.

9.5.2 The Glasgow effect is apparent rather than real

In seeking to explain why deprivation does not account for most of the excess mortality in Glasgow, the first hypothesis that needs to be tested is that the 'effect' is an artefact of the measures used. The most likely explanation in this regard is that deprivation measures are incapable of capturing the true nature of multiple deprivation and social exclusion. A less likely explanation is that is that there exist, particularly in Glasgow, some, as yet unmeasured, factors that adversely influence health in addition to the health-damaging processes associated with deprivation.

In section 9.3.4, I described the caveats surrounding the ability of deprivation measures to describe deprivation itself. If the indicators of deprivation chosen for a particular measure do not count all those individuals who are deprived, or fail to capture aspects of deprivation that are influencing health, then the usefulness of that measure is compromised. No single indicator of deprivation will correlate completely with those actually experiencing the deprivation, so measures of deprivation are usually an amalgam of several indicator variables. Furthermore, if one takes the view of Townsend[89], that relative deprivation is when one fails to have a lifestyle that is considered to be within the acceptable or decent limits of society, then deprivation is a fluid concept and will change over time or from place to place. Thus, the ability of indicator variables to capture the full concept of deprivation will also vary over time and from place to place.

I have presented some evidence which would seem to indicate that this mechanism has occurred. The ability of indicators of deprivation to explain excess mortality has varied over time. In most cities, adjustment of death rates for overcrowding explained most of the local excess mortality in 1981, but this indicator performed very poorly for 2001 death data, at least in part because overcrowding had been markedly reduced. Overcrowding is still considered to be an indicator of material deprivation and is included in both the SIMD and EIMD, yet its relationship with all cause mortality in most cities has changed. The presence of overcrowding on its own cannot be considered shorthand for deprivation but, where it exists in the presence of other indicators, material deprivation is likely to be present.

Similarly, in many cities, Glasgow included, adjusting for the measure of low social class used in the Carstairs index gradually explained less excess mortality with each timepoint. The inclusion of these two variables in the Carstairs index impaired its ability to explain excess mortality in Glasgow in 2001. Given the origins of the index, it is probable that were Carstairs and Morris to repeat their original investigation using death and Census data from 2001 that they would exclude at least overcrowding and probably low social class and include other indicator variables.

I have also presented some evidence that does not support this hypothesis and suggests that the Glasgow effect is 'real'. Figure 85 shows that adjustment of death rates for Carstairs decile does not result in Glasgow's excess mortality being reduced to the same extent as in other cities. Liverpool, for example, had a deprivation profile in 2001 that was not dissimilar to Glasgow, and yet adjusting SMR for deprivation in Liverpool resulted in an SMR that was not significantly different to several other English cities. If there was indeed some sort of breakdown in the relationship between the Carstairs indicator variables and deprivation itself then it is reasonable to expect that Glasgow would not be the only city affected. I think it is more plausible that there is indeed some other factor or factors in operation in Glasgow.

Future investigation into this hypothesis is necessary. Analysis of specific causes of death, stratified by deprivation category is merited. Recent publications by Leyland[267] and Walsh[5] indicate that in the Glasgow and Greater Glasgow area there are particular problems with: alcohol-related mortality in men and women; deaths from external causes among men; lung cancer in women. The relationship between deprivation status and mortality from these causes needs further scrutiny.

Another set of potential mechanisms by which the Glasgow effect might be apparent rather than real, concerns the secondary datasets which I used in my analyses. However, it does not seem feasible that any one of these mechanisms occurred in reality. It might be possible that mortality is recorded and measured differently in Glasgow. Given that I used all cause mortality data, this seems extremely unlikely. A major advantage of using death as a measure of health is that death is inarguable. Had I used specific causes of mortality then it would be more difficult to rule out a geographical bias in the way death is recorded. Might it be possible that I have adjusted for age and sex differently in Glasgow than I have done for other cities? This would imply that the Census population figures that I obtained are unreliable. I repeatedly checked that I had calculated the age and sex composition of Glasgow's population accurately and that I had matched death data to the correct population data. Although there was an undercount of Glasgow's population at the 2001 Census, the figure was very small (less than 1000[272]) and would not make a significant impact on the city's SMR, and so Census data can be ruled out as creating an artificially high SMR in Glasgow.

There are also two issues of geography that need to considered here. The first concerns the disparity in the average populations of wards and Postcode sectors. Ecological fallacy may be masking the appearance of the relationship between deprivation and health outcome in English cities. The second geographical issue concerns the problem of city definitions and ensuring that like is being compared with like. Every city's administrative boundaries are a product of historical and political factors and not created with the needs of the researcher in mind. Accordingly, the demographic, socioeconomic and geographic composition of each city will be influenced by how its borders are drawn and, given the complex relationships between deprivation factors on the one hand and individual, community and behavioural factors on the other, it is important that we compare populations that are, as far as possible, similar to one another. This challenge has been addressed in this thesis but there remains a possibility that differences in how the major cities of the UK are defined accounts in part for the Glasgow effect.

9.5.3 Excess mortality in Glasgow is still a product of deprivation despite the evidence produced in this thesis.

There are two elements to this hypothesis. The first is that Glasgow's current poor population health is a product of historical deprivation which is still impacting on mortality even as current measures of deprivation have improved. The second element is that the 'lived experience' of deprivation in Glasgow is worse than other cities in the UK and this difference has not been captured by current measures of deprivation.

As I discussed in the literature review, the case for adverse influences on health operating across the lifecourse with a delay between risk exposure and health outcome is now well established. The deprivation profiles that I have drawn for both Glasgow and Clydeside indicate that at the time of the 1981 Census, both the city and the conurbation had a greater proportion of residents living in deprived areas than they did in 2001. Although the effects of migration cannot be ignored, it is reasonable to assume that the majority of residents of Glasgow and Clydeside in 1981 continued to reside in the area over the next 20 years. The continued poor population health of Glasgow can possibly, therefore, be viewed as a product not only of the city's current unfavourable deprivation status but also as a direct result of the deprived conditions that current residents experienced earlier in their lives.

This temporal relationship between deprivation and its effect on health outcomes, particularly mortality, has implications for the method of modelling that was used in this project. For example, if one takes the view that the health depleting effects of deprivation 'accumulate' over the life course then modelling current death rates for current levels of deprivation will only account for a portion of the adverse life circumstances that contribute to local mortality levels. There are, therefore, two implications for the models used in this thesis. First, it is extremely difficult to adjust current mortality rates for previous levels of deprivation. People move from one area to another; people experience different levels of deprivation throughout their lives; deprivation experienced during particular phases of life may have greater implications for health; and the nature of deprivation changes over time such that measuring levels of it in the past is difficult. Second, it does seem appropriate to measure current levels of deprivation as there are certain forms of mortality which are probably more closely related to the current socio-economic status of the individual than others. Such forms of mortality might include infant mortality, suicide, homicide and accidents. Thus, the issue becomes, how best to weight the adjustment for current levels of deprivation?

The temporal relationship between deprivation and mortality may have significant implications concerning the magnitude of the Glasgow effect. Unfortunately, it would be difficult to measure historical levels of deprivation in Glasgow. While data for the 1971 Census have been released electronically, it would be necessary to assimilate several paper sources to understand the picture in the more distant past. Of course, studies such as those of the Renfrew-Paisley cohort have identified life-course deprivation as an important factor in adult mortality[273] but such studies would need to be extended to see if lifecourse deprivation played a greater or lesser role in other cities in the UK.

The second element of this hypothesis focuses on the lived experience of deprivation. It is possible that deprivation is more widespread and/or intense in Glasgow than in other cities. So, there is a deprivation effect that arises from this scale and intensity of deprivation that is not fully captured by small area based measures of deprivation. In short, living in a part of Glasgow which has the same level of material deprivation as a small area in, say Edinburgh, may be experienced as 'worse' because the small area is part of a large deprived quarter of the city. Previously, I have noted that many measures of deprivation are correlated with one another. The final ranking may vary from index to index but, broadly speaking, areas that are described as deprived by one deprivation index are likely to be classified as deprived by another. According to this hypothesis, there is some quality to the lived experience of deprivation in Glasgow that is being captured but not fully measured by current indices. It is possible that the concentration and geographical extent of deprivation in Glasgow somehow adds to or multiplies the health damaging nature of deprivation itself. A recent paper by Sridharan[274] provides some evidence that the spatial distribution of deprivation has an additional effect on health outcomes although further study is necessary to determine why this should be the case and if the relationship is true not only for Scotland but for the rest of the UK and Europe.

Evidence to refute this hypothesis comes from the *Aftershock of Deindustrialisation* report published by the Glasgow Centre for Population Health[5]. Compared with several comparable regions of Eastern and Western Europe, the West of Scotland has higher levels of employment, a higher GDP, higher mean incomes, higher levels of education and is more favourably positioned on a number of socioeconomic indicators. However, in many regions that appear to be less prosperous than the West of Scotland, including some in the former Soviet Bloc, life expectancy is improving faster, and in some places has overtaken Greater Glasgow and the West of Scotland. This challenges the notion that Glasgow's higher mortality can be explained by the extent or depth of its deprivation.

At present, the Glasgow Centre for Population Health is embarking on further analysis of health in Glasgow compared with similar regions in Europe. Their focus is to understand better issues of social history and geography that might explain why the comparatively (in European terms) affluent city of Glasgow suffers health outcomes that are worse than some more deprived regions.

9.5.4 Excess mortality in Glasgow and Clydeside results from relative inequalities within the city and the region

The next hypothesis to explain excess mortality in Glasgow and Clydeside is that there is greater material and social inequality in the region than in other parts of the UK. The focus is on the gradient between affluent and deprived rather than the absolute level of deprivation.

The existence of a gradient between affluent and deprived areas in Glasgow and Clydeside is demonstrated by the deprivation profiles that I created.

Adjustment of death rates for Carstairs decile should, in theory, have allowed for the disparity in death rates between affluent and deprived areas

Figure 69 in the results section indicates the spread of z-scores within decile 10 and shows that there was a substantial 'tail' in this distribution. Given that Glasgow had a large number of Postcode sectors classified into decile 10 then it is reasonable to assume that a significant number of them have z-scores that would be found in the decile 10 tail and, moreover, Glasgow areas would be more heavily represented in this tail than those from other cities. This might affect SMR where adjustment is made for Carstairs decile as not all decile 10 areas are similarly deprived.

I addressed this issue by adopting the technique of negative binomial regression. This method allowed local death rates to be adjusted for the continuous Carstairs z-score of small areas. Results from negative binomial regression gave a smaller Glasgow effect than when indirect standardisation was used, but the excess mortality in Glasgow was still larger than in other cities. In other words, there is a 'tail' effect in Glasgow due to the spread of Carstairs scores but it still does not explain the Glasgow effect.

Discussion of inequalities often highlights the close association between income inequality and health inequality. No direct measure of income was used in this thesis. The closest proxy variable for income would appear to be lack of car ownership but this is a very crude indicator of income. There may exist greater inequality in income across Glasgow, Clydeside and the West of Scotland than for equivalent regions across the UK and Europe. Wilkinson[275] has highlighted the association between income inequality and life expectancy in sub-country regions although he points out that deprivation itself rather than the gradient between rich and poor is the mechanism by which poor health outcomes are realised in such areas. Recent collobarative work between the GCPH and the Healthy Working Lives research group at The University of Glasgow[276] has discovered that Glasgow has a greater proportion of long-term incapacity benefit claimants than any other city in the UK while Arnott's[277;278] recent work provided evidence for a growing, affluent professional class within the city. So, Glasgow has a large incapacity benefit population and an enlarging middle class sector.

This suggests growing inequalities but these data do not allow us to quantify the extent to which this phenomenon accounts for the Glasgow effect.

9.5.5 The Glasgow effect is a result of migration patterns to and from the city

The next possible hypothesis states that Glasgow has experienced out-migration of healthy migrants and in-migration of unhealthy migrants.

My analyses offer no insight into patterns of migration in Glasgow between 1981 and 2001. However, I have encountered evidence, some supportive and some unsupportive of this hypothesis. The work of Williams and Abbots[235-238], makes the case for poor health outcomes among the descendants of Irish Catholic immigrants in the Renfrew-Paisley longitudinal study. There are, however, several limitations to the methods used in their study of this cohort. I was unable to find summary information pertaining to religious/ethnic identity for individual council areas, far less individual Postcode sectors in Scotland. The Government Records Office for Scotland possesses such data but does not release it on a routine basis for fear that it would disclose sensitive information. However, their website for Scotland's Census results indicates that they would be happy to release such data for specific research projects. I believe that exploring the links between Irish Catholic ancestry and poor health outcomes in Glasgow and Clydeside would be an interesting future project. If this were coupled with a qualitative project examining the existence of a separate Irish Catholic culture specifically pertaining to health related behaviours then the contribution of this group towards excess mortality in Glasgow and the West of Scotland could be better understood.

9.5.6 Behavioural risk factors explain the excess mortality in Glasgow.

The next hypothesis to be tested is that at a given level of deprivation, behavioural risk factors are higher in Glasgow and Clydeside than elsewhere in the UK.

The results presented in this thesis offer no insight as to whether this hypothesis can be rejected or accepted. However, recent work Gray[279], for the Glasgow Centre for Population Health does address this issue. There were two parts to Gray's work. Several measures of health were analysed (including specific causes of mortality, self reported health, and a measure of health related quality of life) using data from the Scottish Health Surveys of 1995[71], 1998[72] and 2003[70]. Data from these surveys were also used to compare health-related behaviours between three nested areas in the West of Scotland and the rest of Scotland. The three geographical areas were: Glasgow City; the Greater Glasgow Health Board area (although this has now been superceded by the Greater Glasgow and Clyde Health Board); and West Central Scotland, a large area encompassing Greater Glasgow, Argyll and Clyde, Ayrshire and Arran and Lanarkshire Health Boards.

Concerning behavioural risk factors, there was no clear overall pattern to Gray's findings. It was not the case that all risk factors were elevated in the Glasgow region but there were certain individual risk factors that remained elevated even after adjustment for deprivation status. Gray used a variety of socioeconomic measures including: educational attainment, social class, economic activity, employment status and Carstairs quintile of respondent's area of residence.

Among men in Glasgow City, Gray found that binge drinking (drinking more than 6 units of alcohol on any one occasion in a week) and consuming more than the government's recommended weekly intake of alcohol (more than 21 units) were both more common than in the rest of Scotland and this gradient remained even after adjusting for a variety of socioeconomic factors. Meanwhile, men in Greater Glasgow consumed fewer green vegetables than their counterparts in the rest of the country and this difference was still significant after adjustment for socioeconomic factors. Such differences were also apparent among men in Greater Glasgow and in West Central Scotland.

Among women in Glasgow City, Gray found only that binge drinking was more common and that green vegetable consumption was lower, although the differences did remain after adjustment for socioeconomic status. This pattern was mirrored in Greater Glasgow and West Central Scotland.

Gray did not find any significant difference among men or women living in the Greater Glasgow area for a variety of other behavioural risk factors. These include cigarette smoking, physical exercise, high salt and fat intake, low dietary fibre intake and so on.

It is worth reviewing these findings in this detail because the findings are so difficult to interpret. While the findings concerning alcohol ingestion in Glasgow and Greater Glasgow go some way to explaining the high level of alcohol related disease and mortality in the region, Walsh and Whyte[5] report that there are several other forms of mortality that are elevated in Glasgow and West of Scotland that have strong behavioural risk factors, yet Gray found little or no evidence that the risk factors associated with particular morbidities were elevated in the region.

It is clear that many further research projects into the prevalence of risk factors by socioeconomic status is merited. Gray's results were based on the Scottish Health Survey and were cross-sectional rather longitudinal. The Scottish Health Surveys, taking all three years together, had some 20,000 respondents of which 5,000 lived in Glasgow City and although respondents of low socioeconomic status were well-represented, the sample could be criticised for not reflecting the deprivation status of Glasgow as a whole. In addition, the Scottish Health Survey is self-reported and the possibility exists that respondents completed their survey forms to cast their health related behaviours in a favourable light.

9.5.7 Historical factors have contributed to Glasgow's current poor population health

Another hypothesis is that there are particular aspects of Glasgow's social history that have rendered its population more susceptible to ill-health. The emphasis here is different from the life course approach. Life course epidemiology looks at impacts on the health of individuals in cohorts over time and their life courses. Cities like Glasgow now only have populations made up of individuals who have life course histories but the city itself has a social and economic history. These social and economic histories could have impacts on population health that operate in parallel to individual effects. Both have to be considered.

In the literature review, I described life course models of health determinants. These determinants have multiplicative and interactive effects on health. It is possible that there is something about Glasgow's social history that has caused these determinants to interact in a particularly adverse way. Such factors might include the local housing and population management policies of the post-war years or the impact of deindustrialisation and loss of traditional employment types in an area that had prided itself on being a manufacturing centre. A further contributary factor that comes across in populist discourse of Glasgow's poor health status is the idea of fatalism embedded within the local social culture; the idea that the measures and policies that might enable Glaswegians to achieve improved health are beyond personal and local control. This is related to the notion of a 'crisis of confidence' within Scottish culture[280], although it is unclear whether Glasgow is particularly afflicted by this phenomenon, if it exists at all.

9.5.8 The physical environment in Glasgow contributes to the residue of unexplained excess mortality

It is possible that some aspects of the physical environment in Glasgow contribute to the city's poor health status. Candidates put forward in popular discourse include the local climate, levels of lead in the water, transport and health care service provision in the city. However, for most of these factors, no comparative study between Glasgow and other parts of the UK has been accomplished so it is impossible to discuss the extent to which they may contribute to the city's poor health record.

Gillie[281] suggests that seasonal hypovitaminosis D resulting from low levels of sunlight exposure among Scottish residents contributes to Scotland's excess mortality relative to the rest of the UK. In his report, Gillie notes that the prevailing climate on the West Coast (where Glasgow is located), with its high average number of cloudy days and low levels of direct sunshine, could be particularly unfavourable for the synthesis of the biologically active vitamin D molecule. However, he cites no study that has measured the levels of plasma vitamin D among residents of West Central Scotland compared with residents of other parts of the country and does not provide measurements of sunshine hours in this region compared to other parts of the country. Gillie's hypothesis has its merits and he suggests some interesting policy guidelines but it seems clear that further investigation into population levels of plasma vitamin D and controlled trials of dietary vitamin D supplementation are merited.

9.6 Implications for Glasgow

The main message to be drawn from this study is that excess mortality in Glasgow persisted between 1981 and 2001 and actually became even larger over this period. In 2001, the age and sex adjusted standardised mortality ratio in Glasgow was 128. In simple terms, this means that death rates in the city were nearly thirty percent higher than in the UK as a whole. In some sub-groups of the Glasgow population, death rates were more than double those of equivalent groups in the UK as a whole. These are depressing statements to make as Glasgow has for a considerable period of time been a focus for health and social policy makers and yet overall levels of health in the city seem resistant to improvement at a rate that closes the gap with other parts of the UK. It is tempting to conclude that whatever is being done in Glasgow to improve the health of its citizens, it is not enough or that efforts are being wrongly directed. That is not to disparage the work of health promotion bodies and professionals but it is perhaps an acknowledgement that the economic, political and other cultural factors that operate to maintain Glasgow's poor position relative to the rest of the country (and indeed Europe) continue to counteract efforts to resist them.

While Scotland and indeed Glasgow have come a long way in reducing mortality from heart disease, stroke and lung cancer (the big three diseases that were most strongly associated with Scotland's 'sick man of Europe' moniker) worrying new trends in mortality have appeared in the last decade or so. Perhaps the most troubling new epidemic is that of alcohol related mortality. In the 1950's Scotland had amongst the lowest rates of mortality due to cirrhotic liver disease in Western Europe but now has amongst the highest. This has been accompanied by steeply increasing rates of suicide and deaths from external causes among young men. Presently, both of these recently arisen epidemics contribute a small proportion of the absolute number of deaths in Scotland, but they are troubling in two ways. First, they both afflict younger men and are important causes of *premature* mortality. Premature deaths result in poor life expectancy figures for a particular population. Second, they have a strong social patterning i.e. cirrhotic liver disease, suicide and deaths due to external causes are much more common at the lower end of the social scale. Leyland's[267] large body of work shows that these causes of mortality make a large contribution to social inequalities in all cause mortality in Scotland. If Glasgow's position as the city with the poorest population health in the UK is to be reversed then particular attention must be paid to lowering the mortality from these causes amongst the city's most deprived young men. The relative good news is that the data for France published in the European comparisons of Walsh, Taulbut and Hanlon[5] show that it is possible to reverse the trend of alcohol-related mortality over a relatively short time. The epidemic of alcohol-related mortality in Scotland has only recently arisen and it may not yet be too late to return to the conditions where death from this cause in Scotland was much less common.

If we consider the models of the determinants of health that I provided earlier in this thesis then we can see that there are many and varied influences on the health of individuals. These influences could be interactive, additive or even multiplicative. The hypotheses to explain the Glasgow effect that I have presented in the paragraphs above all seem plausible in their own right. However, no single hypothesis would appear to nullify any other hypothesis. The out-migration of healthy individuals, for example, need not have operated in isolation from behavioural factors or psychosocial factors associated with relative deprivation. The reality is that all of the mechanisms that I have presented could have operated (and continue to operate) in Glasgow to bring about poor population health. Galea's model of urban health (presented in Section 3.4.2 of the literature review) seems particularly relevant here. His model explicitly represents the complex interactions between global, national, local and personal factors in creating urban population health. None of these factors operates in isolation from the others; health effects cannot be attributed solely to improvement or deterioration in one single factor, nor are there factors which are perceived to be more important than others.

Thus, in Glasgow and the West of Scotland, a single identifiable factor to which the Glasgow effect can be attributed is unlikely to exist. Instead my findings and my understanding of the literature lead me to believe that Glasgow has been adversely affected by all of the mechanisms that I have described here. This conclusion will be disappointing to friends and colleagues who have often ventured single-factor explanations for the existence of the Glasgow effect when I have been discussing this project with them. Common suggestions such as ‘It’s all these deep fried Mars Bars’ or ‘It’s all the heavy boozing that happens here’ are attractive because they imply straightforward solutions. It would have been pleasing to complete this research and validate one such simple hypothesis and be able to say ‘This is why the Glasgow effect exists’. However, my research questions were not created with a view to answering why the effect should exist, although I hope I have been able to provide leads for future investigations. I have been able to confirm the existence of a Glasgow effect and this is something that no other published piece of work has done. The relationship between measured deprivation and all cause mortality in Glasgow *does* appear to be different. Why this might be the case will take considerably more research.

9.7 Conclusions and recommendations

The results presented in this thesis give partial support to the existence of a Glasgow effect – a residue of excess mortality that remains after adjustment for deprivation. This leads to three not necessarily competing conclusions.

First, that the relationship between measured deprivation and all cause mortality was different in Glasgow in 2001 to that in several comparable cities in the UK. Figures 84 and 85 best demonstrate this finding. There may be something distinctive about the physical or social environment in Glasgow that is particularly detrimental to health. The methods used in this thesis are ill-equipped to answer this question. Multilevel modelling might appear to be a suitable method for identifying the extent to which local cultural factors contribute to excess mortality but in the literature review chapter, I concluded that this method has serious limitations for complex situations such as geographic inequalities in health. It may be that this question is never fully answered. It may not be necessary to do so if a set of social and economic conditions prevail in Glasgow that are beneficial to health. There may also be something distinctive about the most prevalent forms of mortality in Glasgow. Specific forms of mortality, and their relationship with deprivation, have not been investigated in this thesis. There is evidence from other work that alcohol and drugs related deaths, suicides and homicides are particularly common in Glasgow. The crucial question is whether the social patterning of these deaths is similar in Glasgow to other cities. Accordingly, it would be of value if such research was undertaken, concentrating particularly on the forms of mortality listed above. This would also leave room for qualitative work to investigate issues such as whether deprived residents in Glasgow feel less in control of their health and surroundings, and whether local social norms are particularly detrimental to health in deprived areas of Glasgow. Thus, while it might not be possible with current quantitative methods to estimate the contribution of the local social environment to health, such investigations would at least provide an indication that there was something distinctive about Glasgow.

A second, though not necessarily alternative, conclusion is that the Carstairs measure of deprivation does not map well to the lived experience of deprivation in Glasgow. The z-score technique diminishes the differences in the distribution of the indicator variables between areas. This is particularly pertinent given the high number of areas in decile 10 of the Carstairs distribution in Glasgow. It is plausible that the relationship between deprivation and health outcome is different at the most extreme end of the deprivation scale. If the Carstairs measure is unable to differentiate between the very deprived and the extremely deprived then the logical outcome is that Carstairs is less able to explain mortality differentials. In addition, the four Carstairs indicator variables themselves do not capture many of the facets of deprivation and the amelioration in their distribution over time may have happened at a greater rate in Glasgow than elsewhere even though the underlying relative deprivation remained.

Returning to Figure 85, the summary of age, sex and deprivation adjusted SMRs in UK cities over time, the upward trend of SMR in Glasgow may be mainly artefactual because of the reasons described in the two paragraphs above. If it were possible to adjust for ‘real’ rather than ‘measured’ deprivation then it could well be the case that SMR in Glasgow was not signifcantly higher than elsewhere. However, this then calls into question the validity of adjusting for deprivation in the first place. Deprivation is the single largest reason for the existence of inequalities in health. If by adjusting for deprivation, these inequalities are diminished then there is a risk that a crucial health policy message might become somewhat blurred – that relative inequalities in health can be ameliorated by tackling relative deprivation.

A third conclusion for why a Glasgow effect might exist is that the temporal relationship between deprivation and health outcome is causing Glasgow’s current health status to lag behind other comparable cities. The deprivation profiles shown in this thesis indicate that Glasgow had an even greater proportion of residents living in the most deprived areas in 1981 than it did in 2001. Taking the view that the health effects of deprivation accumulate over the life course then it is sensible to conclude that the effects of Glasgow’s historical levels of deprivation are still being played out today. Given that in 2001, Glasgow still had a greater proportion of the most deprived residents, it seems likely that there will continue to be excess mortality in Glasgow compared to other cities in the UK if current trends continue.

10 Appendix

10.1 Deprivation profiles for UK cities and conurbations not included in main text

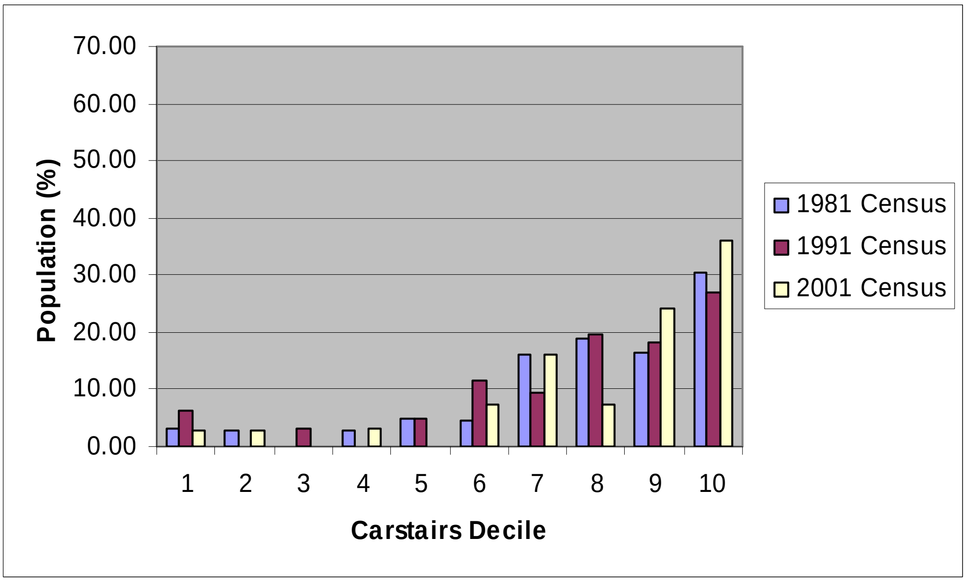


Figure 86: Carstairs deprivation profile for Birmingham, 1981-2001

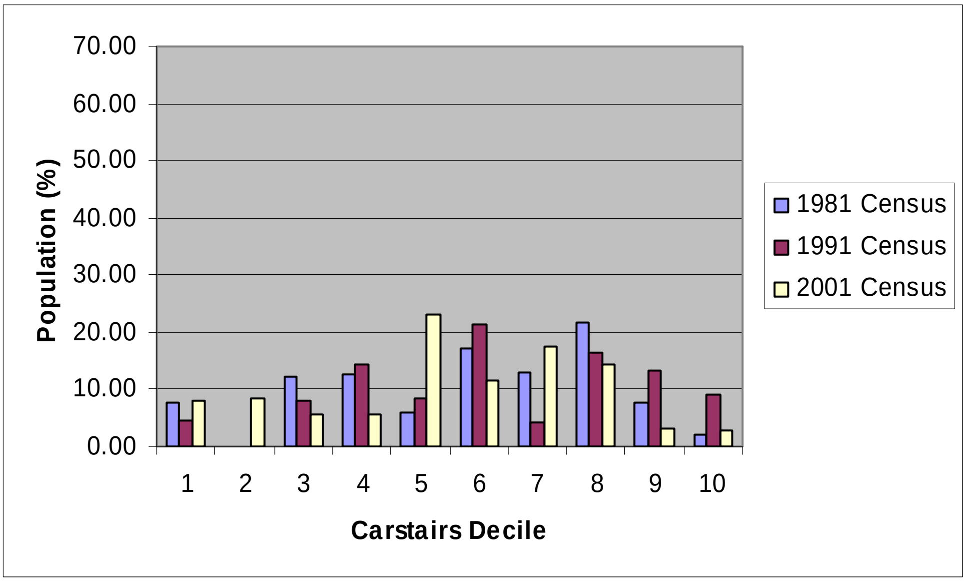


Figure 87: Carstairs deprivation profile for Bristol, 1981-2001

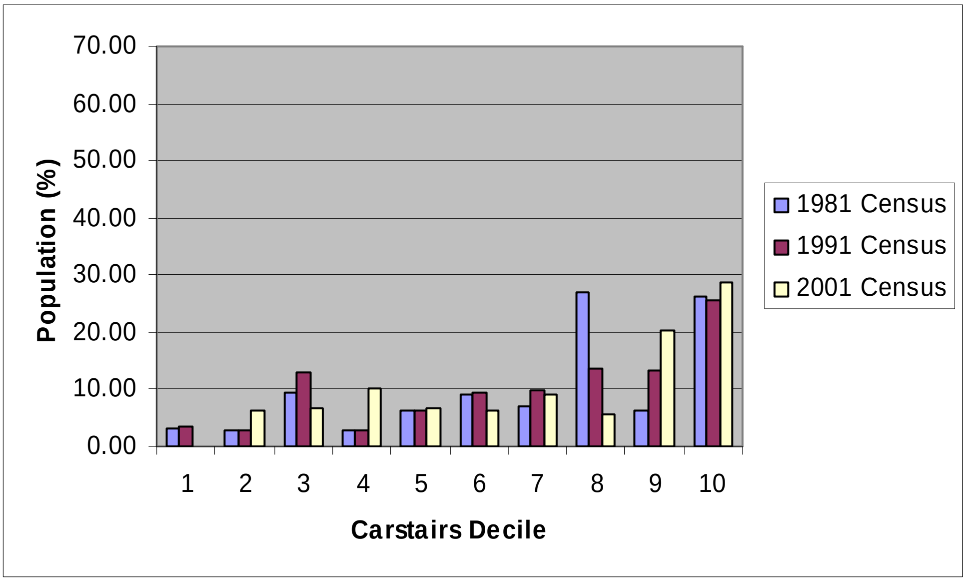


Figure 88: Carstairs deprivation profile for Bradford, 1981-2001

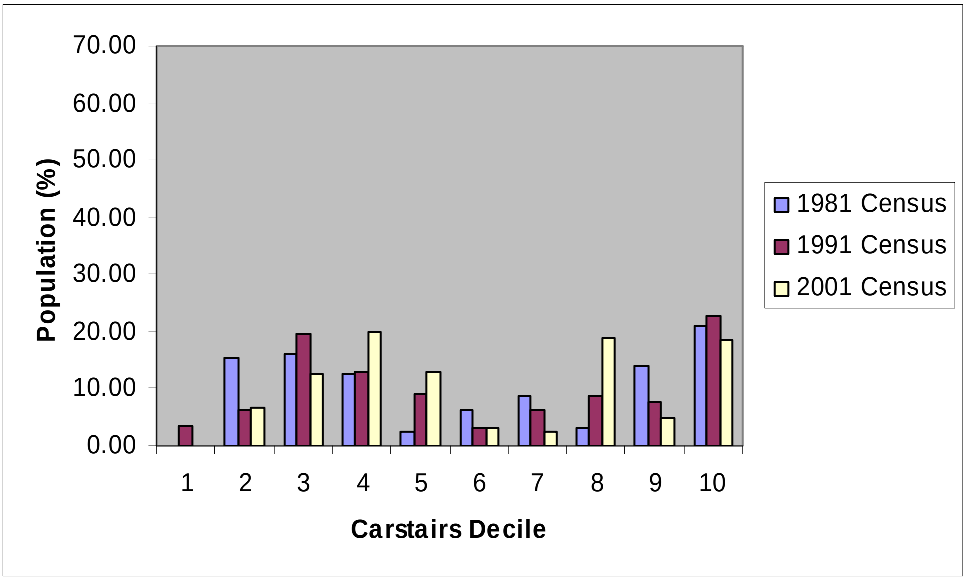


Figure 89: Carstairs deprivation profile for Leeds, 1981-2001

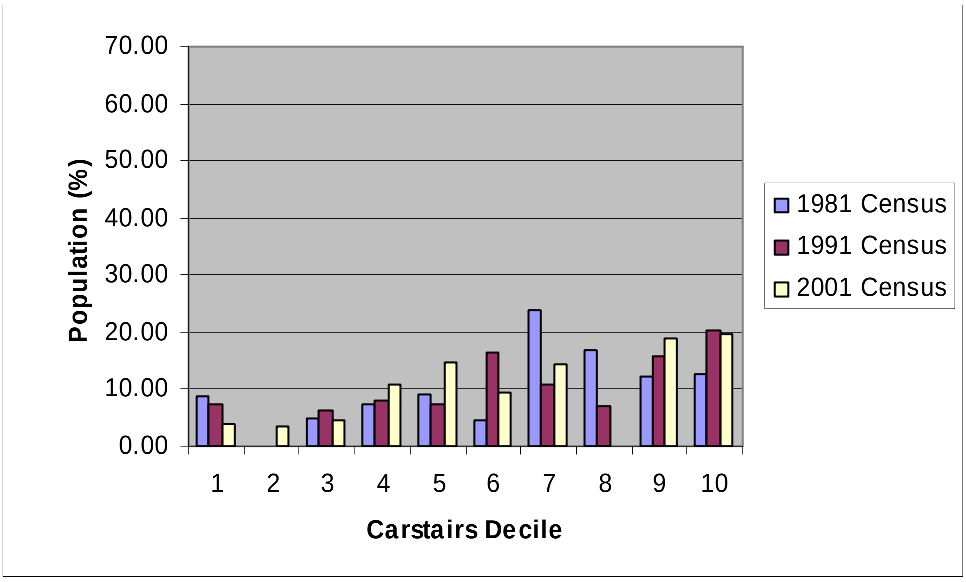


Figure 90: Carstairs deprivation profile for Sheffield, 1981-2001

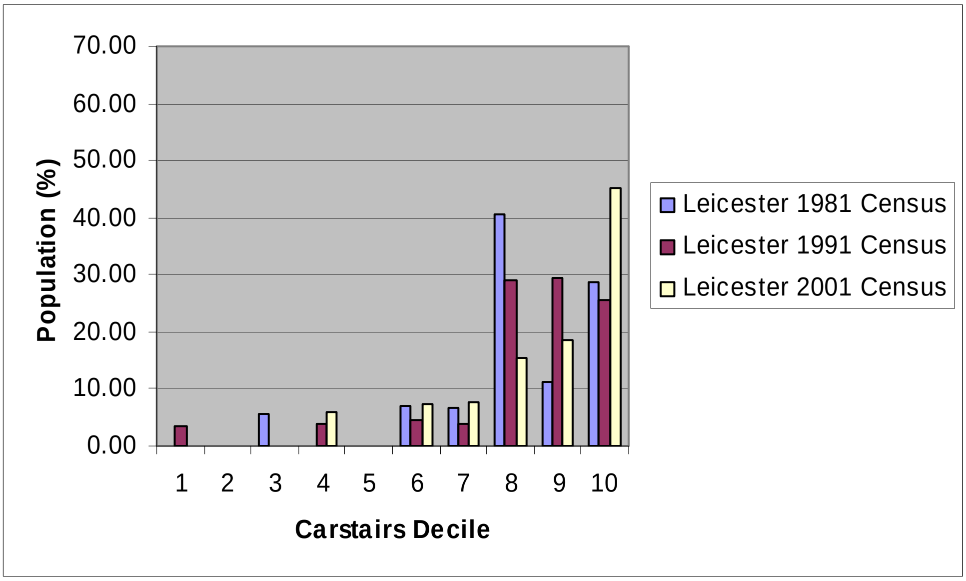


Figure 91: Carstairs deprivation profile for Leicester, 1981-2001

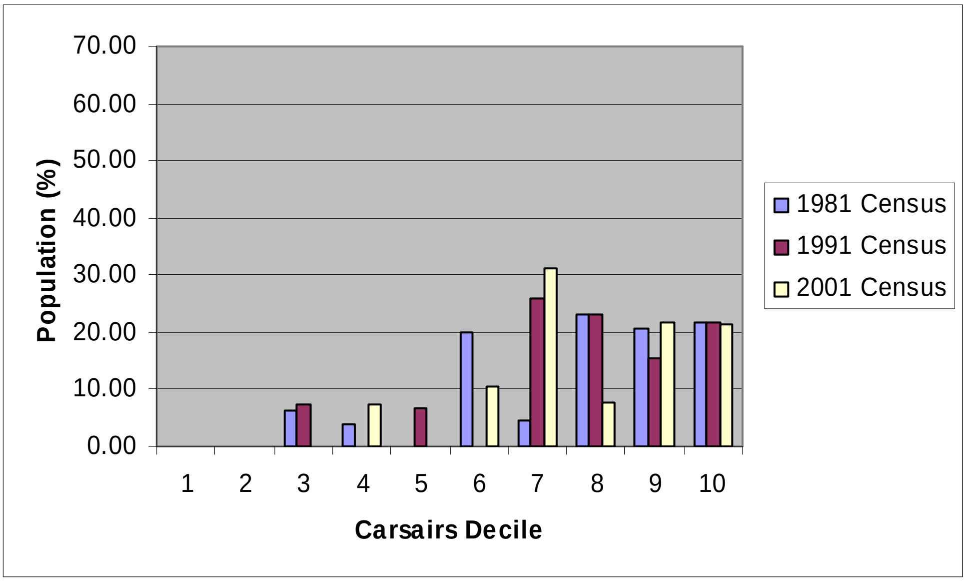


Figure 92: Carstairs deprivation profile for Sunderland, 1981-2001

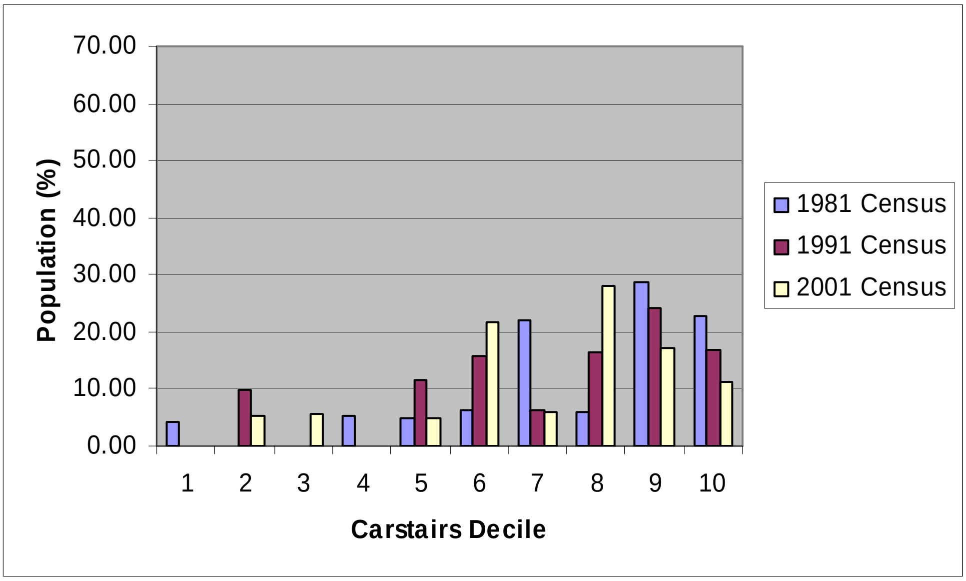


Figure 93: Carstairs deprivation profile for Coventry 1981-2001

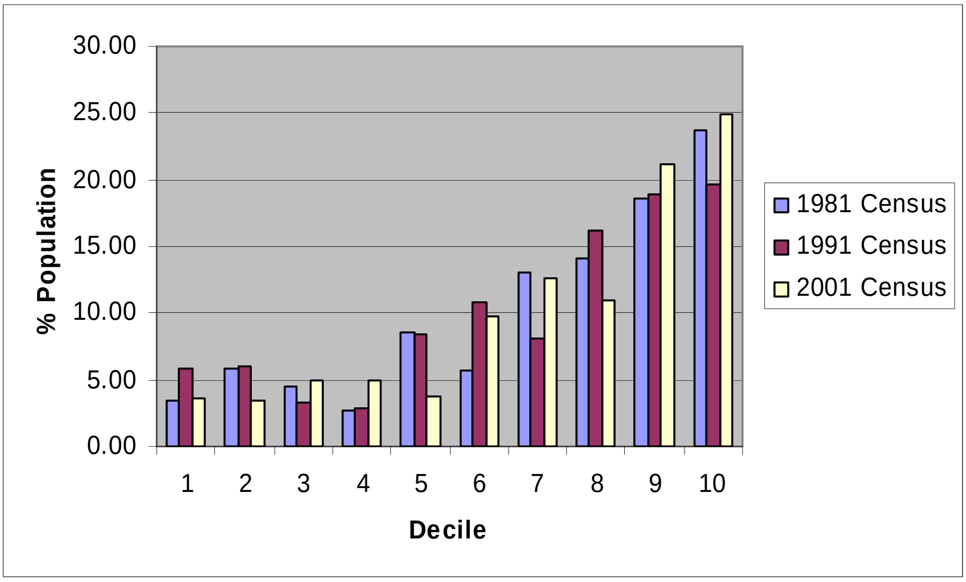


Figure 94: Carstairs deprivation profile for West Midlands conurbation, 1981-2001

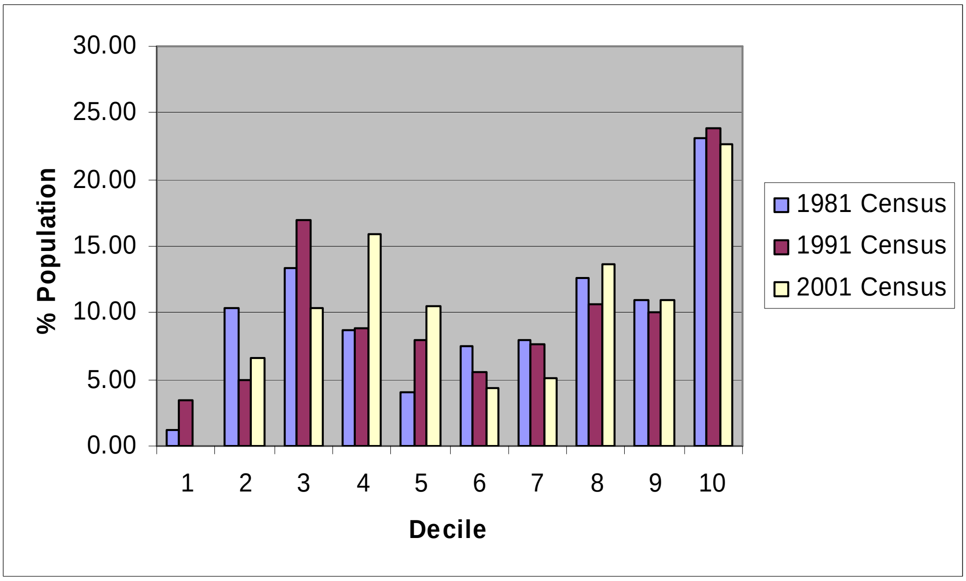


Figure 95: Carstairs deprivation for West Yorkshire conurbation 1981-2001

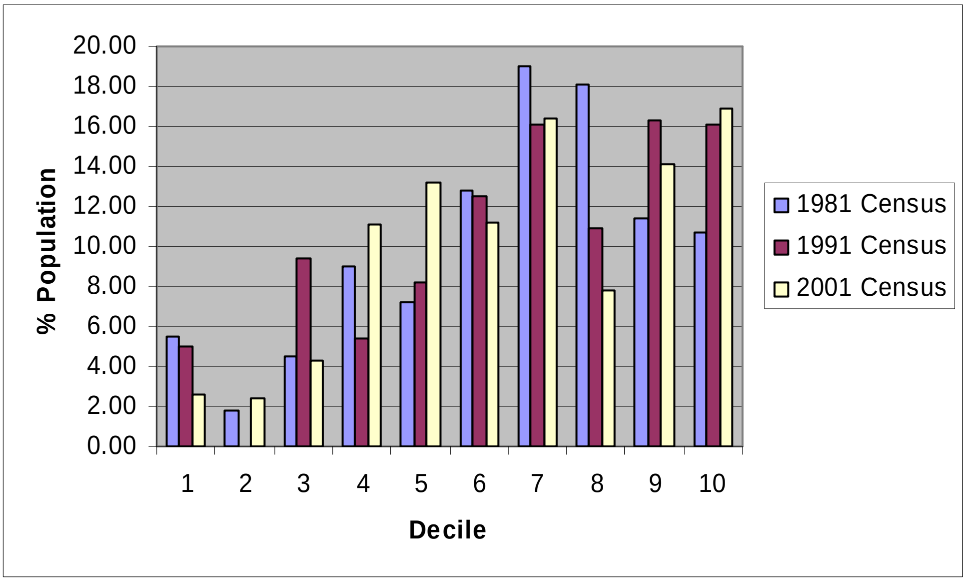


Figure 96: Carstairs deprivation profile for South Yorskshire conurbation, 1981-2001

10.2 Adjustment of death rates in UK Cities and Conurbations

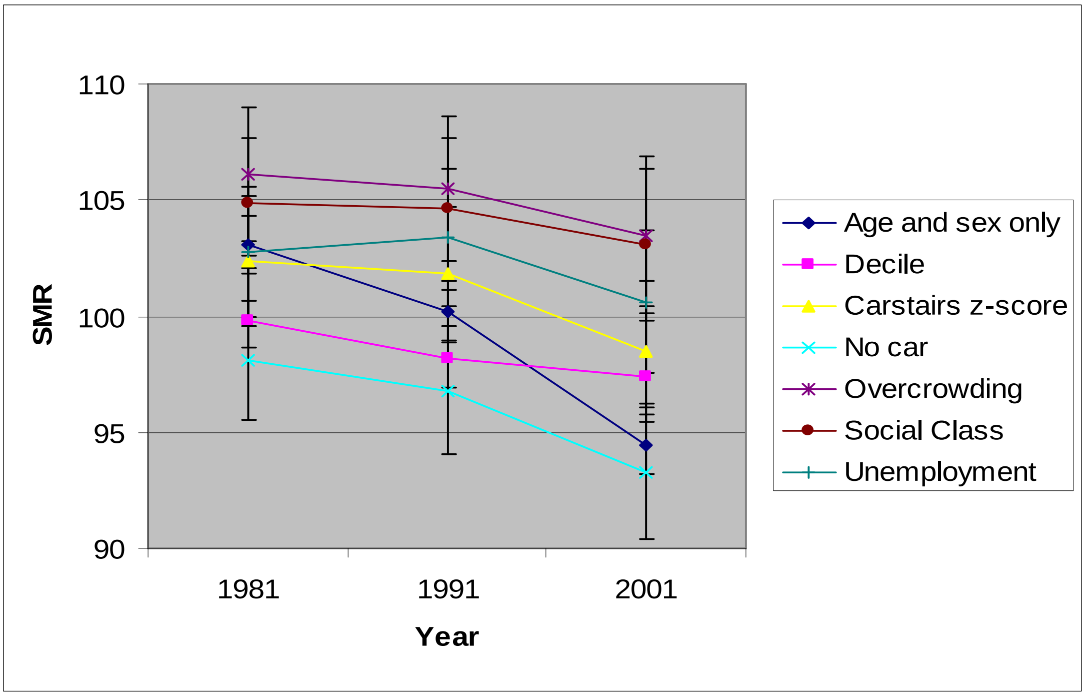


Figure 97: SMR for Leeds with various adjustments in addition to age group and sex, 1981 to 2001.

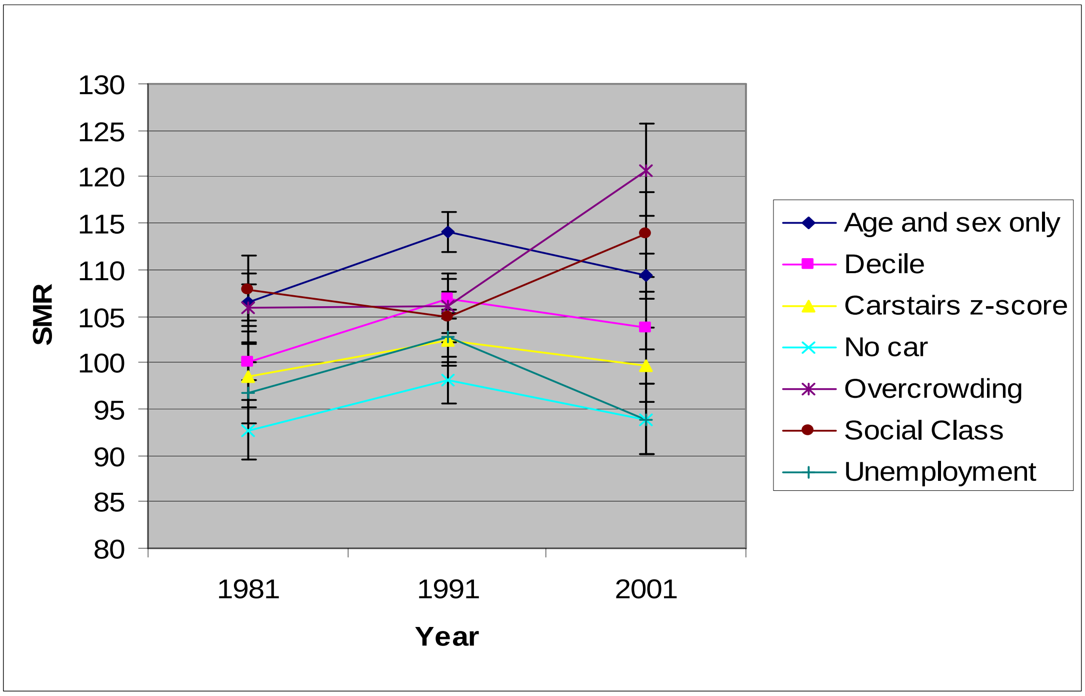


Figure 98: SMR for Newcastle upon Tyne with various adjustments in addition to age group and sex, 1981 to 2001.

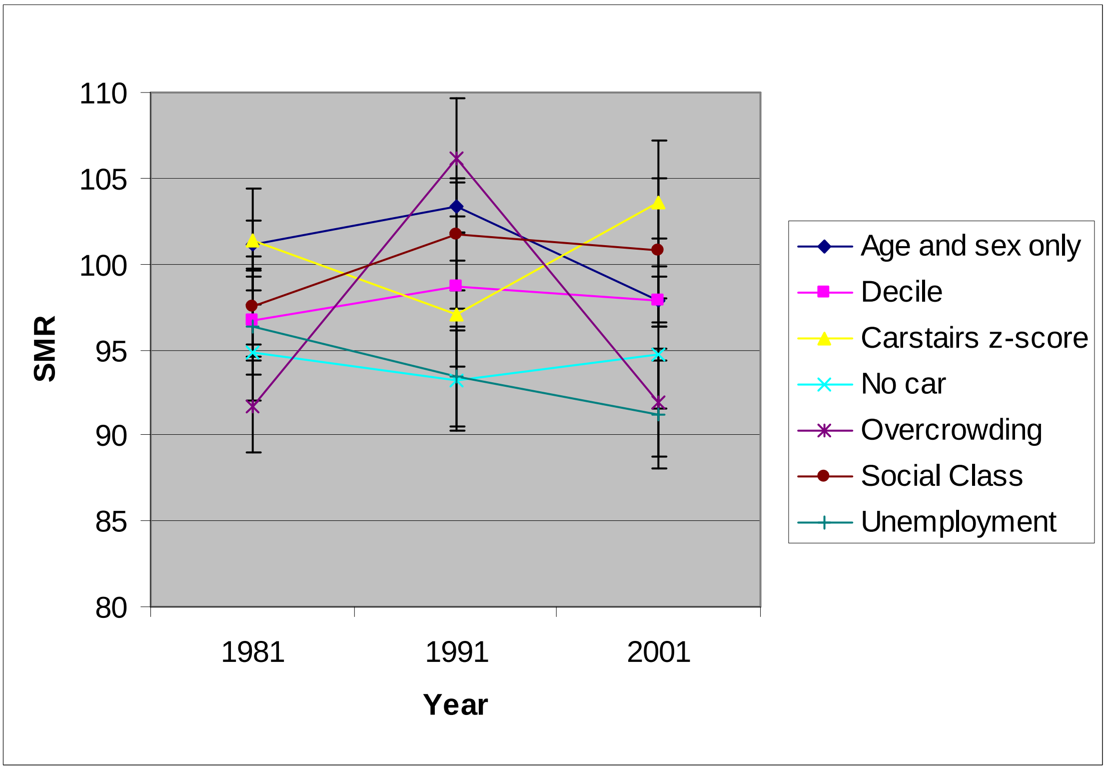


Figure 99: SMR for Sheffield with various adjustments in addition to age group and sex, 1981 to 2001.

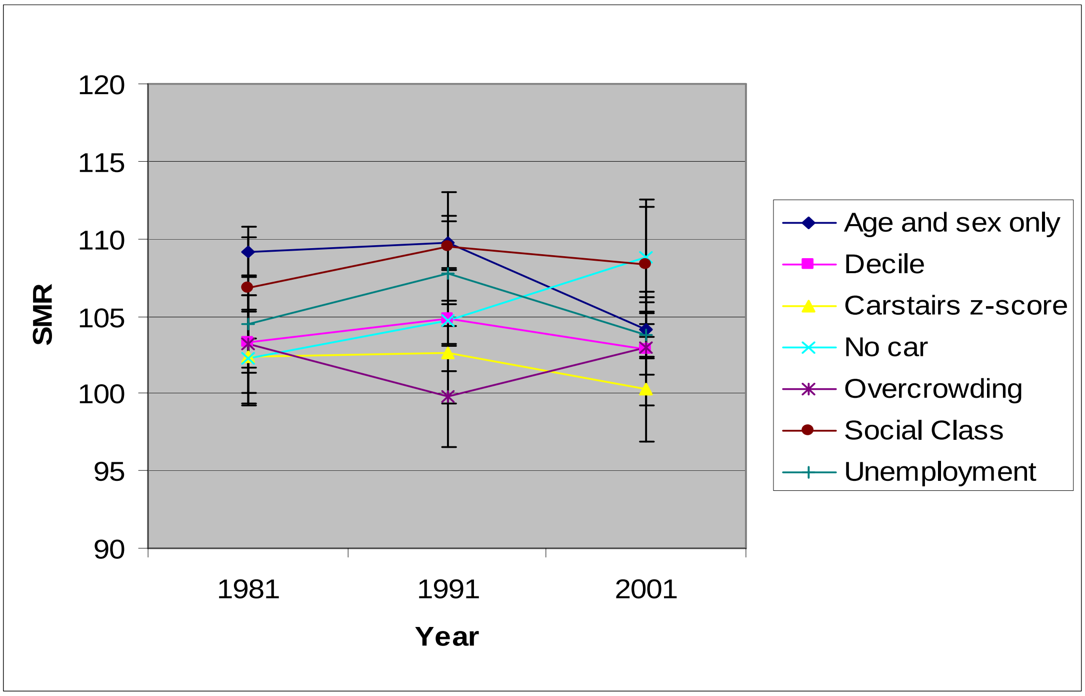


Figure 100: SMR for Bradford with various adjustments in addition to age group and sex, 1981 to 2001.

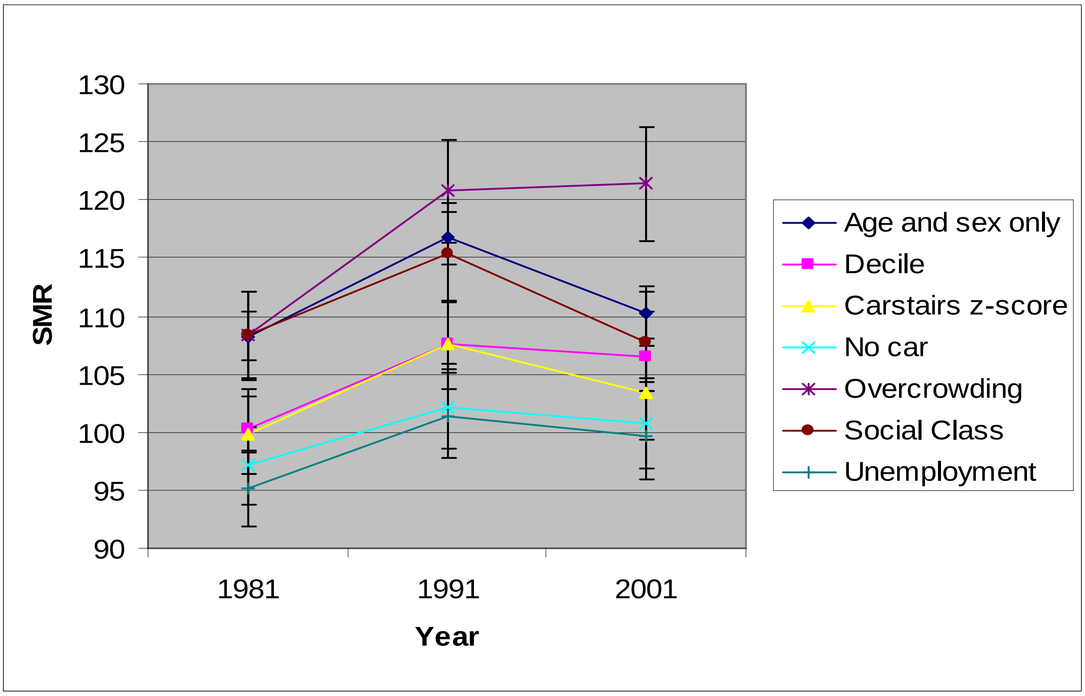


Figure 101: SMR for Sunderland with various adjustments in addition to age group and sex, 1981 to 2001.

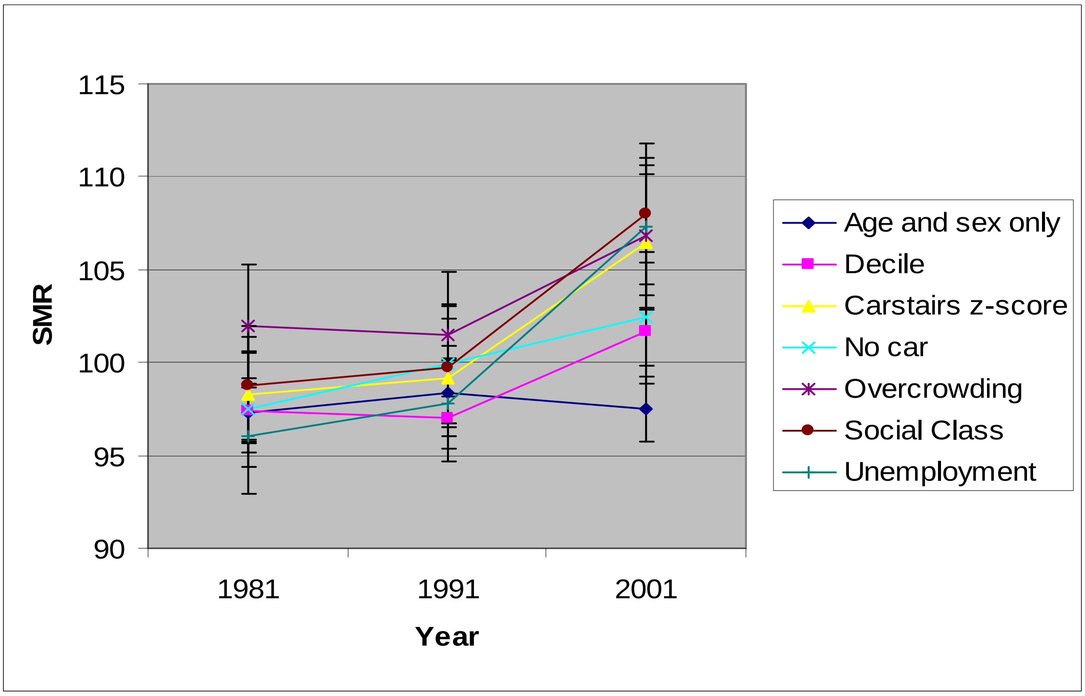


Figure 102: SMR for Bristol with various adjustments in addition to age group and sex, 1981 to 2001.

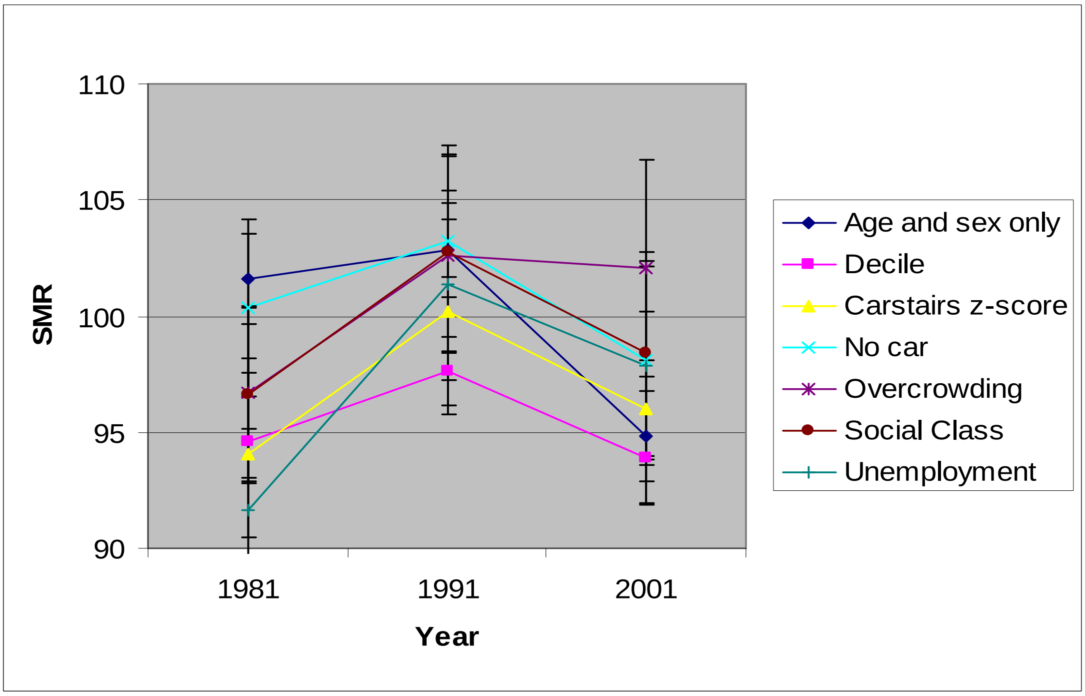


Figure 103: SMR for Coventry with various adjustments in addition to age group and sex, 1981 to 2001.

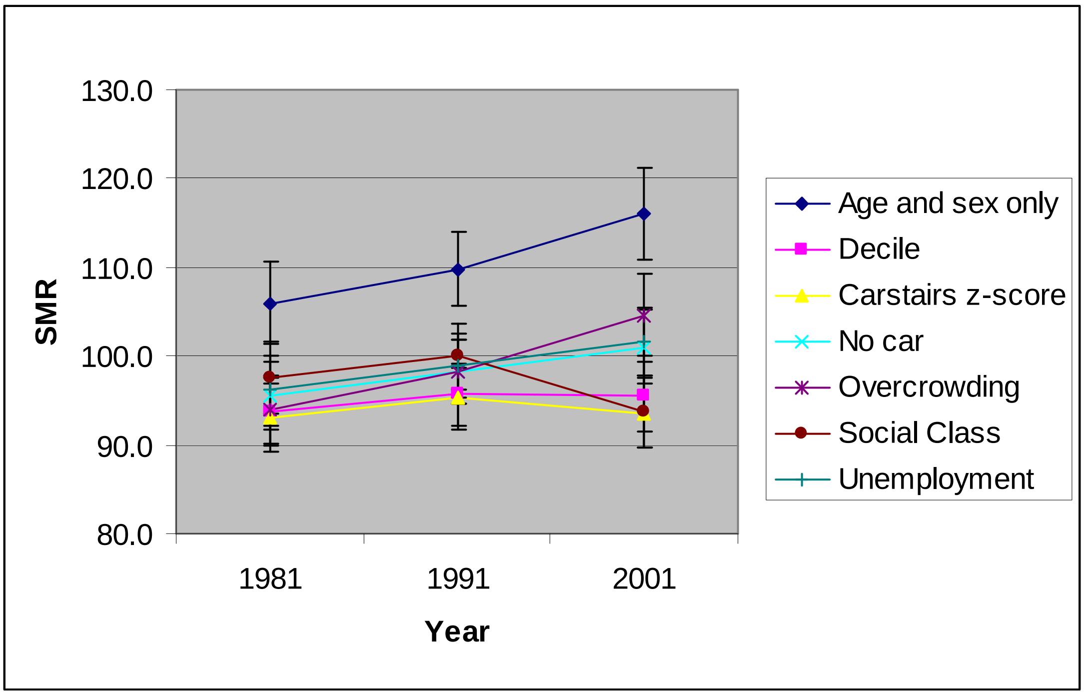


Figure 104: SMR for Leicester with various adjustments in addition to age group and sex, 1981 to 2001.

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