Housing, health and affordable warmth

An investigation into the link between fuel poverty risk and the health of older people

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Abbreviations

Organisations

BMA	British Medical Association
BRE	Building Research Establishment
BRECSU	Building Research Energy Conservation Support Unit
CDU	Census Dissemination Unit (at University of Manchester)
DEFRA	Department of Environment, Food and Rural Affairs
DOH	Department of Health
DTI	Department of Trade and Industry
DWP	Department of Work and Pensions
Eaga-CT	Energy Action Grants Agency Charitable Trust
ELCHA	East London and the City Health Authority
FPAG	Fuel Poverty Advisory Group
FPMTG	Fuel Poverty Monitoring and Technical Group
LBN	London Borough of Newham
NEA	National Energy Action
ODPM	Office of the Deputy Prime Minister

Acronyms

AWI	Affordable Warmth Index
CTB	Council Tax Benefit
ED	Enumeration district
EEP	Energy and Environment Prediction Model
EHCS	English House Condition Survey
FPS	UK Fuel Poverty Strategy
HB	Housing Benefit
HECA	Home Energy Conservation Act 1995
HEES	Home Energy Efficiency Scheme (now known as Warm Front, *see* Glossary)
HIA	Health Impact Assessment
IS	Income Support
NHER	National Home Energy Ratings
SAP	Standard Assessment Procedure (energy rating)
SAR	Standardised Admission Rate
SMR	Standardized Mortality Rate
MIMAS	Manchester Information and Associated Services

Abstract

The research question addressed is whether a relationship can be shown between fuel poverty and the health of older people in Newham, using morbidity data. The aim is to help develop a methodology to measure effects of fuel poverty for evaluating outcomes of investment in domestic energy efficiency and affordable warmth: a complex, multi-disciplinary problem.

First government references to fuel poverty were peripheral to environmentally driven energy conservation targets, designed primarily to reduce carbon dioxide emissions to meet national climate change commitments. However, these targets can militate against solving immediate needs of the fuel poor. Those who cannot afford sufficient fuel tend to 'take back' part of the gain from energy efficiency measures as increased comfort, so that minimal energy savings result from interventions to fuel poor homes. Potential cost savings from associated *health* benefits of environmental targets are disregarded, partly because there is currently no means of measuring them. This problem importantly contributes to the motivation behind the research.

Here, as a new indicator for measuring health outcome of fuel poverty, an excess winter *morbidity* ratio is proposed, rather than the conventionally used ratio of excess winter mortality. Records of seasonal deaths are more easily accessible than disease episodes, but numbers are fewer and represent only extreme outcomes of cold-related health effects. Perhaps health gains could be more readily measurable in terms of reduced morbidity, over a shorter period, than from reduced mortality statistics, following energy efficiency improvements for a given population.

An epidemiological approach was taken, using Newham borough as the research sample, but focussing on the population over 64 years old as the most vulnerable to cold homes. A small area index of Fuel Poverty Risk (FPR) was derived from the combined factors of low income, home energy ratings (a measure of energy efficiency), population age, household size and under-occupation of housing. This was mapped and compared with the incidence of emergency winter hospital admissions for cold-related disease in the older population, as indicated by the calculated Excess Winter Morbidity Ratio (EWMbR). A significant positive correlation was found between the FPR and the EWMbR, adding to the evidence-base of links between fuel poverty and health. The mapped analysis is illustrated using GIS software, which is helpful for presenting multi-disciplinary data and is a common epidemiological tool. The proposed methodology could predict cost benefits to the health services of investment in domestic energy efficiency measures and be used in monitoring and evaluation. The FPR Index could help local authorities to identify areas of fuel poverty risk for prioritising action towards achieving affordable warmth in homes.

CHAPTER 1 Introduction

"Warm, cosy, chaotic winter. A hospital porter comes in with a pulled back: he's been lifting so many corpses, the cost of a spell of cold weather. 'The fridges were full. Twenty or more. Some so bent up they wouldn't fit the trays. Tried to flatten one old girl out and did my back.'"

from: *Some Lives! A GP's East End.* (Widgery, 1991, p95).

The specific research question addressed in this thesis concerns testing the hypothesis that a relationship can be shown between fuel poverty risk and the health of older people in a London Borough, using morbidity rather than mortality data. The aim of the research is to contribute to development of a methodology to measure the effects of fuel poverty for evaluating the broad outcome of investment in domestic energy efficiency and affordable warmth.

The thesis stems from a professional interest in the built environment and the problem of achieving affordable warmth for housing that is difficult to heat, in Britain (England specifically). The drive for energy conservation, as part of the international consensus to confront climate change, forms the backdrop to this issue, although there are sometimes tensions between national policies that have been designed to deal with these two objectives. Thus, central government priorities for reducing energy consumption appear to work against those for tackling affordable warmth, which tend to achieve minimal energy savings. While technological solutions are not in question, the affordable warmth problem needs addressing through capital investment, which, as will be shown, may be justified within several different areas of governmental responsibility. Towards this argument, the focus here is on the subject of what is known as 'fuel poverty' - and its effects on health.

Fuel poverty was first identified as an issue with relevance to social policy in the 1970's, following increases in world oil prices and the perceived effects of the consequent national fuel crisis on low-income households. Lewis defined it in 1982 as "*the inability to afford adequate warmth in the home*" (Lewis, 1982). Boardman demonstrated that 'affordable warmth', as the necessary remedy for fuel poverty, is crucially related to the energy efficiency of the dwelling, as well as to the householder's income (Boardman, 1991). Buildings may be difficult to heat because of their poor insulation characteristics and inefficient heating systems, in addition to the cost of the available fuel. While fuel poverty is clearly linked with poverty in general, the particular combination and compounding of determining factors distinguishes one from the other, with associated different implications for policymaking.

Links between cold-related disease and fuel poverty are frequently asserted, because of the cold and damp homes that result from lack of affordable warmth. Yet there are difficulties in demonstrating direct causal associations between housing and health, because of the many variables that could confound apparent links; and there has been little research specifically designed to examine effects of fuel poverty on health. Confounding factors may include, for example, income and employment status, lifestyle factors such as diet and smoking, or external environmental exposures from the general surroundings or the workplace. Nevertheless, because of known physiological effects of cold on health, certain types of illness that have been linked with outdoor cold have also been associated with low indoor temperatures.

Usually, health consequences of fuel poverty are discussed in terms of excess winter deaths. These occur in greater numbers in Britain than in other countries with similar or much colder winters, but where housing is more effectively heated and insulated (Boardman, 1991). Excess winter deaths are calculated as those occurring in winter over and above the average for the rest of the year. Numbers range from 23,000 to 45,000 annually in England alone[1], depending partly on the severity of the winter. Most of these occur among older people, over the age of 65, and are predominantly due to respiratory and cardiovascular disease. Boardman argues that the frequency of low indoor winter temperatures in Britain is linked to the high rate of excess winter mortality and that both are largely due to the widespread occurrence of fuel poverty (Boardman, 1991).

Here, a new indicator is proposed for measuring health outcome of fuel poverty, in the form of an excess winter *morbidity* ratio, rather than the conventionally used ratio of excess winter mortality. Although records for excess winter deaths are easier to obtain than for disease episodes, they are fewer in number and represent only the tip of an iceberg in terms of cold-related health. It is suggested that health gains would be more readily measurable in terms of reduced morbidity, over a shorter period, than from reduced numbers of deaths, following energy efficiency improvements for a given population.

[1] House of Commons Hansard, 20 12 99, Col 436, figures given for the period 1992-1999

An epidemiological, or population, approach was taken for the methodology, using the East London borough of Newham as the research sample, but focussing on the population over 65 years old. An index of fuel poverty risk was derived from the combined factors of low income, home energy ratings (a measure of energy efficiency), population age, household size and under-occupation of housing. This was mapped and compared with the incidence of emergency winter hospital admissions for cold-related disease in the older population, as indicated by the calculated excess winter morbidity ratio. The mapped analysis is presented graphically using GIS (Geographical Information Systems) software.

Since fuel poverty arises from a complex combination of factors and its effects stretch beyond dwelling conditions alone, tackling both causes and effects requires a multi-disciplinary approach, both in policymaking and practically, on the ground. Hence, the proposed methodology for measuring fuel poverty effects is designed to bring together key policy areas of interest to which the issue is pertinent.

Brenda Boardman's detailed analysis of the phenomenon in her book, which was published in 1991, set out a strong argument for investment to deal with fuel poverty against a wide range of concerns (Boardman, 1991), following its initial identification as a social policy issue almost 20 years earlier. However, it has only recently been acknowledged in government circles as a recognisable problem worthy of specific legislation, albeit introduced by individual members of Parliament rather than by government ministers up to this point and without specific resources allocated. Simultaneously with these developments, central government has come to accept that health inequalities prevalent in the UK should be addressed. The Acheson Report was commissioned by the Department of Health in 1998, under the New Labour government. One of its recommendations brought together these two objectives, linking the need to reduce fuel poverty, by improving insulation and heating systems in buildings, with that of tackling inequalities in health (Acheson, 1998). The growing problem of health inequalities is seen against a background of an increasing gap in income levels in the UK and current discussions of poverty suggest that the two are also linked.

The combination of these different concerns is particularly well manifested in the situation of many older people. They are the group most vulnerable to cold-related disease and are the heaviest users of the National Health Service. In addition, age is one of the contributory risk factors for fuel poverty, as some sections of the older population are more likely to live in older, least insulated housing and have the least resources available for capital investment in their homes. The Joseph Rowntree Trust report, '*Monitoring poverty and social exclusion*', includes excess winter deaths as a health indicator for older people, for the reason that the least well off elderly are almost twice as likely to live in poorly insulated housing as the most affluent elderly (Rahman *et al.*, 2000).

First references to fuel poverty in legislation were as a peripheral aspect of energy conservation targets, which are primarily driven by environmental considerations. Although energy efficiency is an important tool for reducing carbon dioxide emissions and meeting national commitments to curbing climate change, these targets can militate against solving the immediate needs of the fuel poor. Those with limited resources for expenditure on fuel tend to 'take back' part of the gain from energy efficiency measures in terms of increased comfort (Milne and Boardman, 1997), which means that energy savings resulting from interventions to fuel poor homes are minimal. Potential cost savings from associated health benefits are not taken into account with regard to environmental targets, partly because there is currently no means of measuring them. This problem is an important part of the motivation behind this piece of research. If a method can be found to demonstrate links between ill health and the lack of affordable warmth, then it could provide a basis for assessing cost savings to health services from investment in energy efficiency, as an added bonus to environmental benefits.

This research was initiated in response to the call for studies of fuel poverty and health by the Eaga Charitable Trust in 1998, to help quantify the health impact of fuel poverty in order to support strategic policy decisions, at a time when the links were only starting to be discussed in government circles. It was therefore stimulated by a complex, real world problem that requires a multi-disciplinary approach and, although funding was received from the Trust, the budget for resources was very limited. As well as the need for epidemiological evidence of the potential health impact of promoting affordable warmth, tools are required to help direct the necessary investment in the building stock to achieve affordable warmth for the fuel poor. A secondary aim of the research is therefore to provide a starting point for prioritising appropriate investment in energy efficiency, using the mapping tool developed for identifying areas potentially at risk of fuel poverty. However, using the epidemiological approach, it does not set out to identify individual properties within the narrow definition of fuel poverty related to the percentage of income required to achieve a standard heating regime, as used by the government and others.

Thus there are a number of themes for attention in this thesis, underlying the subject of fuel poverty and health. In the next chapter, a brief history of the recognition of fuel poverty as an issue in the UK is described, by means of which its component risk factors are first established. The aggravating conditions for fuel poverty risk in this country are also identified, with regard to characteristics of the housing stock. Inequalities emerge as a central theme in Chapter 3, through further consideration of these risk factors as health status determinants. Here it is shown how inequalities of housing and income, both individually and interactively, lead to inequalities in health status. Current research into links between cold, damp housing and health is also reviewed in Chapter 3, showing how excess winter mortality is widely used as the health indicator for fuel poverty effects and how the epidemiological approach has been used by others. Studies carried out within the different disciplines of public health, social policy and buildings' energy efficiency are used to reveal the problems of housing and health research design.

Because of their particular vulnerability to fuel poverty and to cold-related disease as a demographic group, older people constitute a second theme. Reasons for this vulnerability are examined in Chapter 4, including physiological, behavioural and housing status factors.
The third element of significance is "joined-up" government or policy-making, in view of the cross-departmental solutions needed to address the fuel poverty problem and its multi-disciplinary nature. In Chapter 5, the development of the research methodology is described, partly as a response to the need for multidisciplinary research and practice, partly to find a means of measuring health effects of fuel poverty and partly to attach a cost to any health effects that might be demonstrated. The proposed methodology is justified through consideration of limitations and gaps in research to date, as well as prevailing controversies. This includes an evaluation of the relative merits of mortality and morbidity data, a review of data sources and of the selection of indicators for fuel poverty risk and cold-related health.

In Chapter 6, the methodology is described as it was implemented in a pilot study for Newham. Chapter 7 shows the results of the study, in which correlations were sought between fuel poverty and health as measured by the indicators devised. There is a discussion and analysis of the findings in Chapter 8, together with suggestions for improvements and development of the methodology and its potential roles beyond answering the original research question. In the concluding chapter, the whole is summarised, with indications for how the methodology might contribute towards encouraging long term investment in affordable warmth through integrated policy-making for addressing health inequalities, in the light of various stated government priorities.

CHAPTER 2 Fuel poverty risk

"We do not budget what comes in the house and what is spent....it's too complicated...we spend money on whatever it needs to be spent on...this is how it works every week. When bills need to be paid, we struggle because we do not estimate how much money is needed for gas and electricity. At those times our priority is spending the rest of the money on food and other necessities."

from: *Impact of fuel poverty on health in Tower Hamlets.* (Khanom, 2000, p 81).

2.1 Introduction

In this chapter, first of all, fuel poverty is defined in terms of its causes and indicators as they have emerged from previous research and changing perceptions over the past 30 years. A brief history of its identification and its evolving definitions helps to demonstrate its links with factors far beyond simply the price of fuel (or energy), which first brought the issue to light. The number of these factors render it a complex, wide-ranging area of study and difficult to deal with in terms of policymaking. There has been a long struggle by key players to achieve its recognition by government, a struggle that is not yet resolved with respect to fully co-ordinated responsibility or universal long-term solutions, despite the introduction of a UK Fuel Poverty Strategy in 2001. Much of the endeavour towards gaining proper acknowledgement of fuel poverty and its effects has been based on Boardman's core analysis (Boardman, 1991), the reference point for a good part of this background chapter. The current problems of defining and identifying the fuel poor are raised at the end of the first section as part of the ongoing debate relating to policymaking.

Having introduced the component risk factors for fuel poverty, there follows a review of research related to particular exacerbating conditions in the UK. It is useful to examine comparisons made with other countries, with similar climates, in order to understand the compounding risk factors of the situation in Britain. These comparative studies also highlight the difficulties presented by research in this field, where so many factors are interlinked. Finally, evidence of the extent of cold and damp homes in Britain is reviewed as an indication of the scale of fuel poverty, its effects on housing conditions and, therefore, its potential risk for health.

2.2 Fuel poverty: development of a definition

2.2.1 A modern phenomenon?

It was stated in Chapter One that *fuel poverty* was first identified as an issue relevant to UK social policy in the 1970s, following increases in world oil prices and the subsequent national fuel crisis. In reality, the issue had always been present, although not necessarily recognised until it was aggravated by raised energy costs at this time. Boardman describes how, since then, it has become subject to public attention whenever the winter weather is particularly cold (Boardman, 1991, p1). Today, numbers of the fuel poor, depending on the specific definition used, as will be discussed later in this chapter, are variously estimated to range from at least 4.3 million to 6.8 million households in England alone. Evidently, whatever the definition, this is not an insubstantial problem.

2.2.2 Fuel costs and fuel debt

Concerns over fuel poverty arose during the 1970's and 1980's because of mounting fuel debt, or unpaid bills, which resulted in a dramatic rise in the number of domestic disconnections made by the gas and electricity utilities. Campaigning groups such as The National Right to Fuel Campaign and Neighbourhood Energy Action (now called National Energy Action, or NEA) were set up at this time (1975 and 1981 respectively) in response to the prevailing situation. Both groups lobby on behalf of low-income households who have difficulties keeping their homes warm. As their titles perhaps suggest, originally one was indicative of the fuel debt and disconnection problem and the other of the value of energy efficiency measures to such households.

Cooper (1994) describes how the matter of 'energy conservation' had been considered from time to time throughout the twentieth century, but that, in the 1970's, the term became synonymous with the government's campaign to save energy. That campaign was instigated by fears about the security and costs of imported energy supplies in the short term. He suggests that an environmentalist agenda also lay behind it, with respect to the depletion of fossil fuel resources. Even so, according to Critchley (1997), the 1974 amendments to the Building Regulations for an increase to the minimal thermal insulation for new (but not existing) housing were introduced primarily as an anti-condensation measure. Any prevailing concern regarding energy saving in government circles at that time, therefore, did not relate to the issue of fuel poverty.

Various early studies of fuel debt identified the important factors of both low income and high fuel costs, as described by Bell *et al.* (1994, p35). However, according to Berthoud (1993), older people, many of whom constitute low-income households, are less likely to go into debt or be disconnected by the utilities than younger householders. In a survey of people on low incomes (*i.e.* claiming social security benefits) in a London Borough, Smith (1992) found that as many as a third would economise on heating all the time in order to save money for other necessities (quoted in Griffiths, 1994, p114). Both analyses indicate the possibility that where people are unable to afford sufficient heating, the problem remains hidden and could easily be overlooked or ignored. Furthermore, although disconnections have been dramatically reduced in recent years, this is largely due to many more people now having switched to prepayment meters, therefore being likely to 'self-disconnect', by not boosting the meter when money is short (Bown *et al.*, 2000, p8). In this way, the problem is concealed further and identification of its scale rendered more difficult. So, although useful, fuel debt and disconnections cannot be regarded as the sole indicators of fuel poverty, as they first appeared to be.

2.2.3 Low income and inadequate warmth

The simple definition of fuel poverty as '*the inability to afford adequate warmth in the home*' was introduced in 1982 (Lewis, 1982), but this does not give an indication of its causes other than that of income level relative to the cost of warmth. Markus first wrote about fuel poverty in Scotland in 1979 (Markus, 1979). He looked at data on the relationship between family income and expenditure on energy, which revealed that the poorest one quarter of households spent up to four times as much as the highest income quarter, as a *percentage* of their income. In spite of this, *actual* expenditure was shown to rise with income, meaning that higher income households spend higher amounts on energy but as a smaller percentage of their income. He identified the combined effect of fuel poverty, with four defining indicators:

> *"low income; lower absolute fuel expenditure; a greater proportion of income spent on fuel (hence less on food, clothes, etc); and lower quality thermal environments"* (Markus, 1979).

Again, this describes the conditions where insufficient warmth results from low income relative to fuel cost, but Markus also discussed the fact that the buildings occupied by the fuel poor require more heat than others to be comfortable, bringing the building fabric, its exposure to weather and methods of heating into the equation.

Energy conservation and energy efficiency are issues that are now accepted as undeniably linked with fuel poverty. Through the 1970's and 1980's, government attitudes to energy conservation changed, and the terms used varied, depending on underlying motivations at the time, as described by Cooper (1994). Energy conservation had been regarded as an issue for individuals to address, in which they would be guided by economic signals of the market. Low-income households, without the means for investment, were necessarily excluded from such aspirations.

The drive to *save* energy then transformed to one for greater *efficiency*, initially as a means of improving international competitiveness. The term also came to apply to the domestic sector. Cooper maintains that, during that period, 'energy efficient' measures were judged primarily by their *"cost effectiveness...solely in terms of (their) payback period"* (Cooper, 1994). The payback was seen in terms of the cost of energy saved, as against the cost of the measures installed. It may be argued that this is still predominantly the case, but the ideas that this arbiter is not wholly appropriate when dealing with fuel poor households whose priority is sufficient energy, or that there may be other costs associated with energy inefficient buildings, will be pursued later.

2.2.4 The inefficient dwelling

Brenda Boardman analysed the phenomenon of fuel poverty comprehensively in her book, published in 1991 (Boardman, 1991), considering the characteristics of buildings and heating systems together with the cost of warmth in the UK, identifying the population groups most at risk and also drawing connections with health – as had Markus (1979). She synthesised the problem to emphasize the role of the building with an augmented definition of 'the inability to afford adequate warmth *because of the energy inefficiency of the dwelling'*. One of Boardman's stated primary aims in writing this book was to examine the distinction between fuel poverty and poverty in general (despite the acknowledged relationship between the two). A major stumbling block in achieving recognition of this issue as one worthy of policies in its own right has been the reluctance of government to accept it as separate from poverty, thus requiring solutions other than those based purely on income and benefits. She pointed out that:

> "*...a multi-disciplinary approach is required to examine the characteristics of warmth as a commodity and to help disentangle the differences between poverty and fuel poverty*" (Boardman, 1991).

As stated earlier, fuel prices were initially considered to be the main cause of fuel poverty. Boardman, however, proceeded to distinguish and explore the multiplicity of causes, suggesting that, since 1970, all three major suspect factors had deteriorated in Britain, which she put forward as housing conditions, fuel prices and income levels. She emphasised that the service to be purchased was *warmth*, rather than fuel for its own sake, and it is this that distinguishes fuel poverty from poverty. General poverty, where access to basic goods such as food and clothing is restricted by price alone, can be alleviated through state benefits and income support. Boardman argued that, since the purchase of adequate warmth is dependent on the efficiency of the building fabric and the heating system, remedial policies must deal specifically with the need for capital investment in respect of both (Boardman, 1991, p221). The problem is far more particular than mere lack of income for day-to-day expenditure. Not only do energy inefficient homes demand more expensive warmth, by virtue of the energy required to compensate for that lost through inefficiency, but also poor households, through unemployment, retirement or incapacity, need more of it because they spend more time in the home. Those who live in colder parts of the country need more warmth still but, as Boardman shows, benefit levels make no allowance for differing amounts of warmth needed or its variable cost to households (Boardman, 1991, p227).

Boardman described the outcomes of fuel poverty in relation to health, as distinct from comfort, drawing attention to the high numbers of excess winter deaths that occur in the UK, as compared with elsewhere[2]. She demonstrated that, according to surveys, the British do not actually prefer to be cold, as has sometimes been inferred (Rudge, 1994, p1). Comfort standards are acknowledged as variable, because of individual preferences. However, a minimum indoor temperature requirement is important, especially for vulnerable people, who need an affordable minimum level of warmth to avoid health risk (Boardman, 1991, p126). Boardman cited a range of physiological evidence that strongly points towards causal links between being cold and morbidity or mortality, particularly for the very young and the old. Accordingly, she makes a convincing argument that excess winter deaths are an indicator of fuel poverty.

2.2.5 Affordable warmth

It was proposed that the necessary solution to fuel poverty would be a programme for 'affordable warmth', a concept for which Boardman is responsible. The programme would need to bring all low-income housing to a standard such that adequate *energy services* (including heating, hot water, cooking, lighting and other electrical demands) would cost no more than 10% of a household's income (Boardman, 1991, p227). It was recognised that such a large-scale programme would require billions of pounds capital investment, but that there would be significant employment creation and environmental benefits in addition to the alleviation of fuel poverty. Boardman undertook to define what could be regarded as 'affordable' so that, for the first time, fuel poverty could be quantified. The figure of 10% as a proportion of income was selected because, drawing on data from the Family Expenditure Survey for 1988, she calculated that the 30% of households with the lowest incomes spent 10% of their total expenditure on fuel. This is almost twice the proportion spent by the average household in the UK, although less in absolute terms. The proportion of income spent on heating alone (as opposed to other energy demands) was estimated as 6%, reflecting the apportionment of average household energy consumption. It was argued that this 30% of households equated with a reasonable definition of 'low-income' households. Definitions were also offered for 'adequate energy services' on the

[2] *see* Chapter 3 for full discussion of excess winter mortality

basis of available evidence. These were made in terms of minimum heating periods through the day and minimum temperatures for comfort, health and avoiding condensation. Bell *et al.* (1994, p37) refer to other, more recent, work as having confirmed Boardman's calculations of the requisite energy efficiency level (energy rating) for dwellings[3] in order to achieve affordable warmth. Although they claim that there is room for discussion about absolute figures, they describe her proposal as *"a very clear model that can be used to develop policy in this area"*.

In arriving at these various definitions, Boardman covers the many angles on the subject of fuel poverty by drawing together and analysing evidence of the range of component factors - technical, social and economic. The complexity of this subject raises difficulties in making connections from disparate sources and drawing definite conclusions where relevant combinations of statistics are neither routinely nor comprehensively collected. She takes a pragmatic approach, using available published data, making the necessary overlays, estimations and extrapolations. There are several notes of caution over findings because of discrepancies observed between differently sourced pieces of similar information such as on household energy expenditure, or lack of comparability for indoor temperature data, for example. With reference to technical factors, measuring features of buildings in use is frequently complicated by occupant behaviour (such as opening windows or varied heating patterns), making it problematic to gather comparable or consistent records. Similarly, ventilation heat losses from buildings are difficult to measure, and Boardman claims that all heat loss calculations are necessarily speculative (Boardman, 1991, p63). Problems of measurement in the field are also reflected in calculations derived from computer modelling. It is shown that building heat losses modelled by different researchers vary, because subjective decisions need to be made on so many parameters. These losses form part of the basis of predicting energy savings from different measures that are key to proposals for achieving affordable warmth.

With regard to social and economic factors, there are no universally accepted definitions of poverty in place, which creates problems for linking income and housing data to define fuel poverty (Boardman, 1991, p41). Armstrong *et al.*, in similar vein, refer to the lack of *combined* health and housing statistics, which have further bearing on clarifying effects of fuel poverty:

> *"Despite (the) long-standing recognition of the links between housing and health, there is a surprising lack of statistical information. Difficulties involved in both defining and measuring poor housing...cast doubt upon the extent to which these problems can be quantified, while the tendency for national statistics to relate predominantly to <u>either</u> housing, <u>or</u> to health makes it hard to establish empirically the associations between the two"* (Armstrong *et al.*, 2000, p150).

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[3] *see* Chapter 5 for further details of energy ratings

Boardman argues that the lack of relevant statistics collected illustrates the low priority given to fuel poverty. For example, the limited available temperature data for occupied homes is suggested as indicating the lack of official interest in domestic warmth, while the fact that it is not collected on a comparable basis reflects the *"scant recognition given to the relationship between adequate warmth in the home and good health"* (Boardman, 1991, p127). This is why it was found necessary to use excess winter deaths as a measure of cold living conditions and, by extension, of fuel poverty. Although strong arguments are made to support her claims, she makes it clear that it is

> *"in the absence of more definite data, ...(that) a causal link (is suggested) between the low level of energy efficiency in British dwellings, cold homes and the high seasonal mortality rate"* (Boardman, 1991, p147).

Notwithstanding the inadequacies of accessible and inter-related data acknowledged by Boardman, the careful accumulation of widely sourced evidence and the well-argued solution presented in her book have caused it to be consistently referenced in new research or publications relating to fuel poverty issues. Numbers of excess winter deaths are now commonly cited as evidence of the scale of the problem in this country. However, despite widespread acceptance of the term 'affordable warmth', the concept of purchasing *warmth* rather than *fuel* is not yet generally promoted and attitudes to designing appropriate remedial policies have been constrained accordingly.

2.2.6 Under-occupancy

To complete the definitional picture of fuel poverty, there is a yet more complex version, building on Boardman's definition and quoted by Whyley and Callender from an Energy Action Scotland report, where it is described as:

> *"... the inability to afford adequate warmth through the combined effect of household income, inadequate and expensive forms of heating and the inefficient thermal characteristics of the dwelling"* (Whyley and Callender, 1997, p2).

Although this would seem to cover all possible causes, as described by Boardman, an additional factor leading to fuel poverty is now commonly recognised, as cited by the 1996 English House Condition Survey Energy Report (DETR, 2000, p119) and others (*e.g.* Boardman and Fawcett, 2002, p10). This is the problem of *under-occupancy*, concerning the size of the dwelling in relation to the number of people in the household. It can be particularly relevant for older households, whose families have moved away, and who remain living in houses with more rooms than they habitually use. Under-occupancy was highlighted in the work to produce an Affordable Warmth Index[4], carried out by National Energy Services (Scannell, 2000). The Affordable

[4] *see* Chapter 5

Warmth Index was developed as an indicator of potential fuel poverty when assessing domestic energy ratings depending on the characteristics of possible occupants. In fact, Critchley suggests a qualification to the definition of affordable warmth such that allowance should be made for property size, *i.e.* a property should be a reasonable size for the number of persons in the household (Critchley, 1997, p6).

2.2.7 Fuel poverty risk factors

Despite difficulties of obtaining definite data, the several component factors giving rise to fuel poverty can be summarised as they have emerged from the various attempts at a definition. They are now commonly regarded as:

- fuel prices
- income levels
- housing and heating system characteristics
- under-occupation.

Additional elements of risk include particular vulnerabilities of some population groups with special heating needs and those who need to spend longer than others at home, such as the chronically sick, the disabled, the old or very young, or the unemployed. Markus also emphasises the exacerbating effect of climate, or exceptionally severe weather (Markus, 1994, p2). These effects depend on location within Britain and the degree of building exposure. In the next part of this chapter (2.3), national building and other characteristics are explored as further aggravating factors, since the problem seems to be especially pertinent in Britain. As it is frequently argued that those most likely to be fuel poor are among the older population, age-related questions are discussed in Chapter 4. The range of implicated determinants of fuel poverty indicate the potential responsibilities of different sectors within government and the need for a multi-disciplinary approach both to researching the problem and to making policy to deal with it. Whether designed for the purpose or not, increasing numbers of policies developed to date have some bearing on the issue, although there is not space here to discuss them in detail. However, co-ordinated action between relevant departments is clearly lacking, as will be discussed later (8:5:2). The emphasis in this chapter is on housing- and energy-related policy, in light of which the official recognition of fuel poverty and its definition are now examined.

2.2.8 Government recognition of fuel poverty as an energy issue

It was pointed out earlier that energy conservation has previously exercised central government for reasons of cost and security of energy supply and depletion of fossil fuel resources. More recently, international commitments to curb energy use made at the 1992 Rio Earth Summit and the 1997 Kyoto Protocol have been governed by the need to address climate change and reduce greenhouse gas emissions, such as carbon dioxide.

In view of these environmental priorities, the Home Energy Conservation Act 1995 (HECA) placed a duty on local housing authorities to take on the role of energy conservation authorities and report on measures identified as likely to lead towards a 30% improvement in domestic energy efficiency over 10 years. No central funding was provided towards implementing this target. Initial guidelines to the Act suggested that if any Affordable Warmth strategy existed within an authority, it might include the policy in its report and could consider extending the strategy to tenures beyond its own (DOE, 1996). Official recognition of the fuel poverty issue as relating to energy policy was therefore implied. However, the mandatory targets specified in the annual progress reports only related to reductions in energy use and carbon dioxide emissions; not for tackling fuel poverty. This could bias action in favour of achieving the greatest effect in terms of cutting emissions. The fuel poor use as much fuel as they can afford on a limited budget, so that increasing energy efficiency in their homes would simply allow them to use the same amount to better effect and towards improved comfort. This is known as 'takeback' (Milne and Boardman, 1997). The 'fuel rich', whose use of energy on heating and appliances is not constrained by cost, would therefore prove to be better targets for efficiency measures to effectively reduce energy consumption.

Local authorities have since received further guidance with regard to fuel poverty as a well-being issue and have been asked to report on their policies for tackling it (DEFRA, 2000). However, it appears that co-ordinated thinking is lacking within the single area of policymaking relating to energy use, where there remains an apparent tension between environmental and fuel poverty targets. No government subsidy is provided to counteract the likelihood that the easier, and cheaper, course of action will be followed by local authorities to prioritise energy conservation targets, although there are government initiatives under various departmental areas of responsibility to enable energy efficiency improvements for low income households.

2.2.9 Definition as an instrument of government policy

Having reviewed the definitional development of fuel poverty and Boardman's attempt to quantify its extent, it should be noted that there has been considerable debate around the definition employed by the government in directing policy, now that it is accepted as an issue to be addressed. This discussion is ongoing between certain pressure groups and the government and highlights the difficulties of both identifying fuel poor households and of targeting assistance towards their considerable numbers. Calculation of fuel poor statistics can vary widely.

depending on the definition used, thus affecting the amount of resources required to deal with the problem and, to some degree, the ways in which resources are allocated. It also affects the measure of government claims as to their success in eradicating the problem.

The Warm Homes and Energy Conservation Act 2000, introduced by a backbench MP with cross party support, gave formal recognition to fuel poverty 'as a major issue of public well being' (DEFRA/DTI, 2001). It has the objective of eliminating fuel poverty 'as far as reasonably practicable' within a specified time period, but discussions continue on definitions and, yet again, this Act makes no provision for additional funding to deal with the problem. On the face of it, Boardman's definition has been adopted by the government in the UK Fuel Poverty Strategy, published as a requirement of the Warm Homes Act. Fuel poverty is recognised to exist (in England) where more than 10% of a household's income is necessary to *"maintain a satisfactory heating regime"* (DEFRA/DTI, 2001). The Strategy states that the fuel use to be considered should include that for non-heating purposes, which is also consistent with Boardman's intention. (Not only do fuel prices and income level affect all fuel requirements and, therefore, fuel poverty, but it is also difficult, in practice, to apportion the cost of different fuel uses for a household without separate metering, which is rare.) Some researchers have previously appeared to confuse the distinction between heating and total energy use in respect of the 10% cut-off. For heating energy expenditure, as mentioned previously, Boardman argues that the figure required should be no more than 6% of income. The difference between these figures is evidently significant and would seriously affect the numbers falling into the category of 'fuel poor'.

The key point of the current debate, however, concerns the definition of 'income', which could be regarded as either disposable income, or total income. Groups campaigning on behalf of low-income households maintain that it should be based on disposable income, including all benefits but excluding all main housing costs, specifically rents or mortgage interest. Their argument is based on the fact that such costs are not available to be spent on fuel (NRFC, 2001). Total income, on the other hand, is regarded as including all benefits without allowing for outgoings on housing costs. Housing benefits are calculated on the basis of local costs. If these are high, they could misleadingly affect apparent income levels if included as part of household income from which to notionally apportion fuel expenditure. The government has chosen, however, to favour the 'full income' definition for target setting, although it proposes to quote figures for a 'basic income' definition alongside, for the purposes of comparison with earlier recorded statistics (DEFRA/DTI, 2001). In this context, 'basic income' is regarded as including all benefits received apart from Housing Benefit or Income Support for Mortgage Interest (ISMI). Neither government definition is therefore based on actual disposable income.

The government has also introduced further indicative measures for the fuel poor, such that households for whom it is deemed that either 20% or 30% and above of income would be necessary to achieve affordable warmth are categorised as in 'severe' or 'extreme' fuel poverty respectively. Those who need to spend between 10% and 15% of income are only 'marginally' fuel poor and between 15% and 20% 'moderately' fuel poor. Although it can be seen that this strategy is designed to prioritise assistance where there are limited resources, it has its dangers. It could encourage a perception that the problem is diminished for those regarded as the least severe category, whereas the 10% of income threshold was originally put forward as a maximum and is widely regarded so (Critchley, 1997, p6). Those who only just avoid falling into that category, despite still struggling to achieve affordable warmth, are likely to be discounted altogether in the prevailing climate of supposedly focusing on the most vulnerable. In addition, since the *necessary* amount for adequate heating and the *actual* amount spent are not the same in practice, many could be living in cold homes who would not strictly be defined as fuel poor in in terms of the required costs, although they cannot afford to, or do not, spend as much as 10% of their income on fuel.

The UK Fuel Poverty Strategy itself includes three possible different figures calculated for numbers of fuel poor households in England, according to the extent of housing costs counted as income (DEFRA/DTI, 2001):

- 4.3 million fuel poor, or 22% of all households, if all household income is included
- 5.3 million, or 27% of all households, excluding housing costs from income met by Housing Benefit and ISMI
- 6.8 million, or 35% of all households, excluding all housing costs from income (all mortgage/ rent payments as well as related benefits).

These figures highlight both the scale of the problem and the significant discrepancies arising from the various methods of calculation, with resulting implications for the extent of resources needed to tackle fuel poverty. Different figures still have been quoted elsewhere, but numbers fluctuate because of changing fuel prices and benefit levels. In fact, all numbers are merely estimations based on incomplete data relating to both the housing stock and the numbers of people who may be entitled to benefits, many of whom cannot be counted because they do not claim them[5]. Recent reductions in numbers of fuel poor are claimed by government, being credited to falling energy prices due to fuel liberalisation (Boardman and Fawcett, 2002, p10), as well as to state benefits (such as winter fuel payments[6]). However, according to the EHCS, lower

[5] see later discussion in 4.3

[6] a fixed amount currently payable annually to households over 60 years old or on certain benefits

energy prices are far less effective for the most severe cases of fuel poverty than increased household incomes and improved energy efficiency (DETR, 2000, p144).

There has been a more recent proposal from government that the complex formula for identifying fuel poverty based on energy expenditure be replaced with a proxy measure which deems a dwelling capable of achieving affordable warmth through possession of certain energy efficiency features. The National Energy Action campaign group, although initially supportive of this idea, has expressed its view that the level of energy efficiency arrived at for the 'Decency Standard' is not only inadequate to effectively ensure affordable warmth, but is inapplicable to many properties (NEA, 2002). The government proposal, in fact, suggests that levels of insulation far short of current Building Regulations requirements would be assumed to be sufficient, whereas Boardman had proposed that an energy rating above that achieved by those regulations would be required for her Programme of Affordable Warmth. Difficulties are inevitable where a definition is pegged to fuel prices that are relatively low at present, but cannot be guaranteed to remain so.

Currently, despite the long battle to gain its recognition as such, the term 'fuel poverty' itself is frequently under discussion. It is thought to be counter-productive to campaign or publicise grant assistance around this term because many resist or do not accept for themselves a definition as 'poor'. In the same way as (often older) people will not claim benefits to which they are entitled out of feelings of pride or independence, they do not wish to accept grants or interference in their homes or circumstances. It is also a misleading term in view of Boardman's argument that *warmth* is the required commodity rather than fuel or energy. Furthermore, it serves to reinforce the individualisation of the problem as one attached to the household, rather than to the house, as part of the nation's legacy of an energy inefficient building stock.

2.3 Fuel poverty risk: a British problem

2.3.1 Energy efficiency standards

Boardman considered, in detail, the features of buildings in Britain that frequently lead to under heating and exacerbation of fuel poverty, as neither the phenomenon itself, nor its associated health effects, appear to be such a problem in other European countries. Although Curwen (1981) and Boardman (1986) have shown that excess winter mortality is inversely correlated with outdoor temperatures in this country, international differences in seasonal mortality do not reflect a similar association in accordance with national differences in absolute external temperature levels (Boardman, 1991, p142). As stated in Chapter One, Boardman concludes that the closer relationship between outdoor and indoor temperatures in Britain, because of deficiencies in the building fabric, are key to the higher numbers of excess winter deaths found compared with many other countries.

She demonstrated the relatively poor domestic building standards required in the UK compared with elsewhere, despite regular increases in demands of regulations concerning insulation and energy efficiency since 1974 (Boardman, 1991). A comparison of national standards for 1985, as applied to a standard house type in the same location, indicated that 70% more fuel would be required to achieve the same level of comfort for a new home built to UK Building Regulations as for one built to Finnish regulations. The level of insulation demanded for new British homes at that time was less than for France, Austria, West Germany, the Netherlands and Eire as well as Scandinavia and, although the UK Regulations were about to be upgraded in 1990, parallel improvements were also due in the other countries. Boardman suggests it is likely that similar differences in energy efficiency would have prevailed across Europe in the past, and that the whole UK housing stock is probably more costly to heat than many other countries as a result (Boardman, 1991), which is an aggravating factor towards potential fuel poverty.

Although it is not intended to expand on the reasons for these differences here, there is evidence that includes climatic, historical, technological and social influences on building construction to support this view (Rudge, 1994). Not only is the lack of effective insulation commonplace, but also the housing stock is notoriously 'leaky', due to certain of these influences, including construction methods and quality of workmanship (Nevrala, 1979). Boardman describes the problems of heat loss from British housing due to high ventilation rates and the consequent difficulties that arise in attempting to effectively draughtproof older dwellings. Indeed, as she points out, housing standards in this country have traditionally placed more emphasis on space and freedom from damp than on warmth. As a result, there is no requirement for insulation, or the cost of warmth, as part of the Housing Fitness Standard, under which existing dwellings are deemed fit for habitation (Boardman, 1991)[7].

In fact, because there has been a gradual updating of insulation standards for new buildings since the first nationally applied Building Regulations were introduced in 1965, Boardman argues that this has caused differentials between new and older housing to increase. The scale of such differentials is illustrated by findings of the English House Condition Survey that in 1996, for

[7] The government is currently conducting a consultation process for updating the classification of unfit or hazardous housing through a health and safety rating system, which does recognise the harmful effects of excessively cold temperatures, however (ODPM, 2002)

example, 20% of English housing built before 1919 had no loft insulation at all, while all dwellings built since 1980 had a thickness of 50 mm or more (DETR, 2000, p245). Indoor temperatures were also generally found to decrease as the dwelling age increased. The proportion of English dwellings built before 1919 in 1996 was 24%, while 45% were more than 50 years old. This is further illustration that a high proportion of English housing may be difficult to heat and, as a result, is likely to be cold in winter if resources are lacking to purchase fuel. There are therefore substantial inequalities to be found in English housing standards that, it could be assumed, are reflected in comparative living conditions.

2.3.2 Indoor temperature and climate

Boardman's international comparisons may be evaluated in part against the findings of more recent, related research. The Eurowinter Study was a large-scale epidemiological study designed to consider the effect of winter climate and protective behaviour on excess winter mortality (Eurowinter Group, 1997). The implications for health will be discussed further in Chapter 3, but the research is of relevance in this context because indoor temperatures were measured across regions and cities in a number of European countries, including Finland, the Netherlands, Germany, England, Italy and Greece. These were taken simultaneously with the administration of questionnaires, which were used to survey heating use, clothing and outdoor excursion behaviour. Among the authors' conclusions was that:

> *"striking differences indoors were higher living room temperatures and more frequent bedroom heating in the colder countries, all at a given level of outdoor cold"* (Eurowinter Group, 1997).

England was found to be nearer the 'warmer' end of the scale in terms of the average outdoor winter temperature (calculated from October to March) and with respect to this conclusion. This was not the case, however, when it was judged by the number of days in the year when the mean daily temperature falls below 18°C, which indicates the misleading nature of an 'average' temperature when comparing climates.

The indoor temperature measurements were made as one-off readings taken in living rooms during the surveys, which were carried out in evenings between November 1994 and February 1995. Although these were standardised to a given outdoor temperature through multiple regression analysis, criticism can be made of using single spot measurements as representative of an average indoor winter temperature, which varies throughout the day as well as the season. Hunt and Gidman, (1982, p119) in a national domestic temperature survey, found that spot temperatures correlated with the amount of time the respondent had already been in the room before the measurement was taken, indicating still more problems of comparability in this field of work.

Consideration of average indoor temperature levels alone, with no reference to daily or other variations, allows no acknowledgement of the possible effect on comfort or health of a changeable climate, such as prevails in the UK. Arguments have been made previously of the health effects of temperature changeability, based on a body of health evidence (Rudge, 1994). The fact that temperatures are changeable means that 'mild' averages disguise the extremes experienced, which, if buildings are energy inefficient, will be translated into similar indoor conditions. Even so, the Eurowinter Study adds to the accumulation of evidence that indoor temperatures vary across Europe and that in countries with 'mild' winters, buildings tend to offer less protection against the cold than where the winter climate is more extreme. It is interesting to note that a study of national building regulations in a number of European countries found that they rarely specify minimum design air temperatures for dwellings, the exceptions being France, Italy and Sweden (Sheridan, 1999). Scotland requires that one room only should meet a minimum. There are also temperature design standards for subsidised housing in Northern Ireland and Wales. England has no such requirements now, although the Parker Morris Report (MOHLG, 1961) set out standards including minimum temperatures for living rooms, kitchens and halls that became mandatory for public sector housing in 1969. From 1980 these were no longer required for local authority dwellings, but remained the standard for housing associations (Boardman, 1991, p113). In this respect, the lack of consistent and universal building performance standards in England appears to reinforce Boardman's claim that there is little official interest in cold indoor temperatures and their effects.

2.3.3 Fuel poverty prevalence

Energy efficiency standards and indoor temperatures are respectively indicators of fuel poverty risk and its effects, but some work comparing the prevalence of fuel poverty raises other national differences with potential impact on both. Research carried out by the Policy Studies Institute in 1997 assessed the incidence of fuel poverty in Europe, looking at equivalent population data for the UK, Ireland, Germany and the Netherlands as countries with economic, social and climatic similarities. This report found that the severity of fuel poverty was much greater in the UK and Ireland and that this was:

> *"associated with the relatively low standard of living and housing conditions in these two countries"* (Whyley and Callender, 1997, p33).

The analysis related to household characteristics, poverty and fuel poverty indicators drawn from the European Household Panel Survey in 1994, which had been designed to ensure that questions had a common meaning in each of the EU Member States. Although the data used from this survey was directly comparable, its authors acknowledge the data limitations in terms of fuel poverty, which was not its specific focus. Therefore, rather than direct measures, it offered only a restricted number of indicators of *predisposition* to fuel poverty, i.e. presence of damp, lack of central heating or electric storage heaters and an absence of 'acceptable heating facilities'. They also point out that these indicators are

> *"heavily influenced by individual countries' approaches to a whole range of factors including building standards, housing policy, energy policy, social assistance or low-income households and attitudes to energy conservation"* (Whyley and Callender, 1997, p9).

Analysis of the extent of fuel poverty was based on the further question from the Household Panel Survey as to whether households can afford to adequately heat their homes. The Report concluded that all but 2% of households in the Netherlands and Germany could afford to keep their home adequately warm, while as many as 12% and 10%, respectively, could not afford adequate heating in Ireland and the UK (Whyley and Callender, 1997, p31).

It may be argued that the concept of "adequate heating facilities" as an indicator is somewhat subjective and imprecise and, as the authors point out, "adequate" is not necessarily the same as "efficient".

> *"It is possible that some of the households who believed their heating facilities were adequate still paid more than they needed to for heating, or were unable to maintain a comfortable temperature in their homes"* (Whyley and Callender, 1997, p14).

In that case, the numbers against this indicator may have been *under*estimated. Building types and characteristics were not compared in this study, nor did it include any direct, objective measurements, such as indoor temperatures or heating costs. Although this means that conclusions are drawn only in general terms, the study does serve to demonstrate the complexity of the fuel poverty issue and the difficulties of making international comparisons, particularly where there are so many inter-related factors involved. Nevertheless, when viewed in conjunction with other research, the report presents additional evidence towards the existence of national differences in housing standards and conditions, and propensity to fuel poverty.

2.4 Fuel poverty indicators in the housing stock

2.4.1 Cold homes: a British preference?

In view of research indications that fuel poverty is a particularly British problem and the numbers of households affected, according to government estimations, what evidence is there of its effects in the housing stock? Boardman used the scale of excess winter deaths as a measure of cold homes and fuel poverty for lack of other data. The Eurowinter Study has since also concluded that English homes are colder in winter than those in other, colder countries, but what more is known about the true extent of cold homes in Britain and could it merely reflect a British preference for cooler indoor temperatures? Historically, the logistics of measuring indoor temperatures across a wide sample of housing has proved problematic in gathering national data. Part of the difficulty could be to do with cost, because instrumentation is needed on a large scale to take measurements during a period of similar outdoor conditions, particularly when the climate is as changeable as it is in the UK. Part of it could also be due to the variability of conditions between and within homes, dependent not only on building types, efficiency and layouts but also on the occupants' circumstances and building and heating use patterns.

Hunt and Steele (1980) collated and examined data from surveys done up until 1978, the earliest they identified having been carried out in the winter of 1946-7. They found that most studies used samples that had been carefully selected, rather than random populations, and sample sizes varied from 1 to 1020. Generally, the larger surveys had used spot temperature measurements, whereas longitudinal studies over varying periods of time were more common for surveys involving only a few dwellings. These tended to use thermograph readings, giving continuous measurement over several weeks or months, from which mean daily temperatures were derived. It was found that average indoor temperatures had gradually increased over the decades, partly due to the growth in central heating ownership, but also, it was suggested, due to the growing preference for wearing lighter clothes and fewer layers (Hunt and Steele, 1980).

When Boardman published her book, there were only two available national surveys of home temperatures (Wicks, 1978; Hunt and Gidman, 1982), which she argued was indicative of the lack of official interest in the extent of cold living conditions (Boardman, 1991, p127). These surveys had been carried out on different populations, the first one for older people. Since then, however, there have been three nationally representative surveys published in connection with the English House Condition Survey (EHCS). This is produced by the government department responsible for housing every 5 years and has included questions on heating, insulation and damp since 1976. A separate Energy Report has been produced since 1986, (although the first was not published until 1991), following the incorporation of a temperature survey and questions on fuel conservation and satisfaction with heating for a sub-sample of the total. This is an important resource for much recent research involving the relationship between indoor temperatures and health, as well as for informing government policy on fuel poverty. The 1996 survey was based on approximately 12,000 household interviews combined with physical surveys, of which about 3,300 were included in the fuel survey. The sample is selected to represent as many as possible typical dwelling forms, ages and tenures. The analyses are grossed to national totals, with inevitable margins of error. All these surveys have used the spot temperature method of measurement (taken for the living room and hall only), in common with most previous large-scale studies.

Statistics to emerge from the Energy Report of the 1996 EHCS show that average indoor temperatures are more likely to be lower according to several features (DETR, 2000), including some that are also associated with fuel poverty, as described earlier:

- in households with lower incomes
- in dwellings classified as unfit or defective
- in less energy-efficient housing
- in housing without central heating.

It was found that the proportion of cold homes – and the effect of cold weather on the indoor temperature – increased as the external temperature decreased, supporting Boardman's argument that there is a close relationship between indoor and outdoor temperatures in this country. Twenty-four percent of households considered the current temperatures in their living rooms and hall (as measured during the survey) were 'much too cold', one extreme of a 5-point comfort scale. Over twice as many households found these temperatures too cold as those who found them too warm. On a 5-point scale from 'very cold' to 'very warm', and according to a combination of living room and hall temperatures, 7% were found to have 'cold' and 2% had 'very cold' homes (DETR, 2000, p155). (Temperatures regarded as 'too cold' from a health point of view, against which the EHCS definitions were determined, are discussed in chapter 3.)

As Critchley (1997) points out, because winter temperatures vary from year to year, there are difficulties in comparing these survey reports over time to identify improvements with regard to indoor temperatures, as these are partly dependant on external conditions, particularly in the least efficient homes. The average external temperature during the 1991 survey was unusually mild at 11.0°C, as compared with 6.2°C in 1986 and 6.4°C in 1996, for example (DETR, 2000, p148). There are also the usual provisos to be made regarding the use of spot temperature measurements as representative of average daily temperatures, as discussed earlier. The full extent of cold homes may well be greater than the EHCS illustrates, therefore, depending on what is regarded as cold, the methods of measurement and points of comparison.

The phenomenon of *takeback* demonstrates that people living at low temperatures generally prefer to be warmer if possible, since the potential energy savings and reduced bills are balanced by a measure of increased comfort taken from improved energy efficiency. This is found to be greater, the colder the initial temperature of the dwelling (Milne and Boardman, 1997). In refutation of the idea that the British prefer cold living conditions, Boardman refers to Mack and

Lansley, who found that in 1983 people ranked 'heating in the living areas' first among a list of 26 necessities for a minimum standard of living (Mack and Lansley, 1985). Whyley and Callender (1997, p1) quote various research studies confirming the high priority given to heating bills in low-income households.

More recently, Gordon *et al.* (2000) carried out a national survey on poverty and social exclusion in Britain, using data for 1998-9 and a variety of measures of poverty in addition to income, one of which was the lack of 'socially perceived necessities'. A list of 54 items and activities was ranked by the percentage of respondents who deemed them items that all adults should be able to afford and should not have to do without. The items ranked as second and third priorities on the list (after 'beds and bedding for everyone') were 'heating to warm living areas of the home' and a 'damp-free home'. These items were thought necessary by 94% and 93% of the population respectively, although it was found that one per cent and six per cent respectively did not have these because they could not afford them. Furthermore, an analysis of services exclusion concluded that

> *"more than one in twenty people have been disconnected from water, gas, electricity or telephone and more than one in ten have used less than they need because of cost"* (Gordon et al., 2000).

The listed necessities include a wide-ranging variety of activities, customs and obligations, which perhaps merit discussion in themselves, but these statistics are an indication of the desire for warm, dry homes and the fact that housing conditions in Britain are unlikely to ensure their universal availability.

2.4.2 Damp homes: buildings or behaviour?

This thesis mainly focuses on cold housing and cold effects because of its emphasis on energy efficiency, but dampness frequently occurs together with, and as a result of, low indoor temperatures. It can therefore be an indication of both cold homes and fuel poverty risk. Relative humidity depends on temperature and moisture content of the air. The lower the temperature is for a given moisture content, the higher the relative humidity. In dwellings that are inadequately heated therefore, the relative humidity is higher for a typical household rate of moisture production (from normal living processes such as breathing, cooking and washing) than in a warmer building. Condensation occurs where moisture in the air condenses on cold surfaces, so it is likely to be found in poorly insulated, poorly heated buildings with high relative humidity. Although extra ventilation can reduce the moisture content of air, Oreszczyn and Pretlove (2000, p128) point out that beyond a certain level, ventilation in a poorly heated dwelling will reduce temperature even further, increasing relative humidity and exacerbating condensation problems even more.

Poor quality building construction also leads to penetrating or rising damp – and this sometimes occurs in combination with condensation and fuel poverty. Reasons for this include the lack of available investment for building maintenance in low-income households and the correlation between building age and low energy efficiency.

From the point of view of comfort, damp air feels colder to the skin than dry air at the same temperature, but dampness also has implications for health, as will be discussed in the next chapter. Condensation encourages the growth of mould, which, along with other effects, produces allergens strongly associated with respiratory ailments. There is less likelihood of mould growth from dampness to do with penetrating or rising damp, because the salts brought out of the building fabric with the moisture inhibit it. On the other hand, the water contained in condensation is relatively pure and more conducive to fungal growth (Hunt, 1993, p78). According to the 1996 EHCS, 31% of all English households reported condensation in their homes, and 15% reported severe mould growth (DETR, 2000, p7). The private rented housing sector is the most affected, which is often occupied by the fuel poor.

Fuel poor households are particularly subject to condensation because

- inadequate heating and poor insulation leads to greater likelihood of cold surfaces and high relative humidity;
- they can ill afford to lose heat through ventilation which is needed to expel moist air;
- they are often unemployed, retired, long term sick or disabled, so indoor relative humidity is likely to be greater than in other households by virtue of them spending more time in the home;
- the poor condition of much energy inefficient housing combines to increase the risk of cold surfaces and air temperature as well as dampness in the building fabric through deterioration;
- some may use cookers or paraffin heaters to supplement inadequate heating, but fuels such as gas and paraffin increase humidity when burnt in equipment with no flue.

Although there are technological explanations for these problems, which can also be attributed to low incomes and housing conditions, in the form of fuel poverty, there has long been disagreement in housing management practice as to how far occupant behaviour alone is responsible for excessive indoor humidity and condensation. The details of this controversy are not enlarged upon here, but it has led to reluctance in professional and political circles to accept that remedial measures can be taken through building improvements (Howieson, 1991, p4). Once again, there are echoes of blame being attached to individual households rather than to the state of the housing stock. Green *et al.* (2000) proposed that, by increasing their energy efficiency, buildings could be made more 'tolerant' of many domestic circumstances than their original construction allows. They were particularly concerned with post-war municipal tower block housing. For example, certain forms of construction produce 'cold bridges', where structural elements are carried directly through to internal surfaces from the outside with no intervening insulation. This can result in differential surface temperatures, encouraging condensation on the un-insulated sections. The combination of energy efficiency, warmth and good ventilation, however, helps to accommodate moisture production and avoid condensation.

It is clear that the EHCS provides evidence of low indoor temperatures and dampness due to condensation throughout the English housing stock. There are shared characteristics between those likely to suffer fuel poverty and those living in cold damp housing. Cold homes are not preferred in Britain and high humidity in dwellings is not due to abnormal occupant behaviour. These conditions are regarded as largely the effects of fuel poverty, therefore, especially when considered alongside the estimated several million households deemed to be fuel poor, judged by what is known of the number on low incomes and the inefficiency of British housing.

2.5 Summary

In this chapter, the causes of fuel poverty have been described and it has been shown that the problem is particularly prevalent in the UK, where energy efficiency standards for housing are comparatively low. Even so, until relatively recently, the issue has lacked official recognition. The particular combination of the several risk factors leading to fuel poverty differentiates it from general poverty, although there is evidently an overlap, low income being one of these factors. The distinction between these two problems also necessitates different solutions, such that income support alone would not be sufficient. Boardman has argued for major capital investment in the housing stock, the failings of which is a principal cause of fuel poverty. The estimated numbers of fuel poor households in this country have, so far, inhibited large-scale investment by central government to the extent required and, despite official acknowledgement, there remains some controversy over definitive classification of fuel poverty because of the implications for overall numbers, and resources, in the detail. The government strategy depends on limited targets spread across departments, with tensions between energy conservation and affordable warmth policies yet unreconciled.

Political resistance to its recognition has complicated research into this subject in the past, which, it is claimed, has restricted the collection of appropriate data. Furthermore, the combination of causes demands a multidisciplinary approach to its study and development of solutions, which may be limited by organisational structures. The risk factors themselves are key to the proposed methodology, as will be made clear in Chapter 5. In addition to identification of these factors, the focus of this chapter has been the risks of fuel poverty occurrence in terms of cold and damp homes. The following chapter explores the relationships between the risk factors, their outcomes and health, in the light of recent research.

CHAPTER 3

Fuel poverty risk factors as health status determinants

"Although the heating was on all day they were still cold. There is heavy damp in all rooms. The three youngest children have all suffered from coughs and colds. All the children are always ill from the damp."

from: *I mustn't laugh too much. Housing and health on the Limehouse Fields and Ocean Estates in Stepney.* (Ambrose, 1996, p56).

3.1 Introduction

Boardman uses evidence of cold, poorly insulated homes, high numbers of external winter deaths and the relationship of these deaths with external temperatures, to draw links between indoor temperatures and health in the UK (Boardman, 1991). She produces convincing arguments for the links between fuel poverty and health on the basis of these relationships and unfavourable comparisons with countries whose homes are better heated and insulated. In the previous chapter it was shown that her argument with respect to housing conditions and low indoor winter temperatures is supported and augmented by more recent evidence from a variety of sources. This chapter explores existing evidence of the ways in which fuel poverty, as well as the factors leading to fuel poverty, can affect health.

Although it is widely accepted that there are links between poor housing and health, which seem to many to be self-evident, for some years the specific social and health costs to service providers of poor housing have not been generally acknowledged. This is largely because of the difficulty in eliminating the effects of confounding factors during research but, as Ambrose *et al.* (1996) point out, interest in these relationships is now growing. Recent government acceptance of health inequalities as an issue has raised the profile of poor housing as a potentially related factor. A number of literature reviews relating to housing and health that have been published in recent years are referred to here (Henwood, 1997; Ambrose *et al.*, 1996; Bell *et al.*, 1994; Revie, 1998). They were compiled within different disciplines and with different emphases, but all note the connections between either fuel poverty, or poor housing, and health. Not only do their various findings indicate the interrelationships between inequalities of housing conditions, of income and of health, but they also highlight the resulting disadvantages to older people in particular, which will be the focus of discussion in Chapter 4.

According to Hunt (1997, p161), there has been surprisingly little scientific research into housing and health although in the last decade some progress has been made in understanding the links more precisely. A literature review published by the RICS found that there had been more focus on inequalities of gender and race than on the relationship between housing quality and the differences between healthy and unhealthy occupants until relatively recently. Meanwhile, in the field of medical sociology, more attention had been paid to employment status and health links rather than to housing and health (Ambrose *et al.*, 1996, p7). Hunt also points to the fact that confounding variables lead to methodological problems, caused by trying to:

> *"(disentangle) the role of housing from poverty, unemployment, working conditions, behavioural factors believed to be more prevalent in low-income groups such as smoking, as well as the selection of people in poor health into poor housing and disadvantaged areas"* (Hunt, 1997, p162).

This review cannot be exhaustive, because of the wide range of literature relating to the subject of housing and health in several areas of professional expertise. The approach taken is rather to look in detail at examples of research studies that are representative of different disciplines, different aspects of methodological challenge and the scope of confounding factors. It is necessary to consider the definition of health status and the means of measuring this for the purposes of research. Evidence for health effects of fuel poverty, or cold housing, is then considered under a number of headings: first, medical studies, including those focussed on populations as well as those targeting risk factors affecting individuals; second, studies taking a social policy approach; and third, building, or energy-efficiency, related research. The final section deals with further potential confounding arising from the contribution to health status of the usually underlying condition of fuel poverty, which is that of poverty itself.

3.2 Fuel poverty and health: background to research

Henwood (1997) observes that research rarely investigates the specific relationship between health and *fuel poverty*, but that it is often implicitly explored because of general associations of health with poor housing and with poverty in the wider sense. She identifies two trends pertaining to interest in the health effects of cold homes: one in the social policy tradition and the other in the field of medical research, more specifically to do with epidemiology and physiology. She suggests that these two areas of work are sometimes in tension (Henwood, 1997, p21). It could be argued that there are a number of reasons for this, some methodological and some, it would appear, political. One problem concerns confounding variables and the difficulty of isolating causal links between individual characteristics of housing and specific medical conditions. There is also some debate in this research area that has to do with the tendency, in the past, for the medical community to have avoided looking beyond the symptoms presented by patients, to what may often involve social or economic issues. Barnes describes the traditional bio-medical model as one that

> *"... defines health as freedom from disease which can be diagnosed clinically and is concerned primarily with treating symptoms rather than their underlying causes"* (Barnes, 1999).

In a collection of essays on housing and health connections, edited by Burridge and Ormandy, Hunt takes this point somewhat further:

> *"Too often complaints about housing are seen as 'merely' an excuse to qualify for rehousing and general practitioners have been notoriously reluctant to lobby on behalf of their patients for what they perceive as a 'political' issue"* (Hunt, 1993p 89).

One general practitioner to write about the actual effects, physical and mental, on his patients, of poor living and economic conditions and acute deprivation, however, was David Widgery (Widgery, 1991). Dr Widgery wrote from 20 years' experience of living and working in East London and was overtly political in his descriptions and analysis of the failure of urban renewal in the Docklands to *"benefit the poorest and worst housed of his patients"* (Ambrose *et al.*, 1996, p8). It has been variously argued by others that political and resource implications of the housing / health issue have perhaps hindered investment in related research and influenced methodology.

In 1994, Judge had argued that part of the reason for policy makers ignoring social and environmental determinants of health was the powerful economic and political lobby supporting biomedical interests in the health care industry. He called for multi-disciplinary research to include looking at non-medical influences on health because of the lack of resources invested in their understanding. His argument was that most research funding was currently concentrated on advances in medical technology, despite their relatively modest "*aggregate contribution to the population's health*" (Judge, 1994). More recently, Thomson *et al.*, having carried out a review of housing intervention studies and their health effects, recommended the use of a holistic approach to investigate the wider social context of housing interventions. They also described the possibility of earlier political resistance to housing research:

> *"Traditionally, policy makers in the United Kingdom have not had access to much evidence on the health effects of social interventions. This lack of evidence and the methodological limitations of existing studies may be used by governments to absolve themselves of responsibility for improving housing"* (Thomson *et al.*, 2001).

According to Ambrose (1996), since the 1840's at least, policy makers had realised the impact of housing quality on health. Byrne and Keithley refer to the fact that housing policy was a key instrument for health management by the Ministry of Health between the wars (Byrne and Keithley, 1993, p63). However, after 1945 there was a gradual move away from recognition in public policy that poor housing conditions are linked with poor health. Ambrose *et al.* (1996, p4) suggest that:

> "*With the establishment of the National Health Service the dominant medical model which emerged associated illness with the individual and often failed to address environmental contributory factors*".

This came about despite the fact that it is now widely accepted that some of the greatest contributions to improved health in Britain over the past century came from such developments as better nutrition, or collective interventions in the environment, rather than modern curative medicine (Byrne and Keithley, 1993, p41). With reference to the suggested emphasis on the individual above, a parallel may be drawn with the point made previously (2.2.9) regarding the concept of 'fuel poverty' which, in government thinking, has tended to attach to individual households who are poor, rather than to the failure of an energy inefficient housing stock to facilitate affordable warmth.

It has been described earlier how the factors contributing to fuel poverty include both physical and socio-economic conditions, fuel poverty therefore being an indication of inequalities in both housing and income. These conditions are also inter-related in that, for example, certain low-income groups are more likely to occupy poorly insulated housing than are higher income households. As a result, it becomes increasingly complicated to disentangle the individual and combined effects of such factors on health. In Chapter 2, evidence was presented to demonstrate inequalities in housing in this country in terms of insulation levels, indoor temperatures and levels of discomfort felt by occupiers. What is under discussion in this chapter is how housing – and income - inequalities are likely to lead to inequalities in health.

3.3 Determining health status

3.3.1 Health inequalities and health status determinants

Ineichen commented that the creation of the National Health Service in 1948 was seen by many as a way of ending health inequalities in housing but that, even so, they have proved remarkably enduring (Ineichen, 1993, p48). The Acheson report, published under the New Labour government in 1998, signalled the recent official recognition of inequalities in health in England (Acheson, 1998). The earlier Black Report, commissioned by the outgoing Labour government in 1977, had compiled evidence of significant inequalities in mortality and morbidity, but the newly elected Conservative government, presiding when it was presented in 1980, had refused to endorse its recommendations. The reasons given were the implications for public expenditure and lack of evidence for effectiveness of the proposals (Macintyre *et al.*, 2001). According to Macfarlane, Bartley *et al.*, (2000, p80),

> *"under the Conservative government health inequalities were either ignored or referred to as 'health variations' in policy documents".*

They acknowledge that, since May 1997, inequalities have been back on the agenda, although they suggest it has yet to be seen whether the policies being adopted by New Labour will be adequate to tackle them. Thomson *et al.* (2001) referred to the current government's preference for identifying 'what works' and seeking a 'joined up', or cross-departmental, approach to decision making, as offering potential for tackling deprivation more effectively.

Early in the first term of the New Labour government, the Department of Health commissioned the Acheson Report, an independent inquiry into inequalities in health led by Professor Donald Acheson, a former Chief Medical Officer. Its recommendations were required to be based on scientific and expert evidence and to be made within the framework of no increase in public spending. The emphasis was on identifying possibilities for the development of *"..beneficial, cost effective and affordable interventions to reduce health inequalities"* towards a new strategy for health (Acheson, 1998). The limitations of the short time scale, set at a year, were acknowledged in the Report, this having *"prohibited a very detailed and comprehensive review"* (Acheson, 1998). However, many different types of evidence were evaluated and the report incorporated a process of peer review with an independent scientific commentary.

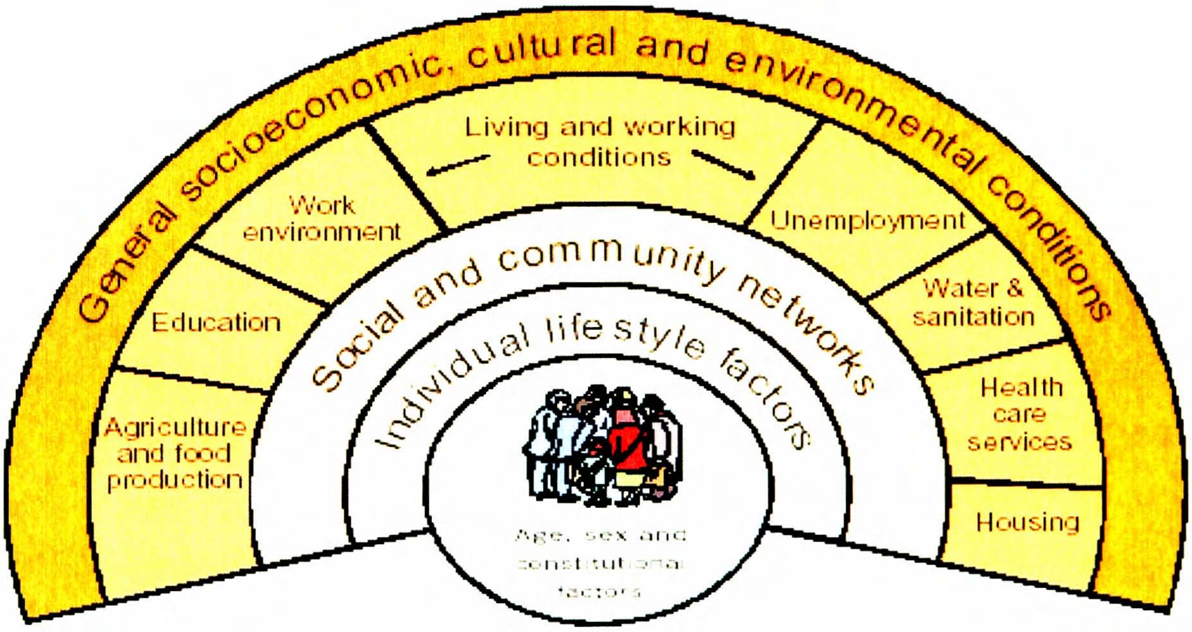

Figure 3-1: The main determinants of health

Source: Dahlgren and Whitehead (1991)

The Inquiry adopted a socio-economic model of health and its inequalities, *"in line with the weight of scientific evidence"* (Acheson, 1998, p5), as contributing to its broad front approach and as illustrated by the diagram in Fig. 3-1. This diagram represents the main determinants of health, as layers of influences, between which interactions also occur. The individuals at the centre of the diagram are conferred with what Barnes categorises as biological attributes (Barnes, 1999), which cannot be altered. Acheson suggests that the surrounding layers of influence are open to modification, in theory, whether by the individuals themselves or within wider social networks or the organisation of society in general. The Report also emphasises the potential for intervention at various points, either through medical care or preventive approaches, the value of which it maintains the Government supports in its stated aim to tackle the root causes of ill health (Acheson, 1998, p7).

Acheson therefore accepts the relationship between health inequalities and social deprivation. Despite growing affluence and increased life expectancy for the country as a whole in recent years, inequalities in both health and income have, at the same time, been widening, as increases have been more dramatic among the higher classes. The Report describes how socio-economic inequalities in health reflect differential exposure throughout life to risks associated with socio-economic position (Acheson, 1998, p6). This analysis is certainly applicable to the situation involving fuel poverty. As described earlier, inequalities in physical and socio-economic environment are part of the defining conditions for fuel poverty. The likelihood of someone living in inadequate housing may either result in, or result from, poor employment opportunities. If they have grown up in poverty, their childhood exposure to deprivation may have led to a biological predisposition to ill health throughout their life course, which may, in turn, have caused them to be in the poor housing situation, or without employment. All these conditions would have their own further consequences affecting lifestyle, behaviour and access to services.

The Inquiry accepted evidence on health associations with housing quality from contributors to the Burridge and Ormandy publication, *'Unhealthy Housing'* (1993), and from an earlier review of strategies to reduce health inequalities, published by the King's Fund (Benzeval *et al.*, 1995), among others. The Acheson Report includes specific mention of the problems of poorly insulated housing with inefficient heating, particularly with relation to quality of life for older people. It suggests that the hazards of poverty such as inability to afford heating, or excess winter deaths caused by cold housing

> *"..could be addressed by increasing the financial resources available to older people and others living on state benefits,(but) a more direct approach would be to improve the energy efficiency, insulation and heating systems of affected housing......Current government schemes, for example, the Home Energy Efficiency Scheme, may not reach homes most in need, such as the private rented sector"* (Acheson, 1998, p52).

Its recommendations included:

> *"policies to improve insulation and heating systems in new and existing buildings in order to reduce further the prevalence of fuel poverty"* (Acheson, 1998, p122).

These statements appear to endorse Boardman's argument in favour of long-term investment in the housing stock and, importantly, acknowledge the relationship of fuel poverty with health.

3.3.2 Measurement of health status

In promoting the socio-economic model of health determinants, the government accepts a wider context for health than the traditional bio-medical model described by Barnes (1999). It has also now charged local authorities with responsibility for the wellbeing of their residents, so that health and local authorities are theoretically involved in a joint approach towards the broad welfare of communities. Once it is acknowledged that there are links between health and aspects of housing, any related research requires a definition, as well as measurement, of health status. The definition of health advanced by the World Health Organisation (1947), as *"... a state of complete physical, mental and social well-being and not merely the absence of disease"*, represents a holistic concept with possibly limitless implications for governmental responsibilities. This all-embracing concept is perhaps one to which society might aspire, although health status defined in these terms cannot easily be measured.

Lowry is also interested in the holistic definition rather than the more limited medical view:

> *"Living in cold damp houses affects people's health. This is true within a strictly medical model, but the problems are even more serious if we look at a wider definition of health, akin to the World Health Organisation concept of emotional and physical wellbeing"* (Lowry, 1991, p19).

The significance of this comment, or the choice of definitions, is not that there are no strictly medically definable outcomes of cold or damp housing. It is that, in looking beyond symptoms and diagnosis alone, the *causes* of ill health may be identified as to do with more than simply the predisposition of the individual, *i.e.* age, sex and constitutional fixed factors, as illustrated in the socio-economic model and the innermost ring of Fig. 3-1. Prevention of disease, potentially in some part through improvements to the defective housing, then becomes an issue, and responsibility broadens across government agencies or departments. Otherwise, if the symptoms alone are dealt with and the underlying health determinants in the two outermost rings in Fig. 3-1 remain, the health problem is unlikely to be cured. Acheson (1998, p118) recognised the need for partnership working to reduce health inequalities, because of the many health determinants that lie outside the health care system and his recommendations for actions such as improving the energy efficiency of housing manifest the preventive, or public health approach. The Report also emphasised that Directors of Public Health, on behalf of health *and* local authorities, should conduct an ongoing audit of progress, again implying long-term co-operative action pertaining to health and other inequalities.

The definition, or measurement, of disease resulting from environmental and socio-economic conditions, such as fuel poverty, presents some methodological difficulties. Should it be confined to a medical diagnosis made by the 'experts' or, alternatively, can it be made through self-reported symptoms? In the area of housing and health research, a case-finding approach may be taken where it is anticipated that certain diagnoses, such as asthma, are linked to housing (Hunt, 1997, p162), but there is also frequently reliance on self-reporting of health status, use of health services or use of prescribed medicines. There is clearly little consistency in the health indicators employed, which limits comparability of findings.

For ease of administration and in the interests of a measure of comparability, non-medical researchers are also increasingly depending on self-completed health questionnaires, such as the Short Form 36 (SF-36). This health survey was originally devised in the USA (Ware and Sherbourne, 1992), but has been anglicised for use in the UK (Brazier *et al.*, 1992). The SF-36 consists of a 36-item battery, with a scoring system to provide measures for 8 dimensions of general health and well-being, but does not apply to specific diagnoses or respiratory conditions. It was used, for example, in the small Nottingham study of housing interventions designed to reduce asthma in cold and damp housing (Howard and Critchley, 2000). In this case, the questionnaire data was supplemented by recorded use of asthma drugs.

Although the SF-36 has been verified as a comparative measurement tool, self-reporting of morbidity generally has produced its own difficulties and controversies. There have been accusations of potential bias where patients may hope to be re-housed by attributing poor health to their housing conditions. The medical community is therefore reluctant to accept findings based on self-diagnosis. Mant recommends that self-reporting of housing defects or of health problems should be avoided where possible as the predominant basis of studies (Mant, 1993, p6). Even so, as Hunt points out, the initial medical diagnosis depends on the 'lay' person (usually cast as an unreliable informant) presenting themselves to the experts, with their own report of the problem (Hunt, 1993, p70). She also refers to the fact that there may yet be disagreement over diagnoses by professionals, which can depend on fashion, especially for conditions of asthma or bronchitis.

To further complicate the measurement issue, Ambrose *et al.* raise another question for researchers, which is to do with perception, suggesting that difficulties arise from the culturally specific understandings of health and illness (Ambrose *et al.*, 1996, p8). This problem relates not only to self-reported health status in interviews or questionnaires, but also to initial presentation for professional diagnosis and treatment and, therefore, to statistics derived from GP visits or hospital admissions. As Strachan comments:

> *"social and cultural background are ... important influences upon the perception of illness, the diagnostic label applied and the uptake of medical services"* (Strachan, 1993, p95).

In fact, according to Amartya Sen,

> *"the patient's internal assessment may be seriously limited by his or her social experience. To take an extreme case, a person brought up in a community with a great many diseases and few medical facilities may be inclined to take certain symptoms as 'normal' when they are clinically preventable"* (Sen, 2002).

He suggests that self-reported morbidity, therefore, has severe limitations and can be very misleading; in extreme cases as he describes, it is apparent that it would be towards an under-estimation of problems, rather than the reverse that is often implied. Indeed, while some are raising the debate concerning 'over-medicalisation' of many of life's normal processes in the developed world (Moynihan and Smith, 2002), it is necessary to keep sight of the real effects of deprivation and poor environmental conditions that remain for the least privileged in this society.

At the same time as it is possible that patients' perception may affect their reporting of health problems, the 'Hawthorn effect' is recognised to operate, potentially, when people are the subject of research. This is where behaviour, or perceptions, may change merely as a result of being studied, or having an interest taken in them as subjects, rather than as a result of any intervention itself. It was first noticed in a workplace where managerial interest in working conditions produced improved quality from the workforce, whether improvements were made or not. It should be recognised as a possible confounder of results from housing research looking at health effects on individuals.

The following piece of research is described to illustrate some of the difficulties in measuring and relating environmental effects to health. Hunt and others carried out a large study across three cities on dampness and health effects on young families with children (Hunt, 1993, p80). Residents in almost 600 homes were given a health survey interview and were asked about their perceptions of housing problems. Building surveyors independently assessed the houses for damp, mould and airborne spores, following the interviews. It was designed as a triple blind procedure, where none of the health, housing or dampness survey datasets were put together until after they had all been collected. Potential confounding factors were allowed for, such as overcrowding, smoking and unemployment. It was found that residents' perception of dampness in their homes did not result in over-reported illness for their children, as might have been expected. In fact, a strong association and dose-response relationship was shown between certain reported manifestations of ill health and actual conditions of damp as noted by the building surveyors. This indicated that residents were unlikely to have been deliberately misreporting either the illnesses or perceived damp in this study, as they were unaware of either which symptoms were associated with mould and airborne spores, or the grading system used for the building conditions (Hunt, 1993, p84). Although the residents' recording of dampness and mould did not match objective measurements in about 30% of the houses, the disagreement occurred in both directions, so they apparently displayed no consistent bias towards over-emphasis on poor housing conditions.

Strachan refers to this work as an illustration of potential reporting bias, or 'differential reporting' of dampness and mould growth (Strachan, 1993, p108). His own epidemiological study of damp housing and childhood asthma[8] in Edinburgh appears to confirm further differential reporting of both symptoms and housing conditions, although only indirectly. Strachan's conclusions, however, also indicate that the appropriateness of the objective measurements used in his study (of asthma and of environmental conditions in the children's bedrooms) were open to question. The validity of objective data must therefore be considered just as carefully as the subjective information against which it is compared. Even so, Strachan suggests that there is still too much uncertainty around making specific connections between housing and health and,

> *"given the current limitations of the clinical and epidemiological data, it may be unwise to place too great an emphasis upon risks to health when making the case for eradication of dampness in houses"* (Strachan, 1993, p113).

This somewhat negative conclusion appears to have been emphasised by several reviewers of the literature (*e.g.* Bell *et al.*, 1994) despite the more positive case made by Hunt, whose study was able to counteract some of the problems of potential bias through careful design. Nevertheless, from the wider, public health point of view, Strachan recognises the value of improving energy efficiency and heating in the housing stock on additional grounds of comfort and energy conservation (Strachan, 1993).

The debate continues on health status measurement, while differences in approach are revealed in the different strands of housing and health research that will now be examined, reflecting the fact that they tend to be carried out by professionals from either medical or non-medical disciplines.

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[8] The causal mechanisms of asthma are as yet unknown, but there is some knowledge of triggers for the condition, such as house dust mites and particulates, among others.

3.4 Health effects of cold homes: epidemiological research

3.4.1 Fuel poverty and health research

As shown already, the health implications of dampness and mould in homes have been the subject of some studies, but less research is published on the effects of cold housing *per se* (Hopton and Hunt, 1996, p273), which, as will be shown, are recognised to be respiratory and cardiovascular disease. In fact, because of the increasing incidence of asthma, there is growing research interest in house dust mites, which are thought to be a strong causal factor (Howieson and Lawson, 2000). There are circumstances when the proliferation of dust mites could be exacerbated by fuel poverty, but they are generally more likely to result from warm, humid conditions rather than cold and damp. There is a significant body of medical and physiological evidence of the effects of cold and damp on health. However, even though both are features of fuel poor homes and one may result from the other, here the focus will be mainly on cold effects, because of the direct correlation found between temperature and excess winter deaths. This body of knowledge underpins attempts to connect health problems with cold housing, but there remains some question over the relative contributory effect of external as opposed to indoor temperature, as will be shown.

In the field of epidemiology, as applied to effects of cold housing, the main emphasis tends to be on excess winter *mortality*. This is discussed here first, being the phenomenon that alerted researchers to the potential role of indoor temperatures in cold related deaths. Following a brief reference to physiological evidence of cold effects on health, recent medical research studies relating to both epidemiology (3.4.4; 3.4.5) and individual aetiology (3.5) are then considered in some detail, illustrating some of the main areas of controversy or debate as well as methodological issues. Further problems are raised by a review of research that considers the health effects of poor housing from either the point of view of social policy (3.6) or of building professionals concerned with energy efficiency (3.7).

3.4.2 Excess winter mortality and cold effects

Excess winter mortality, as indicated in Chapter One, is measured as the number of deaths to occur during the winter months (December to March[9]) in excess of the average for the rest of the year; or else it is measured as a ratio of these figures. The mean annual average excess number for England over the period from 1986 to 1996 was about 30,000 (Henwood, 1997, p27). This phenomenon is evident in all but equatorial climates and is apparently associated with low temperatures, or the relative seasonal fall in temperature (Rudge, 1994). The winter peaks in

[9] According to the Office for National Statistics

deaths, seen as temperatures drop, do not produce corresponding troughs in numbers later in the year and, therefore, do not indicate the acceleration of deaths among the sick and frail during cold periods that would otherwise have occurred later. From historical observations, it has been found that seasonality of deaths begins to emerge in a society for a variety of reasons, but partly as public health measures or improved medical care help to reduce summer epidemics of infection, particularly among infants. De-seasonality (the falling off of the ratio of winter over summer deaths) is shown to follow seasonality as further socio-economic changes take place (Rudge, 1994).

It has been concluded in some research that the increased use of central heating in homes is the main reason for the appearance of de-seasonality in many developed countries (Sakamoto-Momiyama, 1977), although Henwood (1997, p29) describes the direct evidence as inconclusive. In Britain, where central heating ownership spread later than in countries with very cold winters such as Canada, Norway and Sweden, this pattern of de-seasonality was shown to have followed behind those countries. As Boardman has noted, excess winter mortality is higher in Britain than in these and other countries, like France and Denmark, with more similar winter temperatures to the UK. Khaw (1995) observes that outdoor temperatures are most used in mortality analyses, but that outdoor temperature may be a marker for indoor temperature exposure, because of their close relationship. Indoor temperatures have been observed by some to have an impact, but are not strongly related to latitude:

> *"Scandinavian countries (which tend to have indoor heating and building insulation) have less seasonal variation in mortality than more southern countries such as Portugal and Israel where central heating is not widespread and indoor temperatures may vary more in line with outdoor temperatures throughout the year"* (Khaw, 1995).

Bell *et al.* refer to the international comparisons produced by Boardman as presenting

> *"the strongest case for a significant contribution (to seasonal mortality) from low internal temperatures."* (Bell *et al.,* 1994, p39)

Cardiovascular and respiratory diseases are the predominant causes of excess winter deaths in the UK, despite a persisting, widespread assumption that hypothermia, or cooling of the body core, is largely responsible[10] (Keatinge and Donaldson, 2000, p17). A strong relationship has been shown between changes in external temperature and numbers of deaths from these two major causes (Bull and Morton, 1978). Curwen (1991) estimated that a third were attributable to respiratory disease and more than a half to cardiovascular disease (mainly heart attacks and strokes). As Wilkinson *et al.* (2000, p27) point out, this is a linear relationship and not simply a

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10 Hypothermia is discussed further in Chapter 4

step increase in the winter period showing an effect of just the very coldest days. According to Collins (2000, p45), although numerically more deaths are ascribed to circulatory (cardiovascular) disease, the greatest proportional effect of winter temperatures is on deaths from respiratory disease. Keatinge and Donaldson (2000, p18) refer to the time lapses observed between temperature drops and peaks in numbers of deaths, which clearly vary according to the diagnosed cause of death, such that there is a lapse of up to three days for coronary thrombosis and 12 days for respiratory disease. These indicate that the greater part of the seasonal influence is probably due to the direct effect of cold rather than other, indirect, factors, such as reduced Vitamin C in the winter diet, for example. As Khaw observes, there are

> *"seasonal changes in environmental and other factors such as air pollution, sunlight exposure, influenza incidence, and diet (that) have variously been implicated in seasonal changes in mortality"* (Khaw, 1995).

However, she concludes that temperature is the leading candidate.

3.4.3 Physiology and ambient temperature

Collins recently reviewed the long known association between cold ambient temperatures and respiratory illnesses with reference to the physiological and epidemiological evidence (Collins, 2000). Although most studies have focused on damp and mouldy living conditions rather than cold house temperatures, here he concentrates on cold indoor conditions, how these relate to dampness and mould and, consequently, with allergic response respiratory conditions. As Collins demonstrates (but is not expanded upon here), the effects of ambient temperature on physiological function can be explained in terms of pathology (Collins, 2000, p39). These effects include asthma attacks, which can be triggered by breathing in cold air, reduced resistance to respiratory infection, and wheeze in children associated with dampness and condensation on cold surfaces, which produces allergenic mould growth. Evidence for a relationship between temperature and cardiovascular mortality includes, for example, findings on seasonal variation in blood pressure, which is related independently to both indoor and outdoor temperature, indoor temperature having the stronger impact (Khaw, 1995). If blood pressure is raised, as in response to cold, circulatory conditions can be affected. Collins concludes that it is methodologically very difficult to show a definitive link between home temperatures and specific health outcomes, but that both indoor and outdoor cold temperatures can exacerbate respiratory illnesses in the presence of respiratory pathogens (Collins, 2000, p46).

On the basis of physiological evidence, Collins has defined several thresholds for indoor temperatures related to health effects (Table 3-1), which were cited by Mant and Muir Gray in *Building Regulation and Health* (1986). It should be remembered, as he emphasises, that it is difficult to specify accurate safe indoor temperature limits, because of wide individual variations

(Collins, 1993, p118). Perception of thermal comfort varies according to age, state of health, clothing and activity levels and expectations, but these thresholds provide a means of gauging a 'cold' house in relation to health. The dry-bulb air temperature, representing a combination of the air temperature and radiant temperature of surrounding surfaces, is the most appropriate measure for cold conditions (Collins, 1993, p119).

Table 3-1: Benchmark indoor temperatures to avoid health risk
(source: Collins, 1986)

Temperature	*Health risk*
18°- 24°C	no risk to healthy, sedentary people
18°C	minimum for comfort
<16°C	increased risk of respiratory infection
<12°C	increased strain on cardiovascular system
< 6°C	after 2 hours or more, deep body temperature falls and risk of hypothermia

Although these temperature benchmarks are a useful indication of the known health effects of cold, there is also evidence concerning temperature *fluctuations*, which can arise from moving between warm and cold rooms, for example.

> *"In a house in which only one room is heated, especially overheated, the person will suffer acute cold stress every time s/he leaves the room"* (Lloyd, 1990).

Rapid temperature change produces greater respiratory effects than a gradual one (Hunt, 1997, p166). The resulting 'thermal shock' can also exacerbate circulatory disease although, despite an apparent contradiction, those going out into the outdoor cold from a warm house are better protected than if going out from a cold one (Goodwin, 2000, p56). The relationships between indoor and outdoor temperatures and indoor variations are therefore likely to further confuse the relative significance of indoor and outdoor cold on health.

3.4.4 Epidemiological research and excess winter mortality

Strachan defines epidemiology as *"the study of the distribution, determinants and control of disease in human populations"* (Strachan, 1993, p95). He describes epidemiological investigations as normally involving observational rather than experimental research. In this way, as well as in scale generally, they can be distinguished from the intervention studies described below as research on individual aetiology, which forms the other main strand of medical research applicable to the consequences of fuel poverty. He suggests that when monitoring disease variations at the population level, it is not possible to control for confounding variables, but statistical techniques may be used to explore the independent effects of different potential factors. The multi-factorial nature of environmental effects on health has been established earlier. Epidemiological studies relating to cold housing still tend to concentrate on mortality rather than morbidity (the reasons for which will be discussed in Chapter 5).

With regard to excess winter mortality, there is some controversy around the comparative effects of indoor and outdoor temperatures, the relevance to the fuel poverty issue being that, if indoor temperature is significant, then policies are needed to remedy the occurrence of cold housing by investment, as argued by Boardman. Bell *et al.* (1994, p41) conclude that:

> *"Although there are some contradictions in the evidence there is strong support for the view that the level of excess winter deaths (particularly among the elderly) is related to the level of internal temperature found in many dwellings in the UK."*

The contradictions to which they refer are contained in a large study of older people, their domestic thermal conditions and hypothermia by Wicks (1978), in a later repeat study carried out for the Institute of Gerontology (Salvage, 1993) and in various pieces of research by Keatinge. They claim that, despite its findings of many homes with low indoor temperatures, the Wicks study was unable to establish a significant correlation between body temperatures and cold homes (Bell *et al.*, 1994, p38). However, perhaps this only indicates that the likelihood of imminent *hypothermia* was not established when the room temperatures were measured. It does not rule out correlation with conditions that have not reached the extreme condition of hypothermia, which in itself is recognised as accounting for only a very small percentage of deaths (Keatinge, 1986).

Keatinge has frequently, and controversially, used the evidence of one study in particular (Keatinge, 1986) to argue the greater importance of exposure to outdoor cold than indoor temperatures with regard to seasonal mortality. The mortality rate of elderly residents in up to 17,000 units of centrally heated, sheltered housing was compared with that of over-65s in the general population over the period 1981 to 1985. The study looked in detail at a sample of 14 subjects in two of the housing association buildings, recording the indoor and outdoor temperatures on one cold January day in 1986. All the residents had their heating set below maximum, and had a window open during the measurements; all but one claimed to regularly turn off the heating and leave windows open at night. Half of this sample made daily outdoor excursions, including walking up to 4 miles and waiting *"for lengthy periods"* at bus stops. A similar proportional winter excess mortality was observed for both populations, although a lower overall mortality rate was found in the housing association population. Keatinge (1986) concluded that excess winter mortality must therefore be as much to do with exposure to fresh air and outdoor cold as with poor heating since, according to his extrapolations, high indoor temperatures were not shown to be sufficient protection against cold-related death (see Henwood, 1997, p31).

This study has attracted a number of criticisms regarding the methodology employed and the conclusions drawn. Collins (1993, p132) comments that:

> *"It does not explain why excess winter mortality is much less pronounced in countries with warmer homes and colder outdoor winter conditions unless there are large behavioural and clothing differences which prove to be critical."*

Boardman points out the problems of relating projected death rates to temperatures experienced by living subjects (Boardman, 1991, p140). The sample of thermal conditions studied was, indeed, very small (14), compared with the population it was assumed to represent (approximately 15,000) across the country, as pointed out by Henwood (1997, p32). Boardman suggests that heated accommodation obviously has a beneficial effect because of the generally lower mortality rate in the housing association population, despite the fact that they may have elected for warden-supervised accommodation because of increasing infirmity (Boardman, 1991, p140). However, heating may not be the key difference. It could be that warden supervision and vigilance more than compensates for any possible greater vulnerability of sheltered housing residents, this being part of the reason for opting into sheltered accommodation.

Furthermore, are the residents of sheltered housing representative of the elderly population in general? Since the housing association's client group was described as typically 'able-bodied elderly, mainly widows' (Keatinge, 1986), this suggests that they are not a matched population group, nor particularly infirm and there is no indication of socio-economic status. Similarly, the outdoor excursion behaviour of 7 residents out of 14 did not fully represent their complete thermal experience over a day and could not be confidently argued as typical for residents of 17,000 units. Spatial or diurnal temperature variations within the accommodation were not accounted for by the measurements taken, although the fact of open windows and lack of heating at night were mentioned as exposure to cold air. Despite the author's claims, it is difficult to draw firm conclusions that this piece of research offers any clear or robust evidence to explain the role of indoor or outdoor temperatures on excess winter deaths. There is little apparent recognition of the complex relationships between buildings and their occupants with regard to thermal conditions.

A later study by Keatinge *et al.* (1989) considered the growth in central heating ownership in England and Wales and the parallel decline in excess winter mortality over the period from 1964 to 1984. They concentrated on the population aged between 70 and 74 years. It was found that excess winter deaths from respiratory illness declined significantly, even allowing for the varying severity of winters, although there was no significant fall in those attributed to coronary disease or strokes (the major cold-related cardiovascular conditions). Part of the reduction in excess respiratory deaths in this period was due to fewer influenza epidemics. The authors conclude from this (together with the earlier study) that excess winter cardiovascular mortality is likely to be mainly due to outdoor excursions rather than to improvements in home heating (Keatinge *et al.*, 1989). Nevertheless, since others have shown an association between central heating ownership and increased internal temperatures (Shorrock *et al.*, 1992), Bell *et al.* (1994, p39) describe this study as further evidence of the role of *indoor* temperatures.

Although there is no denial that outdoor cold is likely to play a role in poor health, Collins suggests that evidence from Keatinge's studies may indicate the different effects of indoor and outdoor cold, such that cardiovascular deaths are more influenced by outdoor temperatures and respiratory health more by those indoors.

> *"The present evidence therefore suggests that changes in the respiratory mortality in the elderly in winter is* (sic) *most closely related to improvements in home heating and to the occurrence of influenza epidemics. The effects of outdoor cold may be more dominant in causing excess coronary and cerebrovascular deaths, though there may be an indoor factor if the home environment is particularly cold."* (Collins, 1993, p133).

The differences may be as Collins suggests, but Keatinge's conclusions depend on certain assumptions that cannot be taken for granted: that all owners of central heating can afford to use it and that those at greatest risk have acquired central heating (Raw and Hamilton, 1995). In addition, if its ownership by vulnerable groups has increased, has it been at a similar rate to the rest of the population?

The Eurowinter Study (*see* 2.3.2), with which Keatinge was also involved, addresses the issues raised by Collins of outdoor clothing and, to a certain extent, behaviour. In each European region studied, interviews were carried out including questions on hours of bedroom and living room heating, the length and number of outdoor excursions, clothing items worn and physical activity during the excursions. It was concluded that there was a greater percentage increase in all-cause and respiratory disease mortality with fall in temperature and that protective measures were fewer, against a given degree of cold, in regions with mild winters. Evidence was found that linked mortality with home heating and with outdoor cold stress, independently of each other, so that *"results imply adverse effects of both outdoor and indoor cold on mortality"*. The authors go on to recommend that, in relatively warm countries, where effects are apparently more severe:

> *"steps to promote...personal measures, and such public measures as windproofing of bus shelters, offer ways to reduce outdoor cold stress"* (Eurowinter Group, 1997).

In other publications Keatinge acknowledges the likely contribution to health of indoor heating (Donaldson and Keatinge, 1997), or gives equal weight to the influence of outdoor and indoor temperatures (Keatinge and Donaldson, 2000). However, he continues to emphasise the dangers of standing at unprotected bus stops and outdoor exposure on the assumption that in recent years so much has been done to improve home temperatures (Keatinge and Donaldson, 2001). Again, the evidence of, for example, the EHCS does not support the notion that such improvements have occurred equally for all vulnerable groups as for the whole population.

3.4.5 Excess winter mortality and fuel poverty

Two pieces of recently published epidemiological research are now described, because, exceptionally, they specifically investigate excess winter mortality together with aspects of housing and income that can therefore be related to fuel poverty. They both also appear to throw some further light on the indoor and outdoor temperature debate.

One study (Wilkinson *et al.*, 2001) consists of an analysis of deaths from cardiovascular disease in England, from 1986 to 1996, linked by residential postcode to data from the 1991 English House Condition Survey for about 21,000 dwellings. Relationships were sought between excess winter mortality and socio-economic status, dwelling characteristics (relating to thermal efficiency and heating) and indoor temperature and its determinants. Characteristics for individual dwellings surveyed in the EHCS were taken as representative of corresponding postcode areas (which typically include about 14 dwellings). Since the EHCS measured temperatures in only a sample of surveyed dwellings, for this study homes were classified by *predicted* indoor (hall) temperatures, depending on the dwelling and socio-economic circumstances, and 'corrected' to standard conditions (*i.e.* time of day, previous hours of heating and outdoor temperature). The 25% coldest homes were observed to have about 20% greater associated risk of excess winter death for residents than the 25% warmest. The authors state that,

> *"although not conclusive, (the) findings suggest that indoor temperature and markers of thermal efficiency of dwellings, including property age, are associated with increased vulnerability to winter death from cardiovascular disease"* (Wilkinson *et al.*, 2001, p.23).

This work was based on the 1991 EHCS, which, as mentioned in Chapter 2 (2.4.1), was carried out in a particularly mild winter. The researchers acknowledge that the extent of cold homes during low outdoor temperatures is possibly underestimated as a result (Wilkinson *et al.*, 2001, p20). The influence of home heating on mortality may therefore have been correspondingly underestimated. They also recognise that there are dangers in selecting one dwelling's characteristics as representative of a postcode area, but claim that any resulting misclassification would tend to have diluted rather than strengthened the found associations. Apparent anomalies in the lack of association between increased winter excess mortality and some individual determinants of low indoor temperature are attributed to the complex interrelationships between poverty, home temperature and mortality. For example, it was found that low socio-economic status was not strongly related to seasonal excess deaths, unless it was combined with the cost of home heating. It was suggested that this was partly because many housing association and local authority homes are more recently built (therefore more energy efficient) and centrally heated. In these cases, as long as heating costs were not high, low-income households could afford them. The fact that the seasonal fluctuation of daily deaths was

> *"considerably larger in homes that were expensive to heat compared with those that were inexpensive to heat"* (Wilkinson *et al.*, 2001, p viii)

is evidently significant with regard to fuel poverty. Association of excess winter death with lack of central heating was found to be small and statistically insignificant and with dampness it was unclear. The strongest association was seen with building age, although adjustment for this did not affect the strength of association with low indoor temperature (Wilkinson *et al.*, 2001, p6).

The findings concentrate on cardiovascular disease because it was said to show the strongest relationship to ambient temperatures. In contrast, there was no clear association for respiratory disease, but the sample size was only a quarter of the numbers for cardiovascular disease (Wilkinson *et al.*, 2001, p19). The analysis relies on a number of predicted elements, based on several assumptions, which is in the nature of calculating the variable behaviour of buildings and their occupants. Several apparent inconsistencies in the findings are explained on the basis of supposition rather than evidence. However, the authors claim that this study provides the first direct evidence of links between poor housing quality in Britain and the large winter excess of deaths from cardiovascular disease. They highlight the potential public health benefits of interventions to improve the energy efficiency of cold housing, although they point out that the scale of these benefits is yet to be established.

Aylin *et al.* (2001) looked at excess winter mortality over the same period (1986 – 1996) and also drew on the EHCS for heating-related indicators of housing. This study, however, was pursued at the wider spatial level of the electoral ward and examined relationships with different meteorological variables, both census-derived and selected EHCS housing variables, and deprivation. There was little agreement found between area level census variables and individual level EHCS variables, but this could be because only one or two households are surveyed in the EHCS per ward of about 2500 households. Urban wards, in particular, encompass a varied mix of social and housing conditions, which are unlikely to be represented by one house type (Aylin *et al.*, 2001). Those variables that did show a significant association were used together with others common to both surveys, in particular, the lack of central heating in households with one or more residents of pensionable age. Deprivation was compared by use of the Carstairs score[11], which is based on non-housing census variables.

The findings confirmed a strong inverse association of excess winter mortality with outdoor temperature, and established a significant association with lack of central heating. Respiratory deaths showed a higher association with temperature variables than all cause mortality. The amount of rain and wind were both inversely associated with excess winter deaths. The authors surmised that when it was raining or windy people were less likely to go outside and suffer cold exposure. However, there was only 'modest correlation' (notably positive) between temperature variables, rain and wind, implying that these interrelationships may be more complicated. There was no discussion of 'wind-chill' (the cooling effect of wind in relation to temperature), or wind direction, both of which, together with rain, affect the insulating qualities of buildings, as argued by Markus (1993, p156). These would therefore have implications for indoor temperatures. Indeed, as Collins points out,

> *"with regard to the effects of seasonal lower winter temperatures on respiratory disease it is outside temperatures that are measured and these do not usually distinguish between day and night, sudden changes, wind chill, humidity or atmospheric pollution"* (Collins, 2000, p47).

The annual average number of excess winter deaths for the period was calculated by Aylin *et al.* as 30,000 (excluding 1989/90 because of an influenza epidemic), but for 1995/6 the number was more than 40,000. The previously identified downward trend for excess winter deaths over time (claimed to be associated with the growth of central heating, as discussed in 3.4.2) does not therefore appear to be continuing. The deprivation score showed no association with excess winter mortality either for all causes or coronary heart disease and only a slight relationship with respiratory mortality. It was concluded that this score only partly reflects housing quality.

This study produces less new evidence relevant for fuel poverty and health than the other, but rather confirms the relationship of excess winter mortality with outdoor temperature, which was already known, and the fact that it continues to be an important public health problem in the UK. The authors suggest that the presence of central heating in the UK could be taken as a proxy for 'the maintenance of warmth in houses'. Yet they also recognise that, since some low-income households may not use it for reasons of cost, the relationship shown between lack of central heating and higher excess winter mortality could have been diluted (Aylin *et al.*, 2001, p1106).

[11] *see* 5.3.1 for discussion of deprivation scores

They do not mention the relatively small percentage of homes that still do not have central heating compared with those that do, which could also undermine the strength of any association found. In respect of possible interventions to increase central heating ownership, it is suggested that its use should also therefore be affordable in order to impact on health for poorer households. Aylin *et al.* (2001) found that associations with the meteorological variables were stronger for respiratory mortality than mortality due to all causes, coronary heart disease or stroke. On the other hand, Wilkinson *et al.* concluded that cardiovascular disease was more clearly related to temperature. The reason for this ostensible difference in their findings is not apparent. Wilkinson *et al.* found that lack of central heating was a determinant of low indoor temperature, since dwellings without were two degrees cooler than those with central heating (Wilkinson *et al.*, 2001, p10). Taken together with the strong association between excess winter mortality and lack of central heating found by Aylin *et al.*, this tends to support the view that indoor temperatures play a key role in winter deaths, particularly from respiratory disease.

The EHCS is used in these two research studies because there are otherwise no nationally available predictors of housing quality, particularly with reference to thermal conditions. Unfortunately, it is proposed that future House Condition Surveys will not include temperature measurements, which will further restrict an already limited source of data on national thermal characteristics of the housing stock.

Both of these studies are subject to the 'ecological fallacy', which is often in the nature of epidemiological investigations. This is where relationships observed between areas are assumed to apply equally to individuals within those areas (Bardsley *et al.*, 1998). As noted by Bardsley and Morgan (1996, p9),

> *"The observed rate for a ward is a measure of the health of the people living there and does not infer* (sic) *that the area itself in some way produces poorer health in its residents".*

This was also a criticism levelled at the Eurowinter study design in some published responses to the paper. For example:

> *"No causality or temporality can be inferred and there is no way to know whether those who died are those with greater exposure"* (Sperber and Weitzman, 1997).

These commentators argued that such research is useful for generating hypotheses, but that they then need to be confirmed through additional studies using different epidemiological methods.

3.5 Health effects of cold homes: researching individual aetiology

The differences between observational and experimental studies may be illustrated by consideration of intervention studies in the realm of research into individual risk factors in contrast with population studies. The following work described also highlights some of the experimental problems in this kind of research, which potentially influence the choice to opt more often for an epidemiological approach in this field. The conventional pattern of biomedical empirical research employs the randomised controlled trial, which presents both practical and ethical problems in the area of housing interventions that might improve conditions for health of the occupants. It is impossible to improve warmth in housing without the resident being aware of it in order that results might be viewed as completely evidence-based. At the same time, it is often regarded as unethical to select participants as a control group who would not receive the intervention to improve their deficient housing, whether or not it would prove to benefit their health. This has restricted the extent and design of research in the past, which has frequently consisted of small interventionist studies, without control groups or randomised selection. Indeed, as it was commented in the Acheson Report,

> *"the more a potential intervention relates to the wider determinants of inequalities in health...the less the possibility of using the methodology of a controlled trial to evaluate it"* (Acheson, 1998, p29).

Sometimes funding for interventions is obtained at short notice with a short-term deadline and precludes obtaining additional resources for evaluation. In the case of the Cornwall Housing Intervention Study, this led to opportunistic sampling for a virtually impromptu piece of research and limited the size and, therefore, the power of the study (Mackenzie and Somerville, 2000).

The Cornwall study illustrates many of the problems met by researchers in demonstrating links between housing interventions and health outcomes. Yet it also constitutes a successful example of partnership working between a health authority and a local authority housing department. This research was designed as a 'before and after', or longitudinal, study of a single group of subjects. The objective was to reduce damp in the homes of children with asthma, in an area where there is a high proportion of damp housing and asthma is a local health priority, and was proposed on the basis of plausible evidence of an association between these two factors (Mackenzie and Somerville, 2000, p157). Despite this plausibility, no intervention studies had previously been published on the potential of reducing asthma-related morbidity by reducing dampness and mould in the home. Fuel poverty was not specifically defined in this study, but was indicated by the combination of damp, energy inefficient housing and local authority tenure, implying low-income households.

The main intervention carried out to 98 selected households was the installation of central heating, which significantly improved the energy efficiency rating in most homes and improved conditions in many initially unheated and damp bedrooms of the asthmatic subjects. Following the intervention, there was a significant reduction of respiratory symptoms and lost schooldays due to asthma. There were also fewer contacts with health services, which allowed calculation that *"savings to the NHS exceeded the annual equivalent cost of the housing improvement"* (Mackenzie and Somerville, 2000, p161). As this was a longitudinal study, there was some difficulty in keeping track of all the subjects. Characteristically of council house tenants with young families, they tended to be a mobile population. There were further problems in obtaining permission from some families to use medical data. The study authors recognised the need to be cautious in interpreting results because, without a control group and with limited resources for evaluation, several confounding variables could not be properly assessed.

The research design of the Watcombe Housing Project (Somerville *et al.*, 2002) resulted from the experience and shortcomings (in terms of conventional medical research) of the Cornwall study, which was regarded by its authors as a pilot study. It has been carried out on an estate in Torquay, South Devon, and attempts to solve the ethical problem associated with randomising allocation of housing improvements to residents of poor housing. In doing so, it is claimed to be the first research to have involved randomised upgrade of housing. The objective was to examine the extent to which upgrading houses impacts on indoor environment, particularly respiratory health and well-being of residents. Improvements to 127 local authority properties were extensive, including central heating installation, ventilation, fabric upgrading and insulation. Changes in heating costs and energy efficiency were monitored, but it is not clear whether fuel poverty has been defined in the government's terms by linking this data with income levels. Potential cost savings to the NHS from such housing interventions were also considered, as measured by prescription drugs use and primary and secondary care contacts. A control group was achieved by designing a stepped wedge study to run over two years. Using a random selection process, half the participants were to receive the interventions in the first year and the remainder in the second year. The second group acted as the control group during the first period. It would obviously not be possible to eliminate confounding due to any psychological effects of varying delays to receipt of housing improvements.

This is another example of a partnership project, where both the Council and the Health Authority required a health evaluation. Further collaboration was involved with, among others, a university department and also, significantly, resident groups. The co-operation of the local authority was crucial to allow randomisation of the building work and of the residents for detailed health questionnaire and survey data. The second phase building improvements were completed in 2000 and the third round of follow-up surveys should have been completed in 2001, but results from these are not yet published. The project authors acknowledged that they did not know how long it would take for any health benefits to manifest themselves. They also accept that some aspects of rigorous methodology were sacrificed in order to obtain good data and maintain the optimal response from residents (Somerville *et al.*, 2002).

The disadvantage of cross-sectional studies is that the populations within different groups need to be carefully matched. Longitudinal studies, on the other hand, present their own difficulties in ensuring stability of the population, and their circumstances, for true comparison of conditions before and after an intervention. This study combines the features of both types: there was a control group for the first intervention group, while a 'before and after' review of each group was possible because surveys were carried out in between the two sets of interventions, as well as at the beginning and end of the project.

In general, the tendency remains for housing intervention and health studies to be small scale, although the government have now commissioned some multi-disciplinary (rather than medical-led) research on the health effects of installation of energy efficiency improvements through the so-called 'Warm Front' grants. (Qualification for these is possible through benefit receipt or age over 60.) This is anticipated to be a very large project using a longitudinal study, but the achievability of the objectives remains to be seen in view of the numerous confounding variables and logistical difficulties in co-ordinating before and after monitoring. Thomson *et al.* (2001), on the other hand, argue that there is limited potential for generalisation from small-scale studies.

3.6 Health effects of cold homes: the social policy research approach

A recent portfolio of work by Ambrose and others illustrates research in the social policy tradition (Ambrose, 1996; Ambrose *et al.*, 1996; Ambrose, 2000b), looking at the health gain of improved housing in the Single Regeneration Budget (SRB) area of Central Stepney. It does not specifically measure health gains for the fuel poor by defining residents in that category, but reports the multiple benefits of upgrading social housing that had long been neglected. These benefits range from the lower incidence of cold and damp, to reduced fear of crime, greater participation in the community and increased school attendance. Approximately 100 households were interviewed on several occasions during winter of 1996, before the regeneration process, and 70 of these households, who remained in the area, were interviewed again in winter four years later. Some had been rehoused into better accommodation, while others had their existing housing improved. Local service providers were also surveyed and a smaller comparator household survey was carried out in 1996 in an area of improved housing in Paddington. In this project there was great emphasis placed on recording the respondents' own definition of ill-health and symptoms, partly to avoid what might have been "culturally inappropriate" evaluation methods (Ambrose, 2000b, p17). Health effects were assessed through incidence of self-reported 'illness episodes', defined by groups of symptoms. These were further characterised by their length, in terms of 'illness days', and whether they resulted in GP or hospital visits, time off work or school, prescriptions or purchase of medicines.

The 'before' study (Ambrose, 1996) cited many instances of people who were unable to afford or achieve sufficient heating in their homes: 69% of households said that the heating was insufficient to keep everyone warm and 23% of these gave as the reason that they were unable to afford it. Almost 16% used cookers sometimes to help keep their homes warm, an expensive option, while 85% of those who suffered cold also had some damp. It was found that damp, cold and the degree of overcrowding in homes made a significant difference to the residents' perceptions of how closely ill-health was related to housing conditions (Ambrose, 1996, p52). Damp and cold also correlated highly significantly to the average rate of incidence of both illness episodes and illness days. The comparator group in Paddington was not regarded as a fully valid 'control group', being a smaller sample, interviewed in a different season, and not matched for some variables such as ethnicity. However, the findings were reported because of the dramatically lower incidence of illness and higher levels of satisfaction with the housing in Paddington, where the residents had been rehoused from poor conditions. The reasons were concluded as having much to do with residents' involvement in the improvement process and resulting 'empowerment' (Ambrose, 1996, p45).

Ambrose (2000b) showed that, following the SRB process in Stepney, the housing conditions 'likely to affect health' had been much improved and levels of satisfaction with the new housing and the improved estates were high. Overcrowding, damp and cold conditions had all been reduced, although about one third of the overall population were still affected by damp and cold. Evidently, the issue of fuel poverty had not therefore been effectively or fully addressed as part of the regeneration process. The second sample was smaller, but its population characteristics, such as benefit dependence, remained similar to the earlier sample. The 'after' household survey revealed *"... a clear improvement in health standards"* (Ambrose, 2000b, p34). Despite an increased incidence of illness episodes, their average length was shorter and fewer resulted in visits to the GP or in taking medication. The rate of illness days was, consequently, reduced by a factor of seven. It was recognised that a number of factors other than the housing improvements were likely to have contributed to the more positive health outcome. These included the reduced fear of crime and an apparent strengthening of social networks and area identification.

This research illustrates some difficulties of longitudinal studies, which tend to be expensive and labour intensive. Because of the in-depth nature of the interviewing needed to gain sufficient levels of information, the original study was restricted to only 107 households. The initial relatively small sample was then substantially reduced over the intervening four years, since some people had rehoused themselves and moved out of the area. This affected the significance of the before and after comparisons, as the research team acknowledge (Ambrose, 2000b). The method of health assessment allowed a time-standardised comparison over the two interview periods using illness episodes per person per day. It was developed specifically for this study, however, and is not therefore comparable with other similar research, a common problem in this field. This is where a standardised tool like the SF-36 might come into its own. However, it would probably have less relevance for the objectives sought in this study because would not identify specific cold-related symptoms that might be associated with particular housing conditions.

Self-reporting was chosen deliberately as an assessment of how the residents were *feeling*, so that all conditions defined by residents as 'symptoms' were accepted, including everything from major diseases such as asthma, diabetes and cancer, to coughs and colds, aches and pains, or stress and depression. They were weighted by their given order of significance where more than one symptom was cited for any illness episode. It is obviously difficult to disentangle the perceived effect of the housing conditions on health from the reported illness episodes. Nevertheless, whether the symptoms were simply perceived or were clinically diagnosed, they could cause the residents to make use of the health services or medication, or take time off work. The effect of the housing conditions on their lives as they saw it was tangible and measurable in the terms of the study and the nature of the recorded health improvements indicated that costs to health services were reduced following the housing interventions and regeneration activity.

Thomson *et al.*, (2001) included this piece of research in their review of housing intervention studies that measured health effects (as described earlier), which was published in the British Medical Journal. The studies reviewed are generally criticised for their small sample size, methodological limitations and the impossibility of pinpointing the *"nature and size of health gain that may result from a specific housing improvement"* (Thomson *et al.*, 2001). The implication appears to be that the use of self-reporting for physical and mental health, symptoms and use of health services is not sufficiently rigorous. The authors make the point that housing interventions rarely occur in isolation, since poor housing conditions are often accompanied by other forms of deprivation and that this can contribute to a confounding of before and after comparisons. Nevertheless, the Stepney study is an example of the social policy approach where the multi-factorial nature of housing effects on health is accepted by the research team at the outset and, in their report, it is stated that

> *"..it is futile to look for simple 'cause/effect' relationships or to seek 'health gain' as an outcome of housing improvement alone"* (Ambrose, 1996, p13).

Where housing is improved, there would indeed be little advantage to residents or landlords in partial improvement, even if restricted only to measures that are expected to produce a health gain. As Strachan acknowledged, the reasons for improving housing conditions include more than health benefits alone (Strachan, 1993). Furthermore, as was found in Stepney, dampness and cold frequently occur together, so that it is difficult to attribute health gain to remedying one condition without the other and, arguably, it would be unethical to attempt it. As could be seen from the previous sections, it is in medical-directed research that there is far greater stress on trying to isolate causal links although, according to Thomson *et al.*, (2001), none have yet successfully achieved this.

3.7 Health effects of cold homes: energy efficiency related research

The research described so far ranges between social policy and medical studies of temperature and mortality, dampness and morbidity and the effects of general building upgrades on health. The applicability of such research explicitly to the relationship between *fuel poverty* and health varies according to the account taken of income status and specific energy efficiency aspects of housing. The Watcombe project (Somerville *et al.*, 2002) has certainly addressed health outcomes of a combination of energy efficiency measures but, in advance of published results, it is not known how much detail was included of income status and affordability of energy bills. As one literature review has noted, where fuel poverty and health is researched, the independent variable generally used is 'cold homes' or 'damp and/or mould' rather than 'households needing to spend 10% or more of income on fuel' (Baker, 2001).

This section largely concentrates on buildings related research. Professionals working with housing, rather than health, would generally not be concerned with addressing the health effect of cold temperatures, but with the conditions of housing or aspects of housing occupation that lead to cold temperatures and the technology of energy efficiency. Some, however, have crossed the traditional boundaries of professional demarcation and taken a wider point of view, because of their interest in the fuel poverty issue. Their efforts have led to increasing awareness, in the housing field, of connections between cold housing and health so that links are now being made with medical and epidemiological research. In some cases multi-disciplinary teams are beginning to jointly approach this as a research area.

3.7.1 Definition of warmth for health

According to Boardman, awareness of the connections between poverty, cold homes and health problems was evident in the medical press in the 1960's and earlier, having developed in response to increasing reports of hypothermia. It was then recognised that, during severe winters, old people often faced a choice between spending on food or fuel, a choice that indicates conditions of fuel poverty (Boardman, 1991, p17). In 1979, in the architectural press, Markus drew attention to these links and to the elderly as the most vulnerable, quoting an earlier report by the National Consumer Council ('Paying for fuel' London HMSO, 1976):

> *"Data on age, sickness, weather, hospital admissions and house temperatures confirm that it is predominantly the low income old and elderly who show the highest correlations"* (Markus, 1979).

Hunt (1997) argues that:

> *"it is not easy to establish minimum temperatures below which risks to health arise, because of ethical barriers to experimentation".*

The ethical issue has been raised earlier. She also points out that the World Health Organisation, despite making recommendations for minimum air temperatures for vulnerable groups (at 20°C) in 1987, had

> *"reached no conclusion about the average indoor temperature necessary to maintain health in the general population"* (Hunt, 1997, p165).

Nevertheless, Boardman (1991, p125) has examined a range of evidence to determine the temperature levels required to ensure both good health and comfort and, in addition, to avoid condensation and mould growth. This is indicative of her pragmatic approach to seeking a definition of 'warmth' required in dwellings, using available evidence from various disciplines, recognising the multi-factorial relationship between buildings and occupants, and making necessary assumptions.

Howieson (1991, p67) similarly describes a desirable standard of what he terms '*thermal safety*' for buildings, suggesting 16°C as a 24-hour whole house average temperature, compared with 18°C as recommended by Boardman. He proposes this as a standard to be sought for the whole British housing stock, and which the poorest section of the population should be able to achieve, so that internal temperatures are kept above the minimum to avoid cardiovascular stress (in line with the thresholds shown in Fig. 3-2).

The Energy Report of the 1991 EHCS subsequently made links between poorly heated housing and health, acknowledging that

> *"cold homes represent the primary health risk in buildings, contributing to the proportion of some 20,000 excess winter deaths each year"* (DETR, 1996).

In the following EHCS, five years on, the incidence of self-assessed ill health was reported in the light of measured indoor temperatures, accepting the lower minimum threshold to safeguard health as 16°C. In over 4% of households where the living room temperature was below 16°C, at least one household member suffered from respiratory problems (DETR, 2000, p153). It was found that there was a clear positive relationship between poor home energy ratings and people reporting a range of health problems in the previous 12 months. This was particularly so for households with no fixed heating, which are typically rated the lowest (DETR, 2000, p77).

The Report made it clear that simple causal links could not be shown but that it was a matter of concern that so many people with health problems were exposed to cold housing, whether it was a causal factor or not. Apart from more general complaints, specific conditions reported included chest and rheumatic conditions, angina, high blood pressure and eczema. It was noted that the proportion of households reporting respiratory problems was far greater in households where the living room temperature was between 18°C and 21°C, which would not be regarded as a health threat, than where it fell below the minimum desirable for health. It was thought that this could be because people ran their homes at higher temperatures precisely because of health reasons. Alternatively, some of the conditions, such as asthma, appeared to be associated with modern heating systems (DETR, 2000, p153). So although the links between cold housing and health are being recognised in the housing field, there are problems with interpreting results from findings like these, because of the inevitable range of confounding factors. It remains difficult to identify the specific diseases resulting from cold homes and to quantify their effects on health, as mentioned earlier.

3.7.2 Energy efficiency measures and health

It should be recognised that building solutions for increasing the energy efficiency of existing dwellings are not a problem in respect of technological knowledge[12], although some construction types present more complications than others. There are some provisos to be made, however, when it comes to achieving health-promoting indoor conditions. As the EHCS Report noted, modern heating systems might actually contribute to some aspects of ill health. Indoor air quality can be affected where the drive for energy efficiency demands that buildings are made

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[12] *see*, for example, Energy Efficiency Best Practice in Housing Programme publications by BRECSU, BRE .

increasingly air-tight, although some research suggests that the problem may be more to do with the strength of the pollution source rather than the 'tightness' of the house (Bell *et al.*, 1994, p40). There is a large area of ongoing research into the health implications of indoor air quality as affected by, for example, the enormous range of modern construction materials and surface finishes, but this is beyond the focus of discussion here.

Reduced ventilation rates can also affect humidity, increasing the risk of condensation, and therefore mould growth, although current Building Regulations stipulate minimum ventilation requirements for that reason. Poor ventilation combined with warm temperatures can also encourage conditions for house dust mite proliferation, which appears to affect asthma sufferers. Accordingly, Howieson *et al.* (2000, p63) suggest that heat recovery extract fans could assist in striking the balance between sufficient ventilation and minimal heat loss, which is necessary to achieve healthy conditions. However, for research purposes, allowance should be made for these conflicting factors when measuring health outcomes of energy efficiency improvements.

The effectiveness of energy efficiency measures cannot be fully predicted without taking into account behavioural factors that, according to research evidence, can be as influential on energy consumption as physical factors (Bell *et al.*, 1994, p42). As an example, minimum ventilation opportunities may be provided in a building, but if they are perceived as wasteful of heat where fuel is ill afforded, the householder may decide to block them up. On the other hand, as described in Chapter 4, if the occupier regards 'fresh air' as desirable, they might ventilate the building excessively, so that it is colder than the minimum for health, or else it costs far more than necessary to heat effectively.

Green *et al.* (2000) carried out a retrospective study of energy efficiency improvements to four Sheffield tower blocks, with recognition of variations in residents' heating behaviour. The basic premise was to examine the possibilities of achieving buildings that would be 'tolerant' of occupant lifestyles, from the original 'unforgiving' 1950's - 1960's tower block construction that was prone to cold surfaces and condensation. Differences in lifestyle were anticipated as variations in levels of fuel consumption or levels of moisture production. The study was cross-sectional in design, comparing improved with unimproved blocks of similar age, construction, heating system and initial energy efficiency ratings[13]. Health status was measured by self-reported assessment, using the SF-36 survey instrument. Building surveyors assessed the occurrence of damp and mould, while residents took spot temperatures over a two-week period.

[13] *see* 5.3.2 for explanation of energy ratings

These were recorded in a diary, together with notes on levels of moisture-generating domestic activity. Fuel consumption was estimated from utility information and Council data on district heating use, incorporating a number of assumptions.

The blocks were located in the same part of Sheffield and the surveys were carried out in the same winter period to control against climatic variation. Further potential confounding was allowed for by eliminating differences in building and population characteristics, as far as possible. It was attempted to match households for age and socio-economic profile in both improved and unimproved blocks. Although most characteristics were matched including income, in the event employment status was not. It was suggested that the 'healthy worker' effect was not therefore controlled for in the comparison of health status (Green *et al.*, 2000, p101).

The conclusions from this study were that buildings 'tolerant' of a range of lifestyles were produced from the package of energy efficiency measures used for the tower blocks, as evident from improved temperatures and heating costs and elimination of damp and mould. Residents in this study again proved the point that, where efficiency is improved, the benefit is taken preferentially in the form of increased comfort and higher temperatures, rather than as reduced fuel consumption (*see* 2.2.8). Nevertheless, although objective measurements showed that comfort and warmth had been enhanced, the research team was less confident that the apparently better health in the refurbished properties could be confidently attributed to the building improvements. This was largely because it was a comparative study of two populations, rather than one to compare the same population longitudinally. In addition, as a retrospective study, no baseline health status survey was done and there could have been underlying differences that were not taken into account, such as smoking habit. There remains uncertainty about potentially long-term beneficial effects on health, which would not be evident in the study time period.

For all the dimensions of the SF-36 survey, the improved blocks produced higher mean scores, appearing to indicate better health for them. However, the results were only significant for two of the scores, with no obvious explanation, and the General Health Perception score was almost the same for both groups. On the other hand, for most of the SF-36 dimensions, the mean scores were higher in the improved block than the Sheffield city average, whereas the unimproved block scores were lower. (It is not stated whether these differences were significant.) Both study populations had incomes far lower than the city average. It was assumed that the other major positive difference between the population with the higher health status and the average city population was the *"excellent condition of their homes"* (Green *et al.*, 2000, p102). However, this assumption was not apparently based on statistical analysis of comparable data.

The Sheffield study serves to illustrate, yet again, the difficulties of identifying and disentangling confounding variables when attempting housing and health research. It highlights the many points that need to be controlled for, but also that there could be others less obvious, which may not be easily controllable or measurable. As with all such studies where the intervention both improves living conditions and potentially reduces fuel expenditure, it is not possible to calculate the effect of any available extra income. For example, it could be that a healthier diet is afforded, or more could be spent on smoking, either of which could contribute to altered health status. In their systematic review of evidence for health effects of housing interventions, Thomson *et al.* (2001) excluded this project against their criteria for assessing the strength of evidence, because it did not adjust for confounding variables.

The Sheffield research team proposed to carry out further similar work on housing investment and health in Liverpool, but using a longitudinal design for a more powerful study (Green *et al.*, 2000, p103). Some of its members are also part of a much larger multi-disciplinary team currently evaluating the Government's 'Warm Front' scheme of grants for energy efficiency measures, as mentioned earlier (3.5). This project is specifically aimed at discovering the health benefits of dealing with fuel poverty, since the scheme forms part of the Government's Fuel Poverty Strategy. However, the effectiveness of the scheme itself in identifying the fuel poor is debatable. According to one source, where the potential impact of 'Warm Front' has been simulated for a representative sample of English households, only 23% of those eligible for the grant are fuel poor. In addition, the predicted impact on fuel poverty is relatively small, partly because there is no priority given to the least energy efficient homes (Sefton, 2003).

This again raises the problem of a suitable definition for the fuel poor and how to identify or target them for assistance or, indeed, for researching the effect of fuel poverty on their health. If a large-scale study is to be done, on what basis should buildings be matched and how could confounding variables be adjusted for? There are logistical problems in monitoring temperatures and other characteristics before and after improvements, but during similar winter conditions. Close co-ordination with installers of improvements is necessary, but not simple, their priorities generally being different from those of researchers.

The review by Thomson *et al.* (2001) found only four studies meeting their criteria for inclusion that had looked at energy efficiency measures as housing interventions, only one of which had, in their view, adjusted for potential confounding variables. Although many of the studies they reviewed had shown health gains following housing interventions, they concluded that the small study populations or lack of controlling for confounders limited the generalisability of the findings. They emphasised the need for multi-disciplinary research, a certain amount of which was said to be in progress or commencing. However, since much work in this field is done in an *ad hoc* way, or the research element is attached to an intervention already planned for a pre-selected group, it is difficult to envisage any rapid advance towards achieving the 'robust evidence' of housing intervention effects that Thomson *et al.* conclude as being necessary.

In fuel poverty and health research, as this chapter has illustrated, consistency of definition, monitoring techniques and of health status measurement is lacking. There are difficulties in singling out the health effects of cold, or damp and mould, or poor indoor air quality, one from another. Furthermore, how can they be distinguished from incidental side effects of improved levels of income disposition or from longstanding existing conditions? The next section highlights even more confounding elements in the fuel poverty landscape, associated with the underlying fuel poverty risk factor of low income.

3.8 Deprivation and health status

It is recognised in social policy research, in particular, that poor housing conditions are usually accompanied by other forms of deprivation. Fuel poverty itself proves the point, arising from the combination of energy inefficient housing and low income. However, low income has health consequences, whether or not cold housing is involved. A background of poverty can predispose residents of poor housing to disease, because of effects that can last throughout their life course. For example, Bartley *et al.* (1997) point out that

> *"Risk factors for cardiovascular disease in adult life have been found to be linked in varying strengths to both childhood and adulthood socio-economic position."*

It is possible, therefore, that such background effects may help to mask or confuse perceptions of fuel poverty health consequences.

In a Canadian study of over 13,000 children (Dales *et al.*, 1991), where the prevalence of respiratory symptoms was found to be 1.5 times more likely in children in damp homes than those living in dry homes, adjustments were made for smoking in the household, age, gender, heating system and dwelling location. However, Collins points out the weakness of studies that compare the health of participants in different housing conditions, in that those living in cold damp houses may differ in health and socio-economic background from those in drier, warmer homes (Collins, 2000, p41). It is therefore important to consider potential differences when designing or interpreting housing and health research. Hunt reviews housing-related disorders over the past century and clearly describes some of the underlying issues of low income as well as the interconnections with housing:

> *"The persisting links between low income and ill health have led some observers to doubt the role of housing in creating ill health. However, this would seem to beg the question of what it is about low income that makes individuals ill. Part of the answer must surely lie in the inability of disadvantaged individuals to gain access to good quality housing. Moreover, housing conditions may well interact with other factors which are also more common in low-income families, such as unemployment, hazardous occupations and smoking vulnerability"* (Hunt, 1997, p169).

Hunt's point is reinforced by Ambrose *et al.* (1996, p12), who also describe the complexity of inter-relationships between housing quality, health standards and other social indicators, pointing out that the direction of influence is not necessarily one-way. Employment opportunities are partly dependent on health status, housing location and education quality, so that effects may feed back on each other. Elsewhere, they describe the two possible kinds of interaction between housing and health. On the one hand, housing conditions can affect physical and mental health while on the other, health status has its own consequences for housing opportunities (Ambrose *et al.*, 1996, p7).

If deprivation is likely to contribute to the confounding of fuel poverty and health, then how should its health effects be identified, or is it even possible in the midst of such complexity? Poverty is subject to considerable debate among academics and policy analysts, being difficult to both define and to measure. There is a growing disparity of income in Britain, alongside increasing inequalities of health, which helps to fuel the argument around the comparative importance of *relative* as opposed to *absolute* poverty. Wilkinson continually lays emphasis on the health effects of relative poverty, in connection with cultural factors such as social cohesion, as opposed to those of material deprivation.

> *"Part of the association between people's material circumstances and their health appears to be not so much a direct relationship between exposure to unhealthy material circumstances, as a relationship between relative income, or social position, and health."* (Wilkinson, 1999, p256).

He states that absolute income affects health through direct physiological effects of material circumstances, such as diet, damp housing, or inadequate heating. He suggests that relative income, on the other hand, involves inherently social elements in causal processes, producing so-called 'psychosocial' effects. These are explained as the perception of circumstances in relation to others impacting on psychological, emotional and social life and constituting a permanent reminder of one's measure of success or failure in society. Because health inequalities remain despite economic growth in the developed world, he argues that

> *"social, rather than material, factors are now the limiting component in the quality of life in developed societies"* (Wilkinson, 1996, p1).

This argument seems to suggest that the bases of material deprivation are all but eliminated in developed societies and the psychosocial effects of income inequalities are more significant factors for health status, so that less emphasis is required on alleviating absolute poverty. However, economic growth does not benefit all parts of society to an equal extent and income inequalities could be a proxy for other inequalities of opportunity: for example, in education, housing, access to facilities, or the urban environment. These must confound any apparently direct relationships between income disparity and health status.

Indeed, fuel poverty is evidently illustrative of absolute poverty, since its effects are to restrict opportunities to access basic fuel needs and, therefore, minimal warmth and comfort. This alone increases the likelihood of ill health. As demonstrated in Chapter 2, the estimated numbers of households living in fuel poverty (which constitutes material deprivation) are significant in the UK and, therefore, cannot be described as a secondary issue in this developed society. At the same time, fuel poverty can lead to other disadvantages of a social nature. These could be measured in terms of lost schooldays through illness, for example, or unwillingness to entertain friends in a home that is cold and damp, or curtailment of mobility where it is only feasible to keep one room warm in winter. It is possible to envisage potentially psychosocial effects on health from such circumstances, in addition to the direct physiological effects of cold or damp. Fuel poverty is also a reflection of relative poverty in that the poorest are likely to occupy the worst available housing. After all, according to Roberts, *"relative poverty has absolute effects"* (Roberts, 1997).

In relation to the poverty debate, therefore, whether or not health inequalities derive from the fact of relative differences in income, or from differing degrees of access to basic necessities, fuel poverty could be demonstrated to contribute on both scores. It causes multiple disadvantages, with the potential for physiological, social and psychological effects, with varying degrees of quantifiability. Brook's diagram (Fig. 3-2) illustrates one view of the relationship between poverty, fuel poverty and health. It refers to damp rather than cold, and its effects on children and families rather than older people, but it conveys some, if not all, of the complexity of the physical, socio-economic and health links. Fox and Benzeval (1995, p10) argue that a combination of factors is likely to explain the causes of health inequalities, reflecting living and working conditions, resources, social relationships and lifestyles, as the socio-economic model of health acknowledges. In fact, the more the relationships between income, poor housing and health are considered, the more complex and indivisible they appear.

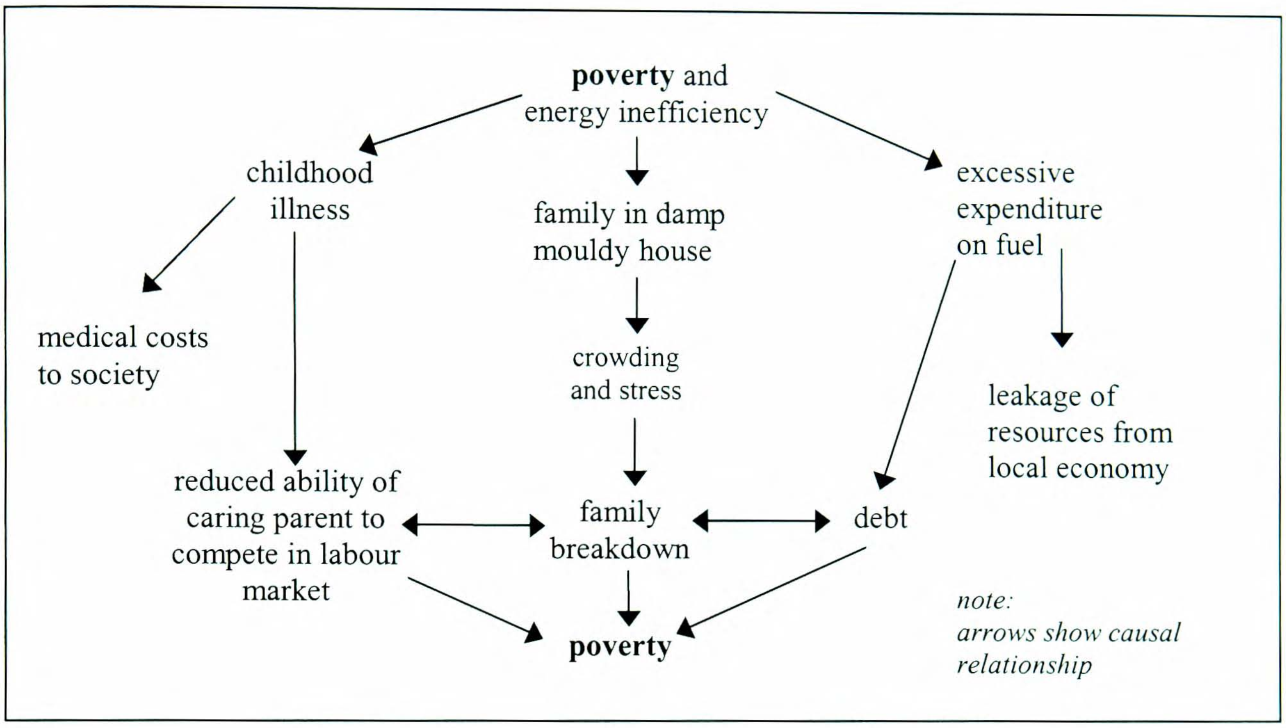

Figure 3-2: The relationship between poverty, energy-inefficiency, health and social effects

Source: Brooke (1994)

It has been shown earlier, for example, that the perception of health and the consequential access to and take-up of health services may be related to income and deprivation, ill health being judged by the sufferer against what seems 'normal'. This potentially adds to confounding when measuring health outcomes resulting from fuel poverty, if poor housing and deprivation are experienced as part of a 'normal' situation for the fuel poor, constantly contributing to poor health. Health perception is therefore representative of both socio-economic and health inequalities as well as having further consequences for health. In such circumstances health status could be both under–reported and exacerbated by lack of appropriate health care.

Attempts to allow for confounding variables raise another problematic aspect of health status assessment. Byrne and Keithley (1993) found that smoking was often perceived as a coping mechanism in conditions of hardship and inadequate housing, in such a way that it becomes *part of* bad housing. It could not therefore be strictly viewed as an unrelated, confounding factor when measuring the effect of housing conditions on health.

> *"Epidemiologists classically treat smoking as a purely individual variable deriving from individual choice. However, if living in particular housing or environmental conditions predisposes people to smoke, their smoking is part of housing.....Statisticians take indicators which may be different aspects of one*

> *structural element and look at their 'separate' contribution...In effect, they are cutting up what might be indivisible"* (Byrne and Keithley, 1993, p49).

They maintain that controlling for smoking, when considering the influence of smoking and bad housing on health, would result in an underestimate of the importance of housing. Other similar factors (such as poor diet or excessive alcohol intake) could also be argued to contribute, cumulatively, to the health effect of poor housing.

Thomson *et al.* point out that, because poor housing conditions are usually only one of several aspects of deprivation, it may be that other interventions will occur alongside housing improvements. Because of this,

> *"the sociodemographics of an area (may be affected, making) before and after comparisons problematic"* (Thomson *et al.*, 2001).

Good response and follow up rates are also frequently difficult to achieve in studies of deprived areas.

Hopton and Hunt (1996) reported on a longitudinal study of the effects of installing improved heating systems in a local authority housing estate. A previous survey had identified widespread problems of dampness, low temperatures and 'hard to heat' dwellings. They found that a number of methodological difficulties arose, in no small way to do with the levels of deprivation. The results were disappointing because no clear health gain was shown from the perceived improvements to warmth and dryness. However, they concluded that improvements to poor housing *"may increase resistance to illness but may not be sufficient to produce health gain.... "*. This, they argued, is because financial difficulties contribute to health and isolated improvements to housing *"are, alone, insufficient to ameliorate symptoms in areas of multiple disadvantage"* (Hopton and Hunt, 1996). In addition, it could be that the single measure of a new heating system would not have sufficiently improved the building conditions, as it was not accompanied by upgraded insulation or ventilation systems.

In this study, some refused the improvement because heating costs were to be included in the rent as a fixed amount after the installation, which implied the removal of residents' control over spending on fuel. Home improvements in rented properties are often coupled with rent increases, which can deter take-up by those on very limited budgets. This potentially affects how representative the population sample can be for associated research projects studying the effects of housing interventions, as it may be that the most needy are those who do not receive improvements, by process of self-selection (Rudge and Winder, 2002).

Both Hunt (1993) and Byrne and Keithley (1993) draw attention to the problems of 'fragmentation' in research of housing and health, as partly exemplified in the previous paragraphs. According to Hunt (1993, p70), technical fragmentation occurs when experts separately study different aspects of a single issue. In the case of dampness and mould in housing, the professions with an interest could include medical specialists in respiratory disease, microbiologists, environmental health officers and architects, but it is rare that they would work together in research projects or even pool their findings. Furthermore, she argues that moral fragmentation is the process of reducing a collective problem, such as damp housing, to the characteristics of individuals, who might be blamed for the dampness and whose respiratory condition might be diagnosed as an 'allergy' without reference to the environmental agent. She relates this back to the medical model, which emphasises individual diagnosis and treatment exclusive of social factors. An alternative approach of identifying 'general susceptibility' is described,

> *"founded on the hypothesis that people may become vulnerable to a variety of ills because of the social and economic strains under which they live"* (Hunt, 1993, p71).

More recently, a number of research studies have been commenced that have taken a multi-disciplinary approach, some of which have already been referred to, so technical fragmentation is perhaps becoming less of a problem. However, despite recognition of the range of socio-economic and environmental factors influencing health status, there would still appear to be an emphasis on seeking direct causal effects of single factors. Although they might seem to be easier to measure, it has to be questioned whether this is done at the expense of acknowledging other factors as part of the same problem, whose significance is therefore underestimated. One government document on tackling health inequalities suggests that most evidence on interventions to address health determinants has been

> *"derived from research directed at changing single risk factors, as these are easier to measure and the causal relationship is much easier to establish"*, but that
>
> *"more complex, multifactorial socio-economic and environmental determinants are much less well researched and the evidence supporting interventions based upon them much less solid"* (DOH, 2002).

Part of the problem is perhaps to do with the credence attached to evidence that is not derived conventionally.

A compilation of current research relating to health and affordable warmth (Rudge and Nicol eds., 2000) shows that no single piece of evidence provides definitive proof of the direct connections between poor housing and health, but the accumulated data tends to corroborate previously gathered argument in favour of the hypothesis. Because of the difficulties in eliminating the effects of confounding factors for research, this seems to be the necessary approach to work in this area – to demonstrate the many apparent associations until the sheer weight of evidence can no longer be disputed.

There has clearly been some success with this approach up to now, in that an increasing number of government documents now refer to the body of evidence showing that health is affected by cold and damp housing. However, there is still some way to go in satisfying those in the field of health service administration who demand the conventional proof of direct cause and effect and this has its repercussions in terms of apportioning the national budget to proven needs. Such demands can also be used as a delaying tactic against providing necessary resources in a climate that requires limits on spending. As Jones *et al.* show in a review of partnership working case studies:

> *"Health authorities in particular may require quantitative evidence on the cost effectiveness of a new approach before they will commit money, or in some cases time. While a number of research projects are in the process of being conducted, it is unclear whether their methodology will be considered sufficiently robust by health professionals"* (Jones *et al.*, 2000, p203).

They emphasised that this uncertainty was prevalent despite the fact that the Department of Health had placed partnership working at the heart of the new Health Bill in 1999. They also noted the continuing tendency for fragmentation of technical expertise:

> *"It was striking ..... how many practitioners and researchers were found to be working in comparative isolation"* (Jones *et al.*, 2000, p206).

It has to be asked whether, in future research, it will be regarded as acceptable to make assessments of health status in terms of 'general susceptibility'? It should be recognised that multiple factors influence the relationships between housing, or fuel poverty, and health and that it may not be possible to account for all potential confounding issues. Absolute and conclusive proof of direct cause and effect may have to give way to a general direction of evidence. Collective deprivational effects, as occur in poor housing, demand that preventive public health measures are broadly targeted. Both can have wider repercussions than single causes or interventions, where the whole is greater than the sum of its parts.

3.9 Summary

In this chapter, the evidence of how fuel poverty and its risk factors affect health has been examined although there has been little research specifically targeting fuel poverty and health. The links between poor housing and health have long been recognised at various levels. Even so, direct evidence is lacking because of the difficulties in controlling for the many confounding variables and earlier political resistance to the recognition of social and environmental determinants of health. In seeking to address increasing health inequalities, however, the government has adopted the socio-economic model of health and acknowledged the fact that fuel poverty contributes to such inequity. It is, accordingly, identified as a public health issue.

The socio-economic model of health distinguishes many layers of variables and their interactions and these help to confound the links sought in researching housing and health. In reviewing existing evidence for relationships, it is attempted to unpick some of the confounding layers of health status determinants. On the other hand, the argument is made that some of the unravelling is not necessarily valid, since it undermines the significance of the whole picture. In research terms, neither is it always possible to separate the layers and interconnecting variables. Nevertheless, they must be recognised for their potential influence on and contribution to results.

In the first place, measurement of health status raises difficulties for this area of research, leading to inconsistencies and poor comparability between studies. Confounding arises from different cultural perceptions and understandings of illness and from questions concerning the acceptability of self-reported health status as evidence, as opposed to 'expert' diagnoses. Further layers of determining factors for health status are the result of life course experiences, which can mask the effects of housing interventions at the time of evaluation. Fuel poverty itself is a result of overlaid risk factors, which may have been experienced over varying lengths of time. Long-term consequences of interventions are difficult to assess without detailed longitudinal studies on stable populations.

The relationship between temperature and excess winter deaths has stimulated the fuel poverty and health debate. In considering environmental effects on health, it is difficult to separate those of cold and damp since one often co-exists with the other. There is biologically plausible evidence of effects of cold alone, as well as of damp and mould, although more work has been done on damp housing. Indoor temperatures are dependent on both external weather conditions and the moderating effect of buildings. Epidemiological studies have contributed to the different viewpoints on the relative effects of indoor and outdoor temperatures to excess winter mortality. It has been suggested that respiratory disease may be more related to indoor temperature and cardiovascular conditions to outdoor temperature, but resolution of this debate is crucial to accepting the importance of the effect of buildings.

Relatively few pieces of work have been completed on the health effects of housing interventions, especially involving energy efficiency packages combining insulation and efficient heating installations. Such studies raise ethical issues concerning who receives interventions and the use of control groups. There may be other implications for the power of studies in relation to eligibility or self-selection of population samples. The interaction of occupants with buildings is another key factor to influence the possible outcome of interventions, since the extent of improved environmental conditions depends on the occupants' priorities, perceptions, lifestyle and level of fuel expenditure.

Social policy led research tends to take a wider view of housing and health than the medical directed approach to single risk factors and their specific effects. It is more likely to pay attention to the background confounding effects of general deprivation, which frequently contributes to the occurrence of fuel poverty in the first place. The underlying factors in fuel poverty risk also contribute to the overall characterisation of community (or aggregate) health – in the terms of Byrne and Keithley (1993). Technical and moral 'fragmentation' in research, as described by Hunt (1993), do not help in establishing cause and effect, or in designing solutions to health-related problems in housing. A multi-disciplinary approach is therefore required to investigate such complex and multi-layered issues, which have implications for the wider community, or for public health. Solutions to fuel poverty do not lie with vulnerable individuals whose own behavioural changes could solve their problems.

Before going on, in Chapter 5, to clarify the research question and a methodology to tackle some of the issues raised here, the next chapter will examine the population group particularly at risk of health effects of fuel poverty, since they will be the focus for the proposed research.

CHAPTER 4 Older people: a population at risk

"In my flat I've got freezing cold feet and my hands are frozen, and I have to sit and watch my television with my hands up my sleeves and I'm frozen.... If I go through to the kitchen, my nose nearly freezes, as if I'm in the 'fridge."

An older person without central heating: (Salvage, 1994, p38).

4.1 Introduction

There are several population groups regularly identified as vulnerable to fuel poverty but, for a multiplicity of reasons, it is a particularly problematic issue for older people, as pointed out in Chapter One. Moreover, the Acheson Report specifically drew attention to this group in relation to health inequalities, recommending that:

> *"... the quality of homes in which older people live (should) be improved – because of dangers of cold housing and accidents, and high heating costs of unmodernised housing"* (Acheson, 1998, p89).

Salvage describes physiological, social and economic factors that place many older people at risk of living in cold housing and render them especially susceptible to its health implications; in fact, placing them in 'double jeopardy' during cold winter months (Salvage, 1992, p19). Wilkinson *et al.* (2001, p19)[14] concluded that their results confirmed older people to be at greatest risk of excess winter death, a risk that, as shown earlier, is related to both low outdoor and low indoor temperatures. At the same time the proportion of older people in the population is increasing, so that health problems relating to this age group are becoming ever more pressing. Apart from humanitarian priorities, the benefits of addressing these problems become ever greater in terms of apportioning national health services resources.

This chapter explores the links between older people, fuel poverty and health and the reasons for focussing on this age group in the research methodology proposed in this thesis. The prospect that some groups of older people are at risk in terms of their housing conditions and income is discussed first. Behavioural issues, which may be influenced by age or generation, are then examined as contributing to the further likelihood that older people may live in cold homes.

[14] *see* 3.4.5

Finally, the potential health problems associated with age itself and low temperatures are summarised, with consideration of the knock-on effects for the NHS.

In all respects, the demographic group over 64 years old includes a cross section of society of more than one generation, representing a correspondingly wide range of age and life experience between extremes of deprivation and privilege, with implications for health and circumstances. It is clear, therefore, that degrees of vulnerability would be similarly variable. Nevertheless, the discussion aims to show that members of this age group may be more likely to be at risk than others because of the potential compounding of relevant risk factors.

4.2 Housing conditions

In Chapter 2, it was shown that the English housing stock suffers a high incidence of low indoor temperatures during cold weather. To reiterate, a significant proportion of dwellings are difficult to heat because of historically low energy efficiency standards and the prevalence of older buildings in the housing stock, which remain poorly insulated, with inefficient heating systems, or in poor condition. There are a number of indications that older people are often likely to occupy such 'hard to heat' dwellings. According to Rahman *et al*:

> *"Older people occupy much of the substandard housing in Britain and the link between ill health and housing is strong for this group. This is particularly important because many older people spend such a lot of time at home"* (Rahman *et al.*, 2001, p66).

The 1996 English House Condition Survey estimated that ¾ million people over 60 years old were living in energy inefficient homes[15], including ¼ million who were over 75 years old (DETR, 2000, p76). Numerically, the majority of these (61%) were in owner-occupied homes. However, when comparing different housing sectors, the private rented sector shows the greatest concentration of older people in energy inefficient homes (*i.e.* 31% of private rented households). Based on a national sample of the general population, the analysis indicated that 35% of the households living in the most energy inefficient homes were elderly and likely to be dependent on heating all day. Within each housing sector, older householders tended to experience poorer standards (DETR, 2000, p68), while single person households and, generally, households with older members were most likely to have the least energy efficient homes. Exacerbating the potential problems still further, it is also found that the poorer they are, the more likely pensioners are to be living in energy inefficient homes, as indicated in Fig. 4-1.

[15] defined as having an energy rating (SAP) of <20, on a scale of 0-100, 100 being the most energy efficient. See Chapter 5 for further discussion of energy ratings.

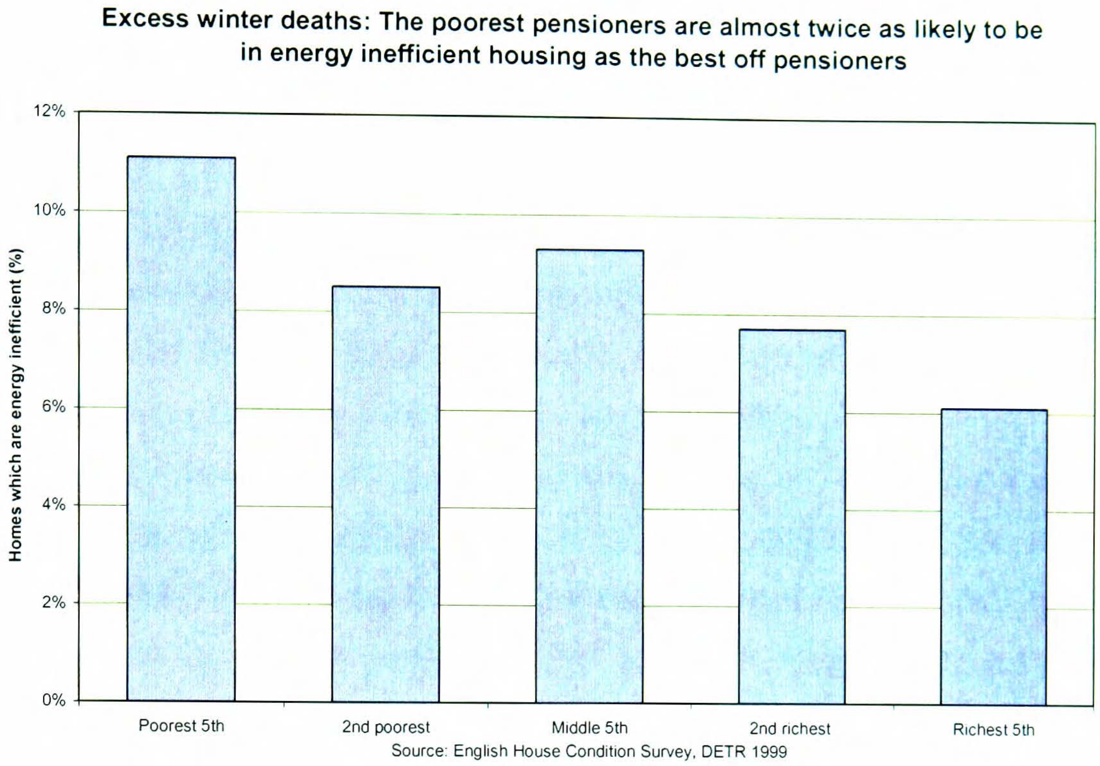

Figure 4–1: Distribution of pensioners by income in energy inefficient homes

Source: 'Monitoring poverty and social exclusion'
(New Policy Institute with Joseph Rowntree Foundation, 2003)

Two national surveys have been carried out specifically concerning the elderly and their home temperatures[16], one in 1972 (Wicks, 1978) and the second by the Age Concern Institute of Gerontology (ACIOG), as a follow up, in 1991 (Salvage, 1993). In 1972, 90% of the survey sample had living room temperatures at or below 20°C[17], whereas the proportion was found to be 85% in the 1991 sample. At the same time, numbers of living rooms found with temperatures of 16°C, or below, reduced from 66% to 37% (Henwood, 1997, p25). In almost a quarter of bedrooms in the 1991 sample the maximum overnight temperature was also less than 16°C. With reference to Table 3-1, it can be seen that rooms below this temperature may present increased health risk. Salvage commented that, despite the small improvements evident over the intervening years between the surveys,

> *"...large proportions of elderly people are still living in homes that, to members of the general population, would be unacceptably cold"* (Salvage, 1993, p119).

In 1996, the EHCS recorded lone older households, aged 60 and over, as having the lowest average hall temperature (17.5°C) and the greatest difference (1.6 °C) between average living room and hall temperatures (DETR, 2000, p152). These findings may be indicative of a tendency

[16] *see* also in 3.4.1
[17] the minimum level recommended for certain groups, including the very old, by the World Health Organization (1987, p19)

to generally heat only the main room, possibly from the wish to economize on fuel, or perhaps of not using central heating, which can provide a more even heat distribution within a dwelling than other heating types (Rudge and Winder, 2002). They would also suggest that such occupants were potentially liable to 'cold stress' because of temperature differences between rooms[18]. Furthermore, the EHCS showed that, when the external temperature was less than 10°C, 36% of households including pensioners in energy inefficient homes[19] experienced living room temperatures below 18°C, while for 15% they fell below 16°C (DETR, 2000, p152). Since this proportion is only given for homes with this specific definition of inefficiency, it is not possible to compare these figures with Salvage's 1991 study. Similarly, no direct comparison of indoor temperatures can be made without details of prevailing external conditions for both studies. However, the EHCS evidence again shows that many homes occupied by pensioners are likely to fall below thresholds of comfort, and even health risk, when outdoor conditions may be relatively mild.

Salvage found that older households in privately rented accommodation were particularly likely to experience low temperatures in their homes, with associated problems of condensation and damp (Henwood, 1997, p26). In general, however, the EHCS shows that mould growth (which is indicative of condensation) occurs more often in larger households or those with children, reflecting typically greater moisture loads than in small, older households (DETR, 2000, p166). It would appear, therefore, that low indoor temperatures present the more likely health risk to older households than that associated with mould growth, when considering effects of fuel poverty.

The extent of cold homes experienced by older households is one indication of numbers likely to be suffering fuel poverty, or lack of affordable warmth, and consequent health risk. There is an increasing trend for elderly people to live alone (Salvage, 1994, p12) and it is also found that lone older households are over-represented as a group among the fuel poor, particularly those in the private rented sector (DETR, 2000, p137). This is in line with the findings regarding household types most likely to experience low temperatures, which tends to support the reasoning that fuel poverty leads to cold homes.

Moreover, in 1996, more than a half of single older households (as compared with over a quarter of all households) were under-occupying relatively large homes and had several spare rooms, while large dwelling size was identified as one of the main determinants of fuel poverty (DETR,

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18 *see* 3.4.1

19 where the SAP (energy efficiency) rating was less than 30

2000). Since older people are often likely to spend most of their time at home, the size of the house that requires heating becomes even more significant. Salvage quotes one interviewee:

> *"Well, I've got an electric fire (in the bedroom) with only one bar working, and I've got an electric fire in the sitting room, so I put the bar on when I get up in the morning and leave all the doors open so any warm air...it can all circulate. But if you're sitting around too much .... the trouble is that a terrible lot of people in our age group are doing just that – sitting around"* (Salvage, 1994, p38).

Although the EHCS report claimed that, in most cases, the provision of efficient heating and insulation measures would prove sufficient remedy to fuel poverty, it suggested that under-occupation of very large properties and/or very low incomes, would cause the exceptions (DETR, 2000, p131). So, not only is under-occupancy an aggravating factor, but it also makes fuel poverty more difficult to deal with. Health advice frequently given to those struggling with fuel costs and cold in winter is to keep just one room warm, but this does not take account of potential thermal stress experienced in moving about the home. In a more recent analysis, Houghton and Bown (2003, p15) argue that under-occupancy, rather than being a prime *cause* of fuel poverty, simply presents an additional *risk*. They point out that fuel poor under-occupying householders are primarily single householders over 60, couples who are over 60 or single adults under 60. The study provides evidence to suggest that under-occupancy is likely to exacerbate health risks such as hypothermia and cold stress (Houghton and Bown, 2003, p2), which implies that the issue is particularly pertinent to the situation of older people.

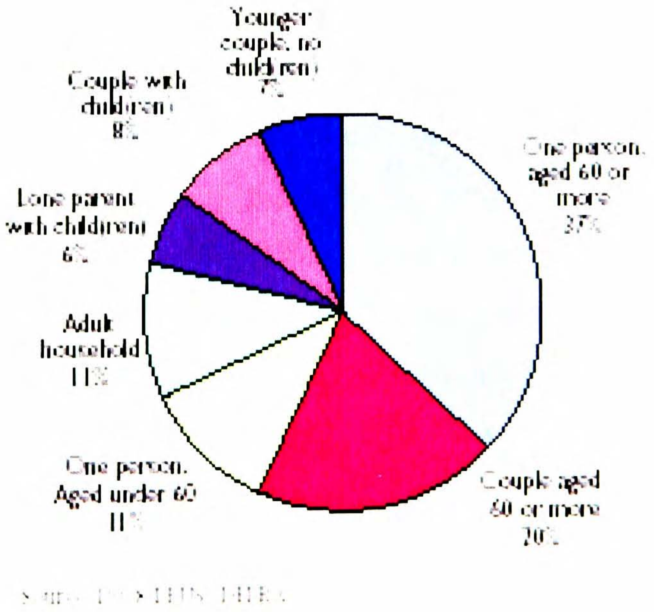

Figure 4-2: Percentage in fuel poverty by household type, England 1998

Source: The UK Fuel Poverty Strategy (DEFRA/DTI, 2001, p34)

Fig. 4-2 illustrates the likelihood that older households, as opposed to others, are to constitute a high proportion of those in fuel poverty. The 1996 EHCS identified nearly 37% of all the fuel poor as lone older households, which, together with elderly couples, accounted for a half of the total (DETR, 2000, p136). (In this case, 'older' was defined as over the age of 60 and the fuel poverty definition was based on total income.) Furthermore, using the income definition that excludes housing benefit and ISMI, more than 60% of the half million households that included someone over the age of 85 years were fuel poor and 12% were severely fuel poor (DETR, 2000, p137).

4.3 Economic factors

The ACIOG 1991 study found that the elderly people who had the lowest incomes and found the greatest difficulty in paying fuel bills were those who had the lowest room temperatures recorded in the survey (Salvage, 1993). This reinforces the picture of fuel poverty among older households and the link with low income. The EHCS includes questions on satisfaction with heating for the Energy Report, and analyses the reasons given for negative responses. Most complaints from older households in 1996 were related to the cost and, of these, around 5% said they could not afford to use heating (DETR, 2000, p178).

As Salvage indicates, some research has drawn attention to the fact that, as a group, elderly people are far more likely to cut down on heating than to put themselves at risk of disconnection (Salvage, 1992 p22). Some may do this to the detriment of their health. This possibility was indicated by a survey carried out by medical researchers on 200 elderly patients (mean age 82 years), who were interviewed following admission to acute geriatric wards during one winter (Morgan *et al.*, 1996). Of these patients, 128 said they could not manage to keep warm in winter without financial hardship and 58 had reduced amounts spent on food in order to pay for fuel bills. A third said that they had had difficulty keeping warm before they were admitted to hospital. Living alone was found to be one of the factors associated with feeling cold before admission, as it is with fuel poverty and cold homes. Rahman *et al.* point out that, as with other age groups,

> *"... health problems amongst older people are not evenly distributed but are concentrated amongst the poorest"* (Rahman *et al.*, 2001, p66).

It is difficult to disentangle the health effects of cold homes, or poor diet, or general deprivation consequences of low income, as previously argued, but an accumulation of these is evidently often concentrated in older age groups. Clearly, in fact, the government recognises that older people are susceptible to effects of cold weather because of the extra heating costs needed, since various forms of cold weather payments are available. Currently, a one-off Winter Fuel Payment can be claimed each winter by those aged over 60, and is paid automatically to benefit claimants, while Cold Weather payments are paid to Income Support recipients following any week of consecutive daily average temperatures at or below 0°C.

The effects of poverty on the lives of older people may be further compounded by an attitude of mind that is resistant to accepting help in certain respects. Nationally, the pensioner population (60 years old and over) numbered about 10 million in 1998 and of these, two million were on Income Support (IS) benefit. However, it was estimated that one million more were entitled to IS but not receiving it (Spence, 2001, p6). Under a government manifesto commitment to tackle pensioner poverty, a survey was carried out by the DSS[20] Social Research Branch in 1998, which concluded that stigma and ignorance were the two main reasons why pensioners do not claim IS. By 'ignorance' it was meant that they were unaware of their right *"due to the complexity and lack of official help in the social security system"* (Spence, 2001, p6). This section of society is therefore vulnerable to fuel poverty because of the numbers who are on incomes so inadequate as to qualify for benefits such as Income Support. More particularly, the numbers who do not manage to augment what income they have by claiming benefits to which they are entitled, for whatever reason, are even more at risk.

The problem is now being addressed to some extent by local authorities, as illustrated by Spence's description of benefit take-up work in Newham (Spence, 2001), but it remains a disadvantage of targeted, as opposed to universally applied, benefits that take-up is limited by the ability or willingness of individuals to claim them. Some insight concerning the reluctance to seek out help from official quarters appears in a recent account of an East End childhood in the 1950's, where the author included reminiscences from older residents of the area:

> *"According to the memories of some of the more elderly contributors to the oral history, it is an ingrained dread of the workhouse and of relying 'on the parish' which accounts for their fear of accepting Social Security and help from Social Services, and of going into hospital; for them, accepting assistance is still associated with the last resort of the absolutely desperate and the dying"* (O'Neill, 1999, p42).

These stories have come from the experiences of a particular cultural group in the East End of London. Nevertheless, the attitude that may be explained variously by fear of stigma, or by pride, and prevents so many older people from identifying themselves as in need, can also lead them to resist acceptance of home energy efficiency improvements targeted at those labelled as the 'fuel poor'.

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[20] Department of Social Security

4.4 Attitudes to energy use

It has been established that, since older households are particularly prone to the combined circumstances of low incomes and houses that are hard to heat, then homes for this group are likely to be cold. Domestic temperatures can also be affected by attitudes to heating and energy efficiency, because of the interaction between buildings and their occupants. Older people are found to display certain mind-sets, typical of their age group, which may either exacerbate their tendency to experience low indoor temperatures or, on the other hand, may colour the impression given to researchers, or others, of their preferences. Underestimation of their problems is therefore possible in research studies.

Salvage suggested that, to some extent, where older people interviewed in 1993 expressed high levels of satisfaction with their current heating systems, this might be explained by comparison with their experience of heating systems in the past:

> *"The current generation of elderly people has lived through at least one World War and its accompanying privations. Their childhood days were spent beside open fires; their childhood nights in unheated bedrooms. There was little question of heat in every room, let alone the ability to control temperature in different rooms..."* (Salvage, 1994, p28).

Expectations are therefore the key here, as may be compared with the influence of perceived 'normal' experience on self-reported ill health, which was discussed in 3.3.2. Indeed, Mack and Lansley suggest that some *low income* households, especially among the elderly, describe themselves as having heating in their living rooms, despite only being able to afford its very limited use. Through a combination of coping remedies, such as wrapping up in rugs, or going to bed to keep warm, and low expectations, they apparently do not feel that they are forced to go without heating (Mack and Lansley, 1985, p105).

Whether or not they are affected by low income, some people prefer cooler temperatures for perceived reasons of health. Salvage maintains that *"many people appear to overestimate the need for 'fresh air' in the home"* (Salvage, 1994, p21). At the same time, they tend to underestimate the extent to which this adds to the cost of heating. Furthermore, in one study, she found that

> *"..draught proofing and double glazing were rejected by some elderly people because they were felt to be 'unhealthy' in the sense that they prevented circulation of 'fresh air'"* (Salvage, 1994, p21).

The study was limited both in size and geographically, including only 100 people, who were slightly older than the over 65-year-old group across Britain. However, Salvage argues that the results supported the idea that the British value 'fresh air' highly, as 41% claimed to always keep their bedroom windows open in winter, while 70% thought it important to keep windows open all year round (Salvage, 1992, p75). At the same time, almost two thirds strongly agreed with the suggestion that a warm home is healthier than a cold one, although a small number emphasised that this was only true within certain limits, as illustrated by the following response:

> *"A too hot home isn't a good thing. It makes you afraid of going out...a too hot house can be damaging to health."* (Salvage, 1992, p63).

Boardman (1991, pp183-5) shows that elderly occupants of cold housing, as others, value warmth highly. She examines the economic benefits resulting from six projects (a total of 120 houses) where energy efficiency improvements were made under the Better Insulated House programme. The results illustrate that, once the cost of warmth is reduced through greater energy efficiency, householders will use part of the savings towards cutting down energy use, but the greater part of it (in these cases overall 61%) towards achieving additional warmth (as discussed in Chapter 2). The homes that were the coldest before improvements, which included one project with elderly occupants, were those with greatest temperature increases measured afterwards. This suggests that additional warmth and improved comfort is *"valued most highly by people in energy inefficient homes"* (Boardman, 1991, p184). Although, as Boardman notes, household incomes were not recorded, she takes the results as indicative of the effect on low-income families because half of local authority tenants are poor.

Wicks, an author of the 1971 national survey of the elderly in their homes, emphasises that their reported levels of satisfaction with indoor temperatures should be interpreted with caution, since many living in the coldest conditions did not claim to often feel cold indoors. He suggests that this could reflect

> *"...an unwillingness to report, or admit to, feeling cold and preferring to be warmer.. (which) ..might be due to pride, independence, or a general reluctance to complain."* (Wicks, 1978).

Apart from the possibility that people may not be able to feel the cold as they become older, he also refers to their potentially greater tolerance of the cold because of lower expectations. Evidently, the older population cannot be regarded as a single homogenous group since, as with all age groups, it represents a wide range of experience, incomes and viewpoints. However, it is reasonable to assume that those on low incomes, whose homes are cold, would be ready to take advantage of warmer temperatures when the cost of warmth is reduced but, without contradiction, might report satisfaction with their existing situation, for the reasons suggested by Wicks and others.

It was demonstrated in Chapter 3 that the growth of central heating ownership has been associated with increasing domestic temperatures, but that it is not known whether ownership is increasing at a similar rate among 'vulnerable' groups, such as the elderly. The 1996 EHCS provides evidence that, generally, homes with central heating are run at warmer temperatures than those without (DETR, 2000, p150), which indicates that ownership should normally be an advantage in terms of thermal comfort, as long as running costs are comparable with other heating systems. (The report does not indicate whether this is the case, but simply that the cost of fuel per square metre is less in an energy efficient home than in one which is inefficient (DETR, 2000, p113), central heating being part of the measure of efficiency.) Salvage showed an increase in the proportion of older people having centrally heated homes between the 1972 and 1991 surveys of the elderly in cold weather. Only 24% of the earlier sample had central heating, while in 1991 this figure had risen to 67% (Salvage, 1993). Even so, although there was a parallel improvement found in bedroom and living room temperatures, its scale was:

> *"...not commensurate with the increase in the level of central heating ownership, suggesting that many of those who had central heating were failing to make sufficient use of it."* (Henwood, 1997, p26).

It has been claimed that the use of central heating by older people may sometimes be inhibited, either by physical inability to use controls, or by fear of being unable to pay the bills (Hamdy, 1977, p40). In fact, the EHCS calculated that 116,000 households own but do not use central heating, relying instead on other fixed or non-fixed heating (DETR, 2000, p85). People aged over 60 years old head 55% of these households, compared with 30% in the total centrally heated housing stock. Running cost was the reason given for non-use by 48% of households over the age of 60. According to a small survey of the elderly by Salvage, 12% of those who did not have central heating thought that it was unhealthy (Salvage, 1992, p 35). Elsewhere, in a project where local authority tenants aged 70 and above were offered a free central heating installation, some refused the offer because they feared the disruption during the installation work (Rudge and Winder, 2002). In other studies free draught proofing measures have also been rejected due to the disturbance factor (see Bell *et al.*, 1994, p45). It is therefore not a simple matter to address the situation where some older people do not own or do not use central heating, particularly as there may be underlying issues behind the various reasons expressed, which are not clear.

The provision of energy advice and its effectiveness is a further complex area for discussion, which will not be entered into here. However, it should be mentioned that, as described by Bell et al. (1994, p43), the idea of 'energy literacy' has been identified as a significant element in general energy efficiency behaviour. The research evidence compiled by Salvage, which included interviewing 100 elderly subjects, found that there is poor understanding of the benefits of investing in energy efficiency and little general knowledge of the efficient operation of heating controls and the running costs of appliances (Salvage, 1992, p22). Energy efficiency is often viewed in terms of deprivation, or cutting down on energy use, rather than investing in positive energy saving measures. This was found by Salvage (1992, p76) among older people and observed by others in the general population (Bell *et al.*, 1994, p46). Of course, where households are on low incomes, investment on the necessary scale is probably not possible, as Boardman makes clear (Boardman, 1991). Misinformation about energy consumption and the cost implications of, for example, keeping windows open could aggravate fuel poverty risk and any resulting adverse health effects. Yet it seems unlikely to be a significant single cause of cold homes, since comfort and warmth are valued and would normally be sought to the extent that they are affordable. Behavioural issues may add to the cumulative effect of fuel poverty for some individuals, causing older people to be considered particularly vulnerable as a group. Not only are they vulnerable to finding themselves subject to fuel poverty and living in cold homes for all the reasons described but, as the next section demonstrates, in many ways they are more likely than other age groups to suffer physical effects to the detriment of their health.

4.5 Age-related physiological problems

In a specific study of elderly people and domestic energy efficiency, Salvage (1992) reviews the medical evidence of age-related physiological factors that cause older people to be more liable to health problems associated with cold. These factors may be summarized as follows:

- Thermoregulatory capacity declines with age, *i.e.* the body can become less efficient at maintaining a normal core temperature regardless of outside temperature.
- Associated with the deterioration of the thermoregulatory mechanism, older people are often less able than younger individuals to perceive differences in temperature. This affects their ability to take appropriate action to avoid becoming dangerously cold.
- Certain medical conditions commonly found in older age groups can further exacerbate physiological thermoregulatory deterioration. Typically, these potential underlying causes of hypothermia include strokes and heart attacks, among others.
- With age, there is a tendency for the body's 'surface area: mass' ratio to increase. Together with an overall decrease in total metabolic heat production from a usually lowered proportion of functioning cells in the body mass, this increases vulnerability to cold weather effects.
- More sedentary lifestyles among the elderly, possibly exacerbated by medical conditions, also result in reduced heat production from muscular activity.
- There is greater likelihood of this age group than others to use medication, much of which can have the effect of impairing thermoregulation and, often, mental processes.

For all these reasons, higher temperatures are generally recommended for older people than for others, because many need more external heat to maintain thermal balance and comfort.

In his review of cold housing and respiratory illness, Collins (2000) refers to the fact that older people may be more prone to risk of respiratory infection because of reduced immune response, existing chronic respiratory conditions or, sometimes, poor nutrition. The complication rate of those living at home and suffering with various respiratory ailments is very high. Although influenza, for example, is not more common among the elderly, it can lead to much greater morbidity and mortality because of resulting complications (Collins, 2000, p43). Since cold is not only associated with lowered resistance to infection, but also reduced functional mobility, it is thought to contribute to hospital admissions among older people due to falls as well as respiratory infections (Morgan *et al.*, 1996). Coronary or cerebral thrombosis diagnoses account for half of excess winter deaths and Collins submits that change occurring in cardiovascular reflexes among the elderly could be a factor (Collins, 1993, p 131).

The Acheson Report recognised that health problems among the elderly can be aggravated, as with other groups, by poverty and deprivation.

> *"Available data, which are fewer than those for younger age groups, suggest that older people experiencing disadvantage tend to have poor health. Respiratory function is lower and blood pressure higher in people from lower socio-economic groups" (*Acheson, 1998, p87*).*

In view of this evidence, the combination of factors leading to fuel poverty and the consequent cold housing conditions would exacerbate health risks to older people.

Hypothermia is an extreme consequence of cold living conditions and is diagnosed when the body temperature falls to a dangerously low level, below 35°C. Boardman shows that a high incidence among the very young and the elderly was noted in the severe winter of 1963, with a very high mortality rate, and led to reports in the medical press recognizing the link between poverty, cold homes and hypothermia (Boardman, 1991, p17). According to Collins, 'urban hypothermia' is a topic that has become

> *"popularly recognized, and...is sometimes used as a political yardstick with which to measure social neglect"* (Collins, 1993, p128).

Because of physiological susceptibility to cold, the elderly are the main focus of concern, particularly when living alone. Collins describes an example of accidental cold exposure:

> *"... it is not unusual for an isolated elderly person to venture from a warm bed into icy-cold rooms forgetting to put on warm clothing. An accidental fall resulting in a broken limb and thus immobilization in cold surrounding is a typical setting for urban hypothermia"* (Collins, 1993, p128).

He also refers to the situation where some old people might inadvertently induce a state of 'voluntary hypothermia', by economizing on heating to the detriment of their comfort and home temperatures. A study in Scotland looked at 93 patients presenting to hospital with hypothermia in the winter of 1993-4 (Hislop *et al.*, 1995). It found that most of those who became hypothermic at home had heating available but were not using it. It was suggested that one reason may have been the cost, or perceived cost, of fuel. Collins states that about one per cent of excess deaths in the winter quarter of the year are caused by hypothermia and for only 0.05% it is the underlying cause (Collins, 1993, p131). Hislop *et al.* argue that the true incidence of hypothermia is difficult to define, intimating a discrepancy between numbers of officially recorded deaths to the diagnosis and the numbers that could be attributed to it, in reality. They claim that the extrapolation of larger numbers from their results could still have been a significant underestimate, taking account of the numbers of older people found dead at home, rather than being admitted to hospital, who may have died of hypothermia.

Given that people can involuntarily, rather than deliberately, find themselves in danger of becoming cold to the point of hypothermia or aggravation of other conditions, the argument for government investment in energy efficiency of the housing stock becomes all the more crucial. Temperatures inside a well-insulated home do not follow those outside so closely as in an uninsulated, leaky building, whether or not the heating is in use, and the cost of heating is far less onerous if the building and the heating system are both efficient.

4.6 Older people as major NHS users

The number of people aged over 65 has doubled in the last seventy years, while two thirds of acute hospital beds are occupied by people over the age of 65 (DOH, 2001). Because of the growing numbers of older households, health problems that affect older people are likely to place increasing strain on the National Health Service. Fuel poverty can contribute to these problems, particularly in winter, because of its association with excess winter deaths and morbidity. The extra pressures on hospitals during winter are well known and are recognized as largely connected with older patients. A recent analysis of emergency hospital admissions in London for 1997-2001 found that:

> *"The greatest use of resources (bed days) in acute hospitals during December and January is by older people, in particular those with chronic respiratory conditions and 'acute on chronic' disease."* (Damiani and Dixon, 2001, p2)

Those aged 60 and over who are admitted as emergencies are likely to require more hospital resources than younger patients because, although numbers of admissions are relatively fewer than for young children, the average length of stay rises steadily with age. The resulting very high numbers of bed days (up to a maximum of 17 days at the age of 95 in the London study) therefore contribute more to 'winter pressure' (Damiani and Dixon, 2001 , p18). Such pressure may be further exacerbated by (or the lengths of stay may be due to) the phenomenon of 'bed-blocking', or what has been termed the 'revolving door syndrome'. As recognized by a government minister recently:

> *"..each winter hospitals have beds filled with people who have recovered from the immediate problem but cannot be discharged because their cold homes will soon put them back into hospital again"* (Wilson, 2003).

Damiani and Dixon found that the winter pressures are largely caused by respiratory conditions, which may be caused or aggravated by cold homes in the first place, as demonstrated in Chapter 3. The role of fuel poverty is therefore key to the bed-blocking issue, with serious implications for the health service as well as for local authorities, which are also responsible for finding appropriate accommodation for people who have finished hospital treatment but cannot be sent home.

The Department of Health is currently producing National Service Frameworks, designed to set national standards and identify key interventions for defined services or care groups. In 2001, the National Service Framework for Older People was published, which includes a standard entitled 'The promotion of health and active life in older age' (DOH, 2001). Under this standard the Framework suggests

> *"wider initiatives involving a multi-sectoral approach to promoting health, independence and well-being in old age".*

These include reference to improving housing quality to reduce fuel poverty and prevent ill health and accidents. It cites the support given by the Department of Health to the national *Keep Warm, Keep Well* campaign to ensure that older people know the importance of staying warm in winter and also identifies the existing role of some health professionals in raising awareness of grants available through, for example, the *Home Energy Efficiency Scheme* (since renamed *Warm Front*). Embedded within this document, therefore, is the recognition that addressing fuel poverty is important to older people for reasons of health and well being. However, there is not, as yet, a universal obligation for health professionals to be involved with the issue, nor is this role widely appreciated at all levels throughout the health service. Indicative of this situation is that the National Heart Forum (in conjunction with others) recently produced a fuel poverty and health 'toolkit' (Press, 2003). This is intended to advise primary care professionals and organisations on ways to identify those at risk from fuel poverty, the associated health effects and how to direct them to the appropriate agencies for assistance.

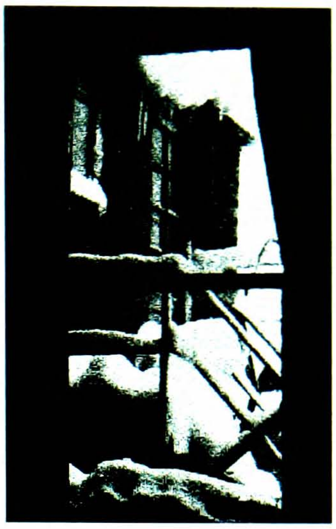
4.7 Summary

Fuel poverty impacts on several vulnerable sections of society, but it is a particular problem for older people, who form a growing proportion of the population. Unless the causal factors are dealt with, fuel poverty is therefore a problem that is likely to grow correspondingly, if it affects older people as a group rather than as a particular generation. Clearly, as a reflection of society as a whole, the situations of older people vary widely and they are not all equally vulnerable to fuel poverty. Some of the attitudinal characteristics of older adults described may be generational, just as others are typical of the population in general, but many of the individual risk factors that lead to fuel poverty and the health risks that can arise from it, are strongly related to age. In addition, as demonstrated, many of the issues examined in this chapter are interlinked. It is the accumulation of these that results in fuel poverty and makes worse any possible health status outcomes. For this reason, tackling the problems of older people suffering from fuel poverty, as recognised in the National Service Framework for Older People, requires a multi-disciplinary approach that includes the involvement of health services.

It is evident that older people are prone to fuel poverty because they are more likely to live in older, more inefficient housing and many are classed as low-income households. The problems of living in hard to heat homes are exacerbated for single person households, of which a growing number are elderly. The fear of debt and the desire for independence from state assistance can contribute to older people limiting their use of heating. Other attitudes may also intensify the problem, including the reluctance to accept domestic energy efficiency measures, the misunderstanding of their effect on affordability of warmth, low expectations of comfort and the health connotations of fresh air. Finally, physiological factors can worsen the health effects of cold or further aggravate the likelihood of older people running their homes at low temperatures without realising the implications.

The fact that fuel poverty contributes to winter pressures on hospitals because of its effects on older people suggests that this group are an appropriate sample for a methodology that involves measuring fuel poverty outcomes. The relationship between fuel poverty and the health of older people is generally acknowledged but, until now, has largely been demonstrated in terms of excess winter mortality. Underlying the mortality statistics is a far larger scale of excess winter morbidity and this is proposed as an alternative measurable outcome, which may be reduced by improving domestic energy efficiency. The following chapter will examine this and further aspects of the proposed methodology and research process.

CHAPTER 5 Development of a research protocol



"The whole family suffers from the cold. The two year old has asthma. Their GP has told them that he cannot do much because the flat is probably the cause of the recurring illness. All the children have constant coughs and colds."

from: *I mustn't laugh too much. Housing and health on the Limehouse Fields and Ocean Estates in Stepney.* (Ambrose, 1996, p56).

5.1 Introduction

The previous chapters have served to demonstrate the multiple causes and risk factors for fuel poverty in Britain, their potential links with health status and the 'double jeopardy' facing older people vulnerable to both fuel poverty and its associated health risks. The basic causes of fuel poverty are clear and, despite remaining disagreement over its exact definition in the language of government policy, its widespread existence in this country is now officially accepted, as exemplified in the recent setting up of the UK Fuel Poverty Strategy[21]. The susceptibility of older people to fuel poverty and the implications for their health are also acknowledged, as revealed in the Acheson Report (Acheson, 1998) and subsequent government health policy documents. However, there remain gaps in the research and evidence for direct links between fuel poverty and health and it is possible that the limitations of available evidence contribute to the gaps in implementation of an integrated public health policy to address fuel poverty. In seeking further evidence, the research question for examination here is to find whether, in epidemiological terms, a relationship can be shown between fuel poverty and the health of older people, by means of *morbidity* data, rather than the conventional use of mortality statistics.

It has been established that there is little existing research into *fuel poverty*, specifically, and health, while the limited amount of *housing* and health research varies in quality and relevance, the number of confounding factors being a major stumbling block to proof of direct links. In this chapter it is intended to summarise the gaps and weaknesses in research to date and, in that context, to set out the justification for the proposed research question, with the reasons for the methodology adopted. The selected indicators for health status and fuel poverty risk will then be

[21] *see* Chapter 2 (2.2.9)

discussed and data sources will be reviewed for their appropriateness as well as possible limitations.

5.2 A methodology to plug some gaps

5.2.1 'Joined-up' policy requirements

In Chapter One it was shown that the government is concerned to introduce 'joined up' thinking to all areas of policy-making and that the issue of fuel poverty, together with its consequences for health status, is particularly suitable for such an approach. This is because of the various interacting causal factors, which include both housing and socio-economic conditions. Professionals from different disciplines and organisations, answerable to several government departments, therefore need to be involved both in solving the problem and dealing with its effects. The current government is also concerned with implementing 'what works', or evidence based policies (Macintyre *et al.*, 2001). For these reasons there is a need to demonstrate, through co-ordinated means, the multiple benefits of solutions to fuel poverty, which are proposed here as energy efficiency improvements. Investment in such measures would then be confirmed as appropriate from a range of government sources rather than simply the department concerned with controlling energy use.

Health impact assessment is increasingly promoted as part of the impetus towards evidence based policy making:

> *"Health impact assessment is a means of evidence based policy making for improvement in health. It is a combination of methods whose aim is to assess the health consequences to a population of a policy, project, or programme that does not necessarily have health as its primary objective"* (Lock, 2000).

The primary motive for energy efficiency upgrading is generally to achieve environmental targets, in terms of reduced fuel use and carbon dioxide emissions. How then, could the health impact of fuel poverty be measured, as evidence of the wider benefits of energy efficiency investment, particularly as for the fuel poor the reductions in fuel use may be minimal? This is what the methodology seeks to test, by first establishing whether the relationship can be demonstrated.

The demand for policies shown to be effective – and particularly for evidence-based health care - calls for monitoring and evaluation of interventions that are potentially beneficial or detrimental to health. Comparable measures and comparative methods are therefore required, which have been lacking in housing and health studies to date. In Chapter 3, it was demonstrated that such studies have originated within different disciplines, with varying motives and priorities, and have employed widely differing measures of outcomes. As Milne (1995) shows, even within the same professional area of concern, studies of energy savings in projects incorporating energy efficiency improvements are not always comparable because of monitoring inconsistencies. Consequently, the objective here is to produce a tool for monitoring and evaluation of potential health outcomes from energy efficiency investment, using a single measure that may be replicated throughout the country. This also implies the need to draw on similar data that should be available wherever relevant.

Attention has already been drawn (in Chapter 2) to the fact that statistics combining data on housing and health are not generally available or collected, which tends to hinder work on drawing the connections. It also reduces the likelihood of inter-disciplinary approaches to assessment of the links between the two. The proposed methodology would seek to address this shortcoming by combining data from sources within different professional areas, in a way that may be simply accessed by diverse agencies.

5.2.2 Cost benefit analysis

Evaluation of any policy implementation by government would normally incorporate cost benefit analysis for justification to the National Audit Office and, to date, there are significant gaps in the assessment of the costs of fuel poverty to society. As shown in Chapter 3, measures to counteract fuel poverty could bring about potential savings and benefits beyond those attached to individual households. It is argued by some that demands would be reduced for not only the health services, but also other service providers. In addition there would be employment and environmental gains, amounting to an overall social and economic cost benefit from investment in energy efficiency for the existing housing stock[22].

The work by Ambrose and others[23], whose team included members with experience in a number of housing fields, found that the connections between poor housing conditions and high costs were multi-dimensional, implicating more than just the health services. As a result of their work they developed a matrix of costs whose levels could be related to poor housing (Ambrose, 2000a, p211), some of which (such as high heating or high housing maintenance costs), could be identified as related to fuel poverty. These costs are allocated as to their implications for both residents and service providers, such as the NHS, environmental health, social care, education or emergency services. They are categorised as to how accurately they could be measured. The matrix shows that high home fuel bills can be precisely quantified, for example, whereas higher

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[22] *see* further discussion in Chapter 8 (8.6)
[23] *see* Chapter 3 (3.6)

Health Service costs include those that *"clearly exist but are currently non-quantifiable"* (Ambrose, 2000a, p212). Could the methodology therefore make some advance towards quantifying these costs?

Part of the motivation behind the research question is to seek a way of attaching some financial costs to health effects of fuel poverty that may emerge. Previously, methods of costing of health effects of cold and damp housing have been variable and not always transparent. They involve a great many assumptions, leading to a wide range of estimated costs, which is, perhaps, inevitable, in the absence of relevant data collection and published statistics. This is a serious gap in research, which should be filled in the interests of promoting large-scale investment in housing improvements. Nevertheless, to be able to attach health costs to fuel poverty, the health outcome must first be established.

5.2.3 An epidemiological approach

There are certain advantages to using a population, or epidemiological, method of assessing health benefits of increased energy efficiency. Importantly in this case, as an observational rather than an experimental piece of research, carried out with limited resources, it facilitates the use of data that is already available to and routinely gathered by existing agencies. The proposal is to make a cross-sectional epidemiological study to examine the differences in health of older people in one London borough according to their exposure to risk of fuel poverty, establishing a picture of the existing situation. This would form the basis of a prospective ongoing longitudinal study for monitoring the effects of future major energy efficiency intervention programmes, which should impact on the scale of fuel poverty risk.

The alternative approach would involve long term and, preferably, large-scale intervention studies of individual households, which would be costly and would be far more dependent on a stable population. Logistical and ethical difficulties attached to intervention studies of this kind have been described in Chapter 3 (3.5). They would need detailed health status interviews with individuals to look closely at links between house condition and health, with careful allowance made for confounding factors. If a 'before and after' approach is not taken, a cross-sectional intervention study design requires thorough matching of demographic groups and housing types, as would also be necessary if a control group were to be included. Matching such features is not only difficult in itself, but is further complicated by building-occupant relationships, as also discussed earlier.

The epidemiological approach, on the other hand, allows the seasonal comparison of morbidity within the whole sample population, which eliminates some of the potential confounders (such as smoking and, possibly, diet) that are likely to be constant all year round. Nevertheless, with this method the dangers of the *ecological fallacy* have to be borne in mind, as described in Chapter 3 (3.4.5), where relationships observed between sets of variables at population level are assumed to operate equally at less aggregated levels (Hunt, 1993, p74). On the other hand, Byrne and Keithley (1993, p53) argue that there are equal, if not more important, dangers in drawing conclusions for an area or population from individual case-centred data (the 'atomist' fallacy), as such data *"distracts from the nature of social structure"*.

Until now, most epidemiological studies of the health outcome of cold housing have concentrated on excess winter deaths as a quantitative measure. This approach does not allow contemporaneous monitoring of the possible benefits of interventions. There has also been limited research that draws together all the aspects of fuel poverty with such health outcomes, although some studies have focussed on factors with varying degrees of relevance to the issue. Intervention studies researching links between cold housing and morbidity have been few and small scale (Thomson *et al.*, 2001). Part of the rationale for this research was to investigate the validity, or usefulness, of morbidity data in examining links between fuel poverty and health and, consequently, for measuring potential health benefits of domestic energy efficiency improvements. The purpose of the following section is to set out the reasons for using morbidity rather than mortality as a health measure.

5.2.4 Morbidity as the preferred health indicator

Mortality rates are commonly used as health indicators for populations, partly because they are consistently collected. The Office of National Statistics regularly publishes mortality statistics and they are easier to obtain than records of disease episodes. Furthermore, the Data Protection Act (1998) and its confidentiality requirements only relate to patient data for living individuals (Strobl *et al.*, 2000). However, mortality statistics give an incomplete picture of health. Many disease conditions do not necessarily lead to early death. In addition, numbers occurring in small geographical areas may be insufficient to allow observed differences between neighbourhoods (Bardsley and Hamm, 1995). The use of morbidity statistics, on the other hand, potentially offers a wider range of observations in relatively small areas as well as the possibility of monitoring improvements over a shorter period. The published geographical breakdown of mortality statistics is by region, local authority and health authority (Macfarlane, Majeed *et al.*, 2000, p52), which is not as detailed a level as would be preferred for the proposed methodology.

There is limited epidemiological evidence of links between housing and excess winter deaths. Nevertheless, as Bardsley and Morgan reason, the use of mortality data is likely to disguise the scale of the problem in terms of people's lives and their use of health services:

> *"Health indicators based on mortality rates represent just the tip of the iceberg of health problems. For example, the most common reason for death is some form of coronary heart disease, yet preceding most of these deaths is the development of a chronic disease that can significantly impact on people's quality of life for a number of years"* (Bardsley and Morgan, 1996, p2).

A study of hospital services use as a proxy for morbidity, which considered respiratory disease among other conditions, also produced the following conclusion:

> *"Mortality information, although useful as a proxy for morbidity in many circumstances, is ... of little value for the common conditions examined here. This is not surprising in view of the small number of deaths associated with these disorders, although their associated morbidity is considerable"* (Payne *et al.*, 1994).

When interpreting the links between cause and death, there are complex issues involved and these are further exacerbated by timescale. Even though excess winter deaths are indicative of low temperature effects, being calculated from seasonal differences, they represent the most extreme, and final, outcome. Death might appear to be the most reliable indicator of a health problem but Macfarlane, Majeed *et al.* (2000) also point out the disadvantages of using mortality rates for this purpose. They describe how Standardised Mortality Ratios[24] (SMRs) are thought to correlate both with measures of illness and with measures of social deprivation and are therefore used as proxy measures of a 'need' for health care or social care to allocate resources. They suggest that, for representing acute hospital treatment or long-term care needs, this approach is flawed.

> *"Using mortality rates ignores the fact that people who suffer severe morbidity, for example a stroke, are increasingly likely to survive and die later from some other cause"* (Macfarlane, Majeed *et al.*, 2000, p52).

This argument further supports the idea that, if mortality data alone are considered, costs of cold effects on health, to both health and social services, are likely to be under-estimated. If some people actually die later from a cause other than that initially induced by the effects of cold, then the link between these deaths and cold-related disease would not necessarily be apparent.

Alternatively, there could be prolonged illness, with considerable time lag between an accumulated effect of cold in the home and an eventual death. In order to link the health condition to cold housing, (and therefore be able, through policy making, to remedy the

[24]SMR is calculated as the number of deaths observed within an area divided by the expected number if national age and sex specific mortality rates were to apply. The ratio is then multiplied by 100. Scores over 100 suggest higher than average mortality (Bardsley and Morgan, 1996, p3).

situation), it should be identified as close as possible in time to the experience of the cold home if, indeed, it is apparent. As Byrne *et al.* (1993, p45) point out, long-term implications for health may in fact be experienced later in life when an individual's housing conditions are good, which further complicates the disentangling of causal mechanisms.

For all these reasons it is suggested that the preferred health indicator should be based on excess winter morbidity prevalence rather than mortality rates. Low temperatures are associated with certain illnesses, identified as predominantly respiratory and cardiovascular disease (Kunst *et al*, 1993). It is suggested, therefore, that these types of illness could be shown to be more prevalent among the fuel poor during winter months than among the rest of the population. If a relationship is shown between fuel poverty risk and seasonal differences in cold-related illness, then it could be assumed that indoor temperatures are a factor, reflecting the poor moderation of outdoor temperatures by energy inefficient buildings.

5.2.5 Proposed research methodology for a pilot study

A methodology is therefore proposed for testing a relationship between fuel poverty and health, concentrating on older people as a vulnerable group, and using morbidity rather than mortality data as a potentially more sensitive health status measure. A pilot study would be carried out for the London Borough of Newham, in East London. The methodology would rely on mapping the overlap of indicators of low income and energy inefficient housing, together with other known elements of risk, for identifying the location of potential fuel poverty. It would then be necessary to compare the location with that of older people who suffer from cold-related illness in winter. In gauging the extent of *excess winter morbidity* and its calls on the health service where there is fuel poverty risk, it may allow a more realistic cost benefit analysis of subsequent energy efficiency improvements than would be possible by measuring excess winter mortality.

The use of mapping is proposed because fuel poverty risk is closely related to a physical measure of buildings, which can be geographically located. Mapping would provide simple and accessible visualisation of the data analysis and has other advantages as a tool in this context. Geographical Information Systems (GIS) for spatial data analysis are becoming more commonly employed in a variety of fields. They are already used by many local authorities, as well as health authorities, and so, for them, the mapping tool could easily be accessed and tied into existing databases. GIS software also functions as an epidemiological tool and the overlaying of health information with building and socio-economic data is therefore well served by geographical analysis.

The process of testing and mapping the fuel poverty and health relationship thus requires the following indicators to locate:-

a) Fuel poverty risk, by the combination of:
   - older households with low incomes
   - housing with low levels of energy efficiency
   - under-occupation

b) Potential associated health effects, by:
   - the incidence of morbidity among older people related to cold temperatures

Ideally, a number of general criteria are desirable for the various indicators needed for the mapping tool. These are set out according to the theory and logistical requirements of the research proposal and with partial reference to recommendations for indicators towards multiple deprivation set out by Noble *et al.* (1999, p9).

- Data should be available from existing sources
- They should be nationally and consistently available at a similar small area level - so that the methodology has potential for replication.
- Data should be up to date, or at least contemporaneous, one set with another.
- Data should be routinely collected, therefore capable of being updated on a regular basis.
- They should be statistically robust, i.e. expressible in terms of rates rather than absolute numbers.
- Data should represent a direct measure of the particular factor.

In the following sections the proposed indicators and relevant data sources will be reviewed.

5.3 Locating fuel poverty risk

In order to locate where fuel poverty risk is likely to occur across the borough, it would be necessary to discover where the various implicated causal factors overlap. It was demonstrated in Chapter 2 that low income and housing with a poor level of energy efficiency are major roots of the problem. The population most likely to suffer fuel poverty, as well as adverse health effects of low temperatures, are older people, as shown in Chapter 4, so age must also be regarded as a risk factor. Additional aggravating conditions are those of under-occupation, particularly where older householders live alone. In the following paragraphs, the most appropriate, and most practical, means of identifying each aspect of fuel poverty risk are considered.

5.3.1 Low income households

A low-income indicator needs to be a proxy for, as far as possible, the ability to afford energy services (without knowing how much these would necessarily be). The aim is to use data that should be within the normal remit of collection by the local authority, preferably. The intention is that the methodology should be robust and is therefore concerned with statistics at a broad level, measuring accumulated fuel poverty *risk* rather than actual occurrence of fuel poverty. It would avoid the level of detail required to look only at those individual households falling within the strict definition of fuel poverty as now used by the Government: a minimum of 10% of income needed to be spent on energy services to achieve acceptable levels of comfort (DETR, 1999). There are potential difficulties in obtaining income data, because data protection and confidentiality requirements dictate informed consent. The geographical level of information needs to be matched to other elements of data incorporated in the methodology. For the purposes of health data confidentiality, this must be at a minimum of ED level (*see* 5.5).

The question of which is the best gauge for locating low-income households is debatable. Johnson *et al.* point out that there are no official poverty statistics published and there is no official definition recognised by government:

> *"The seemingly never-ending debate about what is meant by poverty and whether it is an absolute or a relative concept is evidence enough of the difficulty of defining, let alone measuring, it. Government nervousness about identifying an official poverty line is unsurprising ....The ...annual publication 'Households below average income' is the nearest thing we have to a set of official poverty statistics, though in reality it provides more information about low income or inequality"* (Johnson *et al.*, 2000, p112).

In suggesting that the current emphasis is on inequalities in income distribution, they claim it is more to do with relative rather than absolute poverty, where people simply cannot afford the basic necessities of life. The annual report published since 1998 by the Joseph Rowntree Foundation and the New Policy Institute uses a number of indicators to measure poverty and social exclusion in Great Britain, categorised for different demographic groups (Howarth *et al.*, 1999). People on *very low incomes* are defined in this report as those in households with less than 40% of average income, but the low-income threshold adopted by the Government for measuring progress on poverty is half-average (mean) income. This is calculated after deduction of housing costs, indicating *disposable* income, which is more relevant to the ability to afford energy than income before housing costs. However, the figures are based on annual government surveys (Family Expenditure Survey and Family Resources Survey), which are derived from household questionnaires of nationally representative samples. The data is therefore not available at local level.

Until the early 1980's, statistics on 'low income' families were linked to levels of means-tested benefits. Families on supplementary benefit (now known as Income Support), or on incomes below the supplementary benefit level, were considered to be in poverty, or below a 'poverty line'. Those people whose incomes were within an amount 40% above this line were regarded as being on the margins of poverty (Johnson *et al.*, 2000, p114). Currently, annual statistics are recorded of numbers on income support and estimates of those who are entitled but do not receive it. These statistics are claimed by Johnson *et al* (2000, p116) to be useful, and more easily interpretable, as representative of the numbers on 'poverty' than 'households below average income'. However, these again are not published at the detailed geographic level required for the mapping of fuel poverty risk. According to the *Fuel Poverty Factfile*, the National Right to Fuel Campaign normally assumes a definition of poverty as dependence on the state for 75% or more of income. However, in employing this definition, it has to use proxy indicators since the appropriate statistics are not obtainable (Bown *et al*, 2000, p2).

Some research on housing budgets and living standards has estimated that the IS benefit rate as at April 1992 would be just adequate for a single pensioner council tenant on a constructed 'low-cost' budget[25], but only if they were living in energy-efficient modern accommodation (Griffiths, 1994, p18). This is an indication that, as Griffiths points out, there would be

> *"no flexibility in the budget to meet, for example, the higher heating costs of poor health or poor housing..."* (Griffiths, 1994, p18).

For older people, therefore, it may be assumed that an income up to some level above IS (at that time) would still be likely to limit affordability of heating in a hard-to-heat home.

Deprivation indices

In 1971 the Department of the Environment (DoE) Index of Local Deprivation was developed as an indicator of local needs for extra resources in areas with a high proportion of disadvantaged households (Bartley and Blane, 1994). It was based partly on census information and included employment status as a proxy measure of income as well as measures of housing quality. Since then, several other 'deprivation indices' have been developed for assessing the overall level of affluence or deprivation for geographical areas. In studies of health inequalities, for example, their status may then be compared with related mortality data (Macfarlane, Majeed *et al.*, 2000).

[25] based on the 1991 Breadline Britain survey, including only items which 2/3 of people described as necessities, plus any items which more than ¾ of the population had (*see* Griffiths, 1994, p17)

These indices are also based on points of information from census data, such as the Carstairs or Townsend scores, or on weighted or combined census and non-census variables, like the Jarman UPA (Under Privileged Area) score. All are published at ward level, but the Townsend score is available at ED level as well. From 1998, the DoE Index also included census variables at the ED level.

Different indices reflect different aims for their use, depending on the variables used, although they are often highly correlated (Bardsley and Hamm, 1995). The Jarman UPA score was designed as an indicator of demand for primary medical care and therefore includes a reflection of lone pensioner household numbers. The Carstairs and Townsend measures were developed through an interest in the effects of living standards on health and include items that could indicate the amount and stability of household income, such as housing tenure, unemployment, social class and car ownership.

Evidently, all these scores reflect compound aspects of deprivation, rather than low income alone. MacFarlane, Bartley *et al.* (2000, p78) suggest that they can be misleading in some respects. Census questions change infrequently and the data derived from these can lose their relevance as indicators of deprivation. For example, the significance of home ownership has changed in recent years with respect to social class or inequality. Bartley and Blane (1994) suggest that the categorization of social class is also becoming less satisfactory for measuring living standards, as fewer people nowadays go through life with a single stable occupation. In addition, the census is only carried out every 10 years, which means that the indices can become out of date quite quickly.

It is possible that one of these scores could be used as a proxy for low income, but they represent combined dimensions of deprivation that may overlap with factors to be measured towards fuel poverty risk. Employing such a proxy could therefore confound a fuel poverty risk index based on items that may also be embedded within the multiple deprivation score. Furthermore, when concentrating on the effect of fuel poverty on pensioner households, the inclusion of unemployment as a proxy measure for income levels would not be appropriate. A more direct indicator of low income would therefore be preferable.

Benefit receipt

Newham's published 'Poverty Profile' (Griffiths, 1994, p24) suggests that the receipt of Housing Benefit (HB) is a good indicator of where people are living on low incomes. Housing Benefit is a means-tested benefit that helps tenants with their housing costs. However, as it is not available to owner-occupiers, the many elderly residents who own older terraced houses, with poor energy efficiency characteristics, would not be identified from this information. It is likely that they constitute significant numbers of the fuel poor in Newham, so HB data would not be sufficient on its own.

Alternatively, the indicator used could be that of Income Support (IS) claims. This benefit has a lower income threshold for qualification than HB but savings levels affect eligibility. Griffiths reported that, in 1993, over half of those in Newham who were not receiving IS but did get HB were over pension age. This indicated the number of older residents whose net income was just above IS 'applicable amount', probably because of an occupational pension, but still qualified for the means-tested HB. The use of IS receipt as an indicator could therefore also exclude many older households whose income is still very limited. (When the pilot study commenced, numbers of IS claimants were available only by ward as at 1996 from the Local Government Anti-Poverty Unit, although they were planned to be produced by ED in the future.)

Council Tax Benefit (CTB) is available to all householders, including owner-occupiers, and also overlaps HB receipt. Details of those claiming this benefit would therefore be necessary together with, or possibly instead of, HB data. They exclude those living within a household, such as elderly relatives or students, who do not attract the benefit to the whole household. These data are considerably more difficult to obtain than HB data, but may not be in future as councils rationalise their data collection systems. They are recorded at source by full address and postcode so, for confidentiality, a means of translating that into anonymised information at a lower level of geographical detail is necessary.

Of course, in all cases of information concerning benefit receipt, it is not possible to include the many who do not receive or take up benefits to which they are entitled, nor those whose incomes are still limited but are just above the qualification cut-off point. Therefore, all data will underestimate numbers actually living on low incomes in relation to the fuel expenditure necessary for comfort and well-being. It is assumed, however, for the purposes of this research, that the proportion of population in receipt of CTB will serve as a reasonable indicator of where low-income households are found.

Benefit data is usually supplied as at the date of extraction so a historical record over a particular time period is unlikely to be obtainable by present data collection methods.

5.3.2 An indicator of poor energy efficiency

There are several energy 'labels' that have been developed for housing in recent years, all based on the same computerised calculation technology produced by the BRE[26], but each giving a different type of information for dwellings. Those mainly used are the National Home Energy Rating (NHER) and the Standard Assessment Procedure, or SAP. The NHER is based on total annual fuel running costs per square metre, presented on a scale of 0 to 10, the higher the number, the better the energy efficiency. The original scheme for assessing new dwellings was extended to cover surveys of existing properties and it is widely used amongst local authorities and housing associations. This energy-rating scheme includes costs for lighting and appliance use and standing charges on fuel bills. The model also takes account of climatic variations according to location, wind speed and building orientation.

SAP is a subset of the NHER and is the Government's preferred method for assessing the energy efficiency of dwellings. It was designed to be a Building Regulations assessment tool for efficiency of new buildings and has been part of the Regulations since 1995. The SAP estimates the cost of only space heating and hot water provision per unit floor area, based on heat loss characteristics of the building fabric and the efficiency of the heating system. A SAP rating is produced on a logarithmic scale of 0 to 100 (increased to 120 in the latest SAP2001 version). This rating does not take account of location. Notional fuel and electricity costs are averaged over the previous 3 years and across all UK regions (DETR, 2000). The SAP score is approximately 10 times the values calculated for the NHER rating but, because of the differences in factors accounted for, this is not a constant equivalent relationship. A comparison was carried out for scores in the Scottish housing stock which showed that the NHER scores were slightly lower than those given using the SAP calculation. It was concluded, from the evidence of severe climate effects in Scotland, that this was probably the primary reason for a higher percentage of homes with low NHER scores (Revie, 1998, p13).

These rating schemes assume a 'standard occupancy', which specifies the extent and periods of heating and the amount of hot water used and, where relevant, the use of lights, appliances and cooking equipment. There is no allowance made for differences in occupancy numbers or behaviour. As Revie points out, it is the physical characteristics of a building and its heating system that are assessed rather than patterns of use (Revie, 1998, p12). In fact, Oreszczyn (2003) claims that the calculation is highly sensitive to the heating system, and less so to the building fabric or ventilation properties. Although the ratings reflect energy efficiency irrespective of

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[26] Building Research Establishment

dwelling size, larger buildings tend to have smaller wall to floor ratios and therefore lower heat losses. As a result, they tend to have slightly better SAP ratings than smaller dwellings built to the same standard (DETR, 2000, p339). On the other hand, they ignore the fact that bigger properties cost more to heat (Oreszczyn, 2003). Typically, a SAP rating above 50-60 is taken as a good level of efficiency, whereas below 20-30 is usually regarded as poor (Goodacre *et al.*, 2002). The target level for new housing under current Building Regulations is a SAP of 80. According to the EHCS, the average for the English housing stock was just under 44 in 1996 (DETR, 2000, p49). (In 1991, the average SAP was 35 (DETR, 1996), although this was calculated by a different method and is therefore not strictly comparable with the 1996 average.)

The Affordable Warmth Index (AWI) is based on the same calculation technology, but is designed to compare the running costs for a dwelling with the income of specified occupants to assess affordability. The calculation for the AWI introduces some further assumptions on heating standards and electricity use because it is targeted for certain occupants.

To arrive at an energy rating for properties, certain information must be known to enter into the computerised calculation, including building dimensions, construction insulation values, numbers of chimneys, extent of draughtproofing and details of heating and hot water systems. A worksheet calculation can be done for SAP in Building Regulations applications. NHER ratings may be produced at varying levels of detail and accuracy, depending on the information available, but even at the most basic level an external survey of each property is required at least, with some estimation of insulation and dimensional details.

Under the Home Energy Conservation Act 1995 (HECA), local authorities are obliged to have started compiling energy efficiency data on all domestic properties within their area. However, they receive no extra resources from central government to carry out this work, which has to be done piecemeal for the most part. Most authorities currently have a reasonable amount of information for properties in their ownership but very little detail on privately owned dwellings. Information has to be gathered whenever local authority officers or other agencies have some dealing with the householder and are able to record relevant data according to standard forms. From basic items both SAP and NHER ratings may be calculated at a minimal level of accuracy. This should be a powerful data source in local authority ownership in the future, but to date is far from complete and therefore not yet available.

Ideally, NHER ratings would be preferable for this research, but calculations are only possible with software obtainable through approved training as a qualified NHER surveyor, at some cost.

To assess the energy ratings for all properties in the borough, even on the basis of external surveys alone, would be a lengthy exercise beyond the anticipated scope and resources of the pilot study. Some alternative method was therefore necessary for piloting the proposed methodology. It has been suggested that the SAP rating scheme is inappropriate for use with fuel poverty assessment because the limited basis of its calculation does not include total running costs or take account of location (Chapman *et al.*, 2001). SAP measures energy efficiency, but not total floor area, energy costs or income, which are also important independent factors in fuel poverty. This is why SAP does not correlate with fuel poverty. However, for measuring fuel poverty risk rather than fuel poverty itself, SAP could be used to locate low levels of dwelling energy efficiency in combination with the likelihood of low-income households. Furthermore, in looking at a single borough, the matter of geographical location is not an issue, since there would be no significant variation of climate across an area of that size.

The Energy Report of the 1991 English House Condition Survey (EHCS) gives average SAP energy ratings for typical dwellings across the country, derived from case studies (DETR, 1996). It classified buildings according to the combination of age, ownership and type (low-rise or high-rise flat, terraced house and so on). It was decided to make use of these average ratings consistent with house types matched to the case study examples as closely as possible. Details of the classification methodology employed are described in Chapter 6.

5.3.3 Use of census variables and spatial data analysis

It is recognised that older people are the population group most susceptible to cold-related illness and most likely to suffer from fuel poverty. Authors of the Affordable Warmth Index state that *under-occupation* is a significant factor in fuel poverty (Scannell, 2000). Many older people live in properties that are bigger than they can afford to heat, with more rooms than they would normally occupy. The Census is the most accurate and comprehensive source available for population and household data relevant to this kind of research, although it is only carried out once every ten years. Census variables are, in fact, used towards a number of commonly used deprivation scores, as previously described, and are widely used in epidemiological research. Failing any better or more frequently updated alternative, such data may be used to identify where there is a predominance of pensioners in one or two person households living in larger houses, as a measure of under-occupation.

For the mapping, proportions or rates are required, rather than actual numbers, to allow proper comparison of geographical areas, because of variable population numbers. The Census could also provide base level statistics for the borough for population, household and dwelling numbers. The geographical scale for small area level data is largely dictated here by the availability of morbidity statistics. The use of postcode level is prohibited for reasons of patient confidentiality, since there are only about 14 households to each seven-digit postcode area. The next level up is the enumeration district (ED), which is a census-related subdivision of a ward and the smallest areal unit for which census variables are provided. The average size of an ED in the 1991 Census for England was about 450 persons (Noble *et al.*, 1999, p15), ranging from 125 to 220 households (Haining, 1998, p38). Wards constitute, on average, populations of about 5,500, but areas of this size would be too large to designate as having similar dwelling characteristics, or similar levels of energy efficiency. Alternatively, EDs would probably still give a reasonably detailed classification of housing, health and income data in relation to the area's population.

On the other hand, it should be recognised that when hospital admission statistics are broken down to enumeration district level, for example, the ED may not be a large enough unit to register significant variations. In this case, EDs would need to be clustered, or aggregated, in the final analysis. (The basis for clustering is discussed in Chapter 7.) The accuracy of UK census data is affected by the process designed to help anonymisation of census variables, known as Barnardisation, which introduces some random alteration of figures by 0 ± 1 at ED level within the census results (Haining, 1998, p39). As a result, small overall numbers can be altered radically. This should be recognised, therefore, when dealing with small numbers at ED level and provides further necessity for aggregating data. (For similar reasons of confidentiality, very small EDs are suppressed in the Census, which also requires acknowledgement when appropriate.)

It is necessary to remember, when using Census data, that approximately 1.2 million people in Britain avoided inclusion in the 1991 Census. It is apparent that young men and elderly women were particularly likely to have been missed, but not as a random sample of the population (Shaw *et al*, 2000 p16). At the borough level in Newham, it is thought that even further undercounting occurred than was estimated by the OPCS, largely due to deprivation in the borough and helped by the mobility of the population. Excess population estimates vary from ward to ward (Griffiths, 1994, p144).

5.4 An indicator for ill health related to cold

It has been established that morbidity would be preferred to mortality as a measure of the effects of fuel poverty, although mortality data are conventionally used because they are easier to obtain.

In fact, the available sources of morbidity data are limited. The criteria for this dataset are detailed in this section and the source options are reviewed. There follows a discussion of the suitability and limitations of the data type selected, i.e. hospital episode statistics (HES), judged against the requirements. The choice of diagnosis to represent cold-related illness will then be examined.

5.4.1 Morbidity data requirements

In addition to the general requirements for indicators listed above, further requirements for health data appropriate to the proposed methodology are as follows:

- Data should be representative of appropriate morbidity levels, i.e. indicating the prevalence of *cold-related* disease by diagnosis.
- Calculation of seasonal differences should be possible.
- It should be available at a small enough area level to allow examination of possible relationships with variable housing and population characteristics within the local authority boundaries.
- If possible, the age of patients should be ascertainable, for identification of the older age group.
- It should meet the requirements of the Data Protection Act (1998) with regard to patient confidentiality.

5.4.2 Potential data sources for prevalence of morbidity

Health questions are covered in a number of general population surveys but, for one reason or another, they are not appropriate for the information required here. The problems with regard to self-reporting of health status were made clear in Chapter 3 (3.3.2). The perception and reporting of what constitutes limiting illness may vary independently of disease prevalence, depending on differences of age, gender or social class (Shaw *et al.*, 2000, p17). Even so, this would not necessarily be a reason for rejecting self-reported health data, since the same variations in perception are likely to influence presentation for medical services, as described by Hunt (1993), although statistics involving diagnosis by health professionals are generally regarded as more reliable. Nevertheless, the General Household Survey, which is carried out annually, and includes self-reporting of limiting longstanding illness and use of services, uses a sample size too small for the data to be used at local level (Shaw *et al.*, 2000, p26). The Census covers the whole population and also includes questions on chronic illness, but is too infrequently carried out (i.e. at ten-year intervals) to be of use in this case. Furthermore, questions concerning limiting, long-term illness depend on individual interpretation of the terms used.

Bardsley (2000, p227) has summarised the potential sources of NHS information that may be used to look at housing conditions and health, but finds limitations attached to them all. He mentions that health authorities often carry out *ad hoc* local surveys and suggests that some general health status tools have potential for looking at housing related changes in health. However, these again would rely on self-reported perceptions and, at present, do not constitute a regular or routinely available data source.

The most useful likely sources of information relating to the occurrence of particular diseases throughout the year, at a local level, would appear to be:

- use of general practice (GP) services, i.e. numbers of GP consultations
- use of hospital services, i.e. numbers of hospital admissions.

General practice data

Presently, data that is routinely gathered nationally about general practice is limited, relating to activities involving fees for reimbursement or achievement of targets (Macfarlane, Kerrison *et al.*, 2000, p224). As Bardsley suggests (2000, p227), it may be possible to use GP activity data such as numbers of visits to GPs, or diagnostic data such as visits for asthma, as part of local health status measures, but this could only occur with the co-operation of local practices. A variety of projects across the country have collected information on morbidity and use of services, some of which have been for local use, although participation in many projects is voluntary and some depend on practice ownership of a particular type of computer system. General practices are not required to subscribe to any universal system of routine detailed data collection that would be relevant to the research described here. For example, the General Practice Research Database was used in a study by Hajat and Haines, which describes only 45 to 47 practices in the Greater London area as contributing between 1992 and 1995. Furthermore, it was not possible to distinguish between emergency and elective consultations (Hajat and Haines, 2002). The latter would include, for example, routine visits for simply renewing prescriptions and so would not necessarily be indicative of seasonal effects.

Nationally to date, not all GP practices have computerised medical records. Extraction of data where they do have them is likely to require staff time and expertise and, therefore, cost. Moreover, since information to cover the whole borough would have to be requested from several practices, there could be a problem around lack of consistency, as Majeed points out:

> *"A major limitation of primary care data is that not all practices are currently recording morbidity data on their clinical computer systems. Even when practices are fully computerised, the accuracy and completeness of the data recorded varies considerably between practices"* (Majeed, 2002).

The extent of retrospective data available could also vary according to how recently computerization had been completed. These difficulties would not discount use of GP data in the future, when more consistency and wider computerization has been achieved. It is planned that eventually electronic medical records will be held by general practices for everyone, which would potentially be a major person-based data source in due course (Macfarlane, Kerrison *et al.*, 2000, p222).

Hospital services data

Hospital Episode Statistics (HES) is a database of all episodes of care in NHS hospitals in England. They form part of the basis of hospital activity information that is used for many purposes, including resource allocation, monitoring and evaluation and research among others, as described by Hansell *et al.* (2001). HES data have been collected since 1987, since when their completeness and accuracy have gradually been improved. According to Macfarlane, Kerrison *et al.* (2000, p217), by 1993-4, coverage was 98 per cent, with 96 per cent of records coded and, although at first it took almost 2 years to complete annual data files, since 1998-9 they have been produced on a quarterly basis.

Information on hospital activity is obtainable through different sources and in various formats. *Ad hoc* tabulations and extracts can be acquired directly from health authorities, if the data for analysis relates only to a few providers (hospitals or community trusts). It was decided to use this method for sourcing health data, since, in the case of Newham, the whole borough falls within the boundaries of the area covered by one health authority, the East London and the City Health Authority (ELCHA). There are some recognised problems attached to this type of data and, like mortality statistics, they are also described as representing the 'severe' end of the health spectrum (Bardsley, 2000, p227). However, this appeared to be the best (if not only) option available, the merits and limitations of which will be discussed following a description of its scope.

5.4.3 Fitness of HES data

With regard to meeting the criteria for selection of health data, as set out above, HES are an existing source of data, from which ELCHA were willing to provide extracted information in a form appropriate and relevant to the research. It should also be possible to obtain such data similarly elsewhere, if necessary, for purposes of replicating the methodology. The need to maintain patient anonymity was met by supplying the data according to enumeration district (ED), which is a geographical level still sufficiently localised to compare with housing and population characteristics that identify potential fuel poverty risk.

Seasonal variations in numbers of hospital admissions, or episodes, can be observed because dates of admission are part of the data. Diagnosis codes are also given for each episode, so that the diagnoses chosen to represent cold-related disease can be selected against dates of admission as well as the age of the patient. (These codes are given according to the International Classification of Disease (ICD), although there are periodically revisions to these codes, which need to be taken into account when extracting data.)

Although being admitted to hospital is usually indicative of poor health for an individual, there are difficulties in interpreting admission statistics at a broader level (Bardsley and Morgan, 1996, p13). It is therefore necessary to ask how far hospital admission rates actually reflect the scale of cold-related disease among the population. Research from the USA and elsewhere has consistently found hospital admission rates to vary across geographical areas (Payne *et al.*, 1994). Wennberg *et al.* (1987) found the supply of beds and specialists to be the main determinant of admission rates at inter-regional and inter-district level and that hospital use apparently related clearly to morbidity only for a small number of conditions that are easily diagnosed, with consensus on treatment. An example of such a condition would be myocardial infarction (heart attack) (Wennberg *et al.*, 1987). It may be questioned how closely results from work carried out in the USA would parallel the situation in England where the organisation of health services is rather different. In fact, Royston *et al.* (1992), in their work, used the premise that, at a sufficiently small area level, populations are competing for the same supply of services and that different relative use of services therefore reflects variations in their relative needs.

Payne *et al.* (1994) looked specifically at the use of hospital services as a proxy for morbidity. Morbidity levels for seven diseases or procedures were measured by validated survey questions. Respiratory disease, for example, was defined as a positive response to questions on asthma and chronic bronchitis. It was concluded that two of the conditions examined in this study of a typical health district (respiratory disease and depression) showed a positive correlation between hospital admissions and disease prevalence at ward level. In fact, these were the conditions accepted as more likely than others to lead to hospital admission. At electoral ward level, the correlation between mortality and respiratory disease was less, as would be expected because of the relative numbers. Since the correlation explained less than 50% of the variance, the authors suggested that caution should be exercised when hospital service use is considered as a proxy for morbidity, particularly for other than a limited range of conditions. In consideration of variance found between wards, they attributed this only partially to a variation in response rates, or variable use of the private sector, while it was also possible that postcodes were not completely accurate.

Hansell *et al.* (2001) reinforce the cautionary approach to what they describe, nevertheless, as a valuable source of information. They discuss a number of factors that should be recognised as influencing variations in hospital activity data, in addition to the underlying severity and prevalence of disease. The so-called 'provider effect' explains part of the variation in admission rates between providers of secondary care. It may include variations in completeness of data and coding differences, but also differences in numbers of hospital beds available, admissions policies, hospital access and distance from the hospital.

Nevertheless, other research found that many measures of deprivation are strongly associated with hospital admission rates, particularly for emergency rather than elective admissions, but that the widely varying practice characteristics of primary care groups are less so. They conclude that the differences are mostly explained by sociodemographic patient factors.

> *"Deprivation may affect admission rates directly through increased morbidity, or indirectly through later presentation resulting in more acute symptoms or by lack of social support at home forcing admission"* (Reid *et al.*, 1999).

This could have relevance for Newham, in particular, because of the high levels of deprivation in the area.

To summarise, HES are considered a valuable data source, but it is necessary to be aware of the associated difficulties described. The level of accuracy is improving but has been questionable in past years, for various reasons. Hansell *et al.* stress that

> *"small area studies and comparisons of trusts are particularly vulnerable to bias resulting from variations in quality of the data and the 'provider effect'"* (Hansell *et al.*, 2001, p55).

Ideally, the coverage and completeness of data should be investigated in small area spatial analyses, although that would be beyond the scope of this piece of work, where the focus is on the potential of the methodology. Since the methodology proposed here is concerned with comparisons only within one London Borough, which falls within one health authority area, the premise followed by Royston *et al.* (1992) for small area levels may perhaps be assumed to apply. It would be useful to take account of the number of trusts involved, however. As shown earlier, respiratory disease is one of the conditions regarded as related to cold so, despite their reservations over most other conditions, the findings of Payne *et al.* (1994) make clear that, in this case, hospital service use would probably be a suitable proxy for morbidity. One further limitation of HES is that they do not include records of private provision of secondary care services. However, this would be more likely to be significant for conditions requiring elective surgical procedures (Bardsley and Morgan, 1996, p13), which is not the case here, as only emergency admissions are under investigation.

5.4.4 Diagnosis for cold-related illness

In Chapter 3 it was shown that Collins (2000, p45) attributed the greatest proportional effect of winter on respiratory mortality, although numerically more deaths are attributable to cardiovascular disease, as is also the case throughout the year. In their study of determinants of excess winter deaths, Wilkinson et al (2001, p6) claim to have selected cardiovascular mortality as their point of reference because this disease has the clearest relationship to ambient temperature. There are no references given specifically for this statement, so the reasoning cannot be properly challenged, but it would appear that the view relates to the physiological evidence concerning such issues as increased blood pressure and blood viscosity changes due to cold. It may be that the greater numbers associated with cardiovascular mortality were a further influence on the choice of diagnosis.

However, it has already been shown[27] that evidence also exists associating ambient temperature with respiratory effects. At the same time, it has been suggested that respiratory, rather than cardiovascular, disease may be more closely related to low indoor temperatures. In view of the apparently greater effect of winter temperatures on respiratory mortality, it is considered that this may be the more fitting diagnosis for a cold-related illness indicator.

When considering data for morbidity as opposed to mortality, there is additional evidence to suggest that respiratory disease is an appropriate diagnosis to relate to cold winter temperatures. Hajat and Haines (2002) looked at GP consultations between January 1992 and September 1995 for respiratory and cardiovascular disease. The data was derived from around 40,000 patients aged 65 and over from the 45-47 London practices contributing to the General Practice Research Database. The study found a strong association between consultations for respiratory disease and mean daily temperatures up to 15 days earlier, particularly when temperatures fell below 5°C. There was no relationship observed between cold temperatures and consultations for cardiovascular disease, but it was pointed out that acute cardiovascular events would probably lead to direct hospital admission or death, thus bypassing primary care contact.

Elsewhere, reference is made to various pieces of work indicating that increases in hospital admissions are related to external temperatures, particularly for ischaemic heart disease, cerebro-vascular disease or strokes but, most spectacularly, for respiratory disease (Revie, 1998, p21). There is currently a large-scale project ongoing between the Met Office and the Department of Health, based on this very premise (Met Office, 2001). The aim is to allow hospitals to anticipate

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[27] See Chapter 3 (3.4.3)

the need for emergency beds following predicted drops in external temperature, and adjust their elective procedure timetabling accordingly. It has been shown earlier (3.4.2) that different time lags occur following temperature falls in winter for different diagnoses of emergency admissions, ranging from up to three days for coronary thrombosis to 12 days for respiratory disease (Keatinge and Donaldson, 2000, p18). This knowledge provides further basis for the Met Office predictions of hospital bed needs.

However, according to Damiani and Dixon (2001), who have looked at winter pressures on hospitals in the London area, the only category of emergency admission to show any real seasonal variation is respiratory disease. Not only are respiratory admissions related strongly to winter temperature changes, but the patients most affected, as shown earlier, are those aged 60 and over. They were found to have used 75% of the total bed days of all patients admitted as an emergency with respiratory disease during the four years studied (Damiani and Dixon, 2001, p24).

The work under discussion here aims to show that the apparent relationship with external temperatures is also a reflection of indoor temperatures in poorly heated homes. The resulting cold-related health indicator is therefore proposed as based on excess winter morbidity measured by emergency hospital admissions for respiratory disease for older patients (although the ratio could also be tested for other age groups from the HES data obtained).

5.5 Ethical issues for data use

Reference has been made to the issue of patient confidentiality and anonymity of personal data, which relates to both benefit and health data. Under the recently implemented Data Protection Act (1998), which came into force in 2000, personal data is viewed as relating to a living individual, who can be identified from the data, or from its combination with other information in the possession of the organisation controlling its processing. Such data can only be used with the informed consent of the individual, for the purposes given and, at the same time, it is covered by the common law duty of confidentiality.

For these reasons, the only information that could be used for the pilot study would have to be strictly anonymised and non-identifiable to individuals. The East London and the City Health Authority considered that hospital admission information given by patients' post codes could identify patients, particularly if combined with dates of birth. Neither of these items of information could therefore be given out and the lowest level of detail they could make available was by ED (*see* Appendix G). This necessity has governed the level of mapping detail possible for the pilot study.

There has been some controversy around difficulties for epidemiological research arising from interpretation of the Data Protection Act, as discussed by Strobl *et al.* (2000). They describe a case study that illustrates local variations in interpretation of the Act and highlight the lack of debate concerning the use of patients' records in epidemiological studies. They also point out that

> *"the Department of Health acknowledges that there are conflicting legal views on applying (the common law) duty (of confidentiality) and is trying to interpret it for the health sector. In particular, the issue of consent and the conditions under which consent can be implied or waived need to be clarified"* (Strobl *et al.*, 2000).

According to this paper, clarification was still required on the use even of fully anonymised health data without consent, in the light of an ongoing court case. However, a letter response to the paper, from a member of a Local Research Ethics Committee pointed out that the Act

> *"...exempts research from most of the provisions of the act, allowing further processing of data for purposes it was not originally collected for...and to publish provided the data is in an anonymized form ... "* (Ellis, 2000).

The original paper (Strobl *et al*, 2000) also suggests that if data are fully anonymised, they are not personal and do not fall within the scope of the Data Protection Act. Using data at ED level would appear to satisfy this requirement, but this depends on the data being supplied at the appropriate level by the source agencies.

5.6 Choice of study area

The work towards production of this thesis was initially based at the University of East London School of Architecture, located in the London Borough of Newham. A number of established contacts were already in place with the borough and with the relevant health authority - the East London and the City Health Authority (ELCHA). Officers in the Borough Housing Department had expressed interest in the research proposal, as they were already committed to addressing the problem of fuel poverty, and their colleagues in the Anti-Poverty Welfare Rights Unit similarly had an interest. Members of the health authority, within the Health of Londoners Project, were particularly concerned with the problem of showing connections between housing and health. Fortunately, in addition, Newham lies completely within the area covered by the one health authority. For these reasons, Newham was selected as the basis for the pilot study.

5.7 Summary

The research question aims to establish whether a relationship can be shown between fuel poverty and the health of older people in a way not previously demonstrated. If such a relationship can be shown it would contribute to the government demand for evidence on which to base public health policies. It could also lead to some means of health impact assessment for policies promoting energy efficiency improvements in hard to heat housing. It is proposed to use an epidemiological approach, based on morbidity rather than mortality data, whereas earlier population studies concerned with housing and health have concentrated on excess winter deaths as the health measure. The only intervention studies to look at health outcomes of cold and damp housing so far have been small scale, with no consistent measures or methodologies employed.

In the past, there has been a lack of combined housing and health statistics, to the detriment of research into relationships. The projected methodology aims to relate health to housing data that, combined with low-income information, would form part of an indicator for fuel poverty risk. Mapping, using GIS software, is suggested for presenting the data and analysis, as a suitable means of overlaying fuel poverty risk factor data together with possible health effects to test for relationships.

The methodology is designed to be replicable so that consistent and comparable evaluation would be possible in different locations. Small area level comparisons are proposed, using EDs as the basic unit of data, whether it is derived from the local authority, health authority or the Census. To locate low-income households, Council Tax Benefit receipt is the proposed identifier. Poor levels of energy efficiency would be derived from comparing local combinations of dwelling characteristics against EHCS case study house types, which are representative of average SAP energy ratings. The health indicator for cold-related illness would be based on seasonal comparisons of hospital admission data for a diagnosis of respiratory disease. In the following chapter, the full details of the methodology are described, as tested in the pilot study.

CHAPTER 6
Implementing the methodology: the Newham pilot study

"One has to cut one's coat according to one's cloth, You can't put the fire up high all the time. You've got to do something about it – you can't have it on all day or all evening."

Older person without central heating. (Salvage, 1994, p41).

6.1 Introduction

In Chapter 5 a proposed methodology has been outlined and justified for answering the research question at the heart of the thesis. The methodology is designed to demonstrate whether a relationship exists between fuel poverty and the health of older people. In this chapter there follows a description of how its feasibility has been tested by carrying out a pilot study in the London Borough of Newham.

A proposal for the pilot study was first submitted by the author as a funding application to the Eaga[28] Charitable Trust (Eaga-CT) under their call for research projects on 'Fuel poverty and health'. Eaga-CT awarded a grant for one year's part-time salary to carry out the project, on the condition that they would also cover the cost of appointing an 'appropriate medical expert' to act as adviser, in recognition of the necessarily multi-disciplinary nature of the work. Accordingly, a consultant epidemiologist was appointed to advise the pilot study, which was commenced in May 1998. A Report on the study was published in April 2001 (Rudge, 2001a). (The study has also been described, at various stages, in a chapter in a book co-edited by the author (Rudge, 2000a), posters presented at two conferences (Rudge, 2000b, Rudge, 2001b) and a journal article (Rudge, 2001c), contained in Appendices H-L.) The initial study is described here in full, with the inclusion of some recent small additional refinements to the methodology.

As explained previously, the study involves locating dwellings of older people at risk of fuel poverty and examining the relationship with the home location of older people admitted to hospital for cold-related disease in winter. The analysis therefore depends on drawing together information regarding buildings, population, income and hospital admissions. In addition,

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[28] Energy Action Grants Agency

meteorological data would be necessary to indicate the degree of winter severity that could influence the occurrence of cold-related disease. The period of study looked at (1993 – 1997) was dictated by the obtainable health data, as was the geographical level of analysis. Before detailing the data acquisition and methods of identifying fuel poverty risk and excess winter morbidity for all EDs in Newham, the background characteristics of Newham, the study area, will be examined.

6.2 Study area characteristics

6.2.1 Population and income

The population of Newham was estimated by the OPCS for 1993 as about 226,000 (Bardsley and Hamm, 1995, p11). The borough constitutes 24 wards subdivided into 460 enumeration districts, each representing a population of around 500 according to the 1991 Census, although this figure was highly variable[29] (Griffiths, 1994, p127). As already noted, the population numbers projected from census figures should allow for a margin of error recognised at the time of the 1991 Census due, in particular, to under-registration for avoidance of Poll Tax. Since deprivation was thought to be an important factor in under-registration, this would be especially relevant to figures for Newham (Griffiths, 1994, p145). The Department of Environment Local Conditions Index 1993 categorised Newham as the most deprived of 366 local authorities in England (DETR, 1993). In fact, according to Bardsley and Hamm (1995, p18), Newham is among the six most consistently deprived boroughs in London and England by whichever deprivation index is measured.

In 1992, the *Newham Housing Needs Survey* found that household incomes were markedly lower than for London as a whole (London Research Centre, 1993). The population is characterised by a high proportion of young people, great ethnic diversity and, typically of urban areas, it has a high rate of population movement. Overcrowding, when defined as households with more than one person per room, affects 30% of children and 16% of all residents in the borough (Bardsley and Hamm, 1995). According to the 1991 Census, Newham has the second highest level of overcrowding, which is a major feature of housing deprivation in the borough (Griffiths, 1994, p51).

There are more than 30,000 people of pensionable age and more than one third of these live alone, constituting half of the high proportion of single person households in the borough. In the

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[29] *see* Appendix A for numbers per ED

health authority district there are fewer people aged over 75 than would be expected from national rates because of a historical lack of suitable nursing home accommodation locally, but this would not affect the numbers in private dwellings.

'Difficulty paying bills' was reported by 38% of respondents to the Housing Needs Survey, while the *Newham Health for All Survey* found that 16% of respondents could not afford to keep their homes warm (LB Newham, 1996). A small survey in Newham of people dependent on social security benefits carried out in 1992 showed that 31% economised on heat all the time (Griffiths, 1994, p22).

Mobility of population may be argued as problematic for the purposes of the research, but the built housing largely remains the same and the pilot study is looking at health episodes that may be related to buildings, rather than to a specified population. It may also be argued that the mobile sections of the population are likely to be from younger age groups than those who are most expected to be at risk of fuel poverty.

6.2.2 Housing

The 1996 Newham HECA Report listed the numbers of dwelling units in the following ownership:

local authority	25,635
private rented	15,300
housing association	7,800
owner-occupied	39,000

Within the private sector, 9,100 units were unfit and the majority of dwellings are terraced houses. Of the local authority properties, most are low-rise flats or maisonettes and tall blocks, built between the early 1950's and late1970's.

According to the 1996 English House Condition Survey Energy Report (DETR, 2000), the national average energy rating (SAP rating, *see* 5.3.2) is just under 44. Eight per cent of dwellings in England - over 20% of these being privately rented - had a rating below 20. By comparison, the average SAP rating stated in the 1996 Newham HECA Report was 38 for local authority properties and 40 for private and housing association ownership.

Out of the 366 local authorities in England, in 1994 Newham had the 33rd highest percentage of pensioner households without central heating (Griffiths, 1994). The *Newham Housing Needs Survey* in 1992 estimated that 13% of pensioner-only households were in housing need, defined by an index based on factors of sharing accommodation or basic amenities, lacking basic amenities, serious overcrowding or dwellings with serious damp problems (Griffiths, 1994, p50).

6.2.3 Health

For a number of health indicators the worst values in London are to be found in Inner London Boroughs, including Newham. In fact, a briefing paper published by the Health of Londoners Project finds clear relationships between measures of deprivation and health indicators (Bardsley and Morgan, 1996, p7). Health inequalities within London as a whole have been increasing in recent years (HOLP, 1997). Of the London boroughs, Newham has one of the highest standardized mortality ratios[30] (SMR), at 114 far worse than the national average (Bardsley and Hamm, 1995, p88).

During 1993-4, there were almost 1.4 million admissions to hospital for all London, which is equivalent to an annual rate of 196 admissions per 1,000 population (Bardsley and Morgan, 1996, p13), of which around 75 are emergencies. Using an age and sex standardised admission rate (SAR) based on values for Greater London as a whole, the highest admission rates were shown in the boroughs of Tower Hamlets (123) and Newham (121). (SAR is calculated in a similar way to SMR.) Respiratory diseases admissions, including for asthma, are slightly higher in Inner London, Newham being among the boroughs with the highest SAR, at over 115. In contrast, the lowest value of 80 is found in Kensington and Chelsea (Bardsley and Morgan, 1996, p16).

It appears that the level of hospital admissions is linked to the (electoral) ward level of deprivation, with considerable variation between boroughs and between wards within them. The higher proportion of emergency admissions in East London Boroughs, including Newham, is also noticeable and strongly related to deprivation levels. A number of factors are suggested, including

> *"a tendency to admit more frequently in poorer areas because of the social circumstances of individuals"* (Bardsley and Morgan, 1996, p14).

According to Bardsley (2000, p230), in London there are more than 80,000 admissions to hospital every year for respiratory disease, which is equivalent to about 12 admissions for every 1,000 residents. In the year 1993-4, the Health Authority reported 51,980 hospital admissions for Newham residents so, compared with the population of about 226,000, this represents about 230 per 1000. For respiratory disease, annual numbers of admissions per 1000 are given as just over 14 (Bardsley *et al.*, 1998, p115). Evidently, the *average* number per ED (with an average

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[30] for definition see 5.2.4

population of approximately 500) would therefore be about 7 and it could be anticipated that in many years, there would be no respiratory admissions for many EDs.

In the following sections there is a description of methods used to acquire data for the various indicators required to characterize fuel poverty risk in Newham.

6.3 Council Tax Benefit receipt: a low income indicator

The first component of fuel poverty risk considered here concerns low income. For this and the remaining indicators, a number of 1991 Census variables were used, extracted by ED. These were obtained through the Census Dissemination Unit (CDU) at the University of Manchester based MIMAS[31] service. The Small Area Statistics tables for Great Britain (Manchester Computing Centre, 1992) list the variables available at ED level, which are then used to query the database held at Manchester. Derived data, such as deprivation indices, are also obtainable. Some variables were used to confirm particular characteristics of dwellings, population or households; some assisted in estimating the distribution of building types, in combination with other data; and others allowed the calculation of rates per ED as a means of comparing EDs of varying size. The variables used are identified by their codes in Appendix B.

Although the study period for the pilot study was from 1993 to 1997, it was not possible to get hold of information on low incomes for the same period. From the commencement of the study in 1998, it took some time to establish which benefit data would be made available and which would be the most useful, or appropriate. Benefit data is usually supplied as at the date of extraction so a historical record over a particular time period is unlikely to be obtainable by present data collection methods. Newham Housing Department was willing to provide Housing Benefit data of both closed and live cases, which might have given a partial historical picture. However, for the reasons discussed in Chapter 5, the possibility of obtaining CTB receipt data was investigated beyond the initial unsuccessful inquiry to the Finance Department. Eventually, this data was forthcoming via the Anti-Poverty and Welfare Rights Unit at Newham. They commissioned the data compilation from a newly established 'data warehouse' within the Borough. Since the warehouse was only recently set up, the data was not expected to be totally without error and the information was also supplied current to the date of extraction, i.e. July 1999. The only historical data available were the overall numbers of recipients for the relevant years. Although the data is therefore not contemporaneous with the health data, it was used as an

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[31] Manchester Information and Associated Services.

indication of low income for the purposes of testing the methodology and potential data sources. Since the methodology at this stage concentrates on older people, it is assumed that they are a reasonably stable population and their circumstances would not have changed dramatically over the previous few years.

The data given included both CTB status (open, or open/suspended) and HB status. Postcoded addresses were provided on the basis of an undertaking that individuals would not be identifiable and numbers of benefit recipients would be aggregated at ED level. Within the terms of the 1998 Data Protection Act (which had not yet come into force), the resulting statistics are anonymised. The source data was kept securely and unnecessary details were deleted following the conversion process, for reasons of confidentiality.

The process was as follows:-

1. The list was sorted for addresses with open or suspended CTB status. Those with HB status only were omitted for the sake of simplicity. It was thought preferable for the purposes of the pilot study to concentrate on a single benefit receipt as a low-income indicator, particularly as one (CTB) is awarded to households and the other to individuals.
2. Postcodes were corrected to a seven-digit/space format for the conversion to ED process.
3. A list of unique records of postcodes was produced; the 'PC2ED' utility, available through the Census Dissemination Unit (CDU) at the University of Manchester, was used to convert these to EDs. Note that 9.4% of postcodes could not be matched and therefore were incorrectly listed, or may have been new or altered since the 1991 Census. Some postcodes were also incomplete and could not be included.
4. The equivalent ED was added to each address record, accordingly.
5. The list was cleaned up to exclude non-Newham EDs and those without complete ED numbers.
6. The number of CTB recipients (open status) was counted for each ED.
7. The numbers of households in each ED were extracted from 1991 Census data (*see* Appendix B for variable used) .
8. The percentage of CTB recipients per total households for each ED was then calculated (*see* Appendix A for results)

6.4 Housing energy performance indicator

6.4.1 EHCS house types

As previously explained, for lack of available energy rating data, Newham house types were to be approximated to the 1991 EHCS house types for which average SAP ratings are given in Fig. 6-1. Newham dwellings could then be assigned SAP ratings according to the house types matched. The 1996 EHCS Energy Report may have been a better guide for the study period (1993-1997), but this had still not been published at the time the pilot study was undertaken. (Although it has become available since, the types illustrated vary from the 1991 Report and a new method has been introduced for calculating the SAP ratings which has produced different figures for those types that remain the same. It is assumed that the relative differences between SAP values would be approximately the same as before, however.)

As Fig. 6-1 indicates, the identifying features of dwellings required to categorize them are building age, building size and type and building tenure. It was necessary to draw on a number of sources and methods to establish the required information. The EHCS house types are taken from case studies representative of the whole of England. The types in Newham do not conform straightforwardly to these and although it is possible to approximate to the middle of the range, at the boundaries there are necessarily estimations to be made and difficulties in distinction. For example, none of the post-1980 housing types were shown as local authority tenure in the EHCS, so any recent local authority stock was assumed to be the same as the equivalent housing association type.

6.4.2 SAP ratings and available Newham data

As required under HECA[32], Newham has started to make an assessment of energy efficiency for all dwellings in the borough. The Housing Department has set up a database of residential properties by address and tenure, and energy rating details are gradually being entered from a variety of sources. The information already included within the borough was so far incomplete, particularly with regard to the privately rented and owned sector. However, it had been thought that the validity of the EHCS average ratings in the Newham context could be tested against examples for which data did exist, provided by Newham's Energy Efficiency Officer, once the ratings had been estimated from available information.

[32] Home Energy Conservation Act 1995 (*see* 2.2.8)

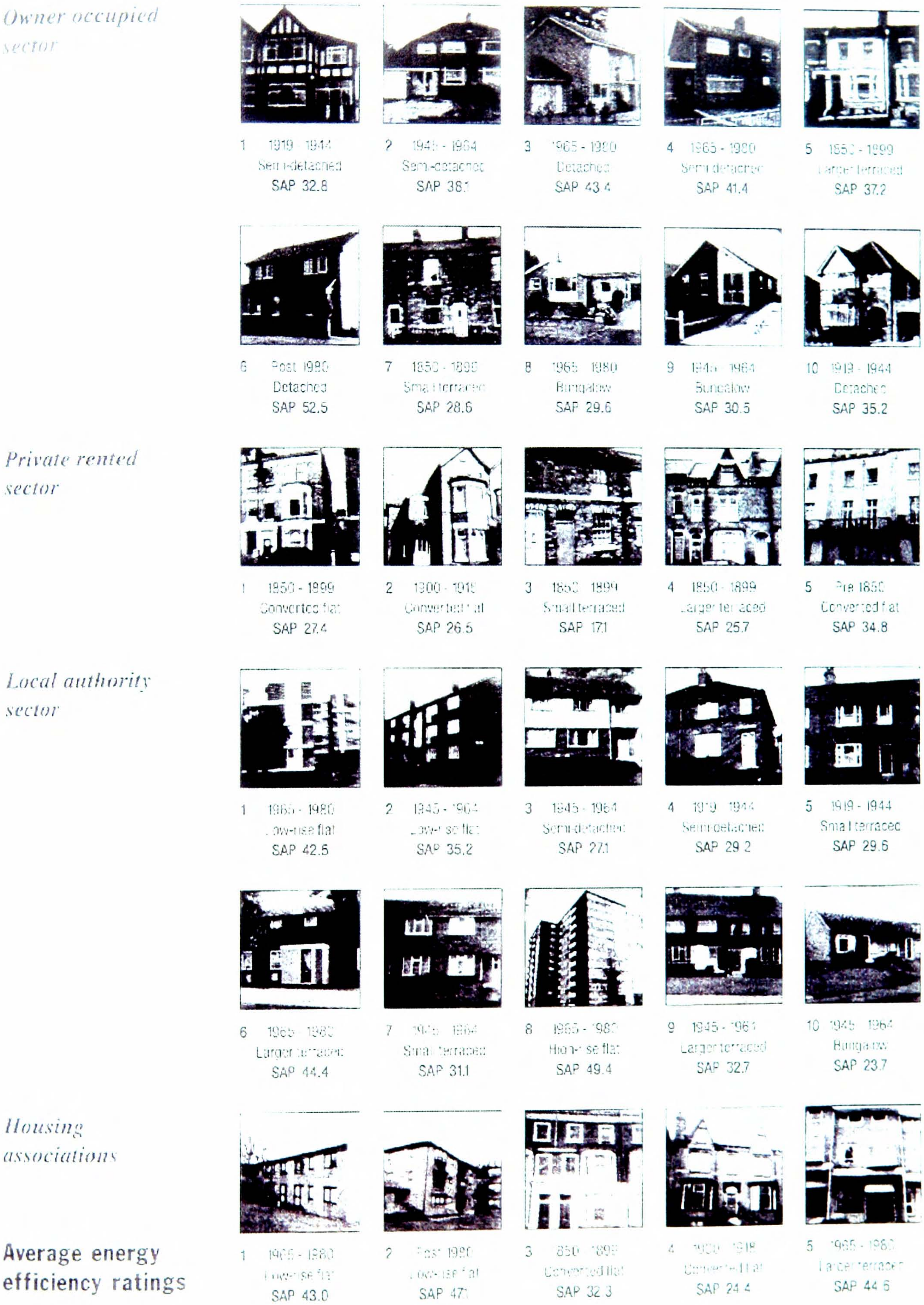

Figure 6-1: EHCS case study house types and SAP ratings

from the Energy Report of the *1991 English House Condition Survey* (DETR, 1996)

In the event, the Newham figures appeared generally to be more optimistically calculated than the EHCS case studies. The Newham database contained data scattered across EDs but none for complete EDs, so that percentage figures for the distribution of SAP ratings could not be compared ED by ED with the study's estimated SAPs. From some individual examples of house types taken randomly, in some cases, the ratings in the database appeared to be lower following improvement than the EHCS comparison would indicate. Because of these apparent inconsistencies and serious gaps in data, it was decided, therefore, to work only with the EHCS method as designed for the pilot, rather than alter the definition criteria to fit the Newham data available at the time.

6.4.3 Building age

Details of the age of buildings were collated onto a single colour-coded map (*see* Fig. 6-2) for the pilot study from information on a series of maps compiled by Newham Planning Department in 1982. A transparency indicating ED boundaries was overlaid on this map and the percentages of different dwelling age groups within each ED were estimated (visually) to the nearest 5%. From the map, it is very clear that in most cases whole streets have similar characteristics. (One ED usually comprises two or three streets.) The age groups defined by the Planning Department differed slightly from the EHCS categories, so equivalent groupings were used as shown in Table 6-1.

Table 6-1: Equivalent building age categories assumed for classifying Newham house types

Newham Planning Department		*EHCS (DETR, 1996)*
A	pre 1850	pre 1850
B	1851-1870}	1850-1899
C	1871-1895}	
D	1896-1916	1900-1918
E	1917-1944	1919-1944
F	1945-1960	1945-1964
G	1961-1980	1965-1980
H	post 1980	post 1980

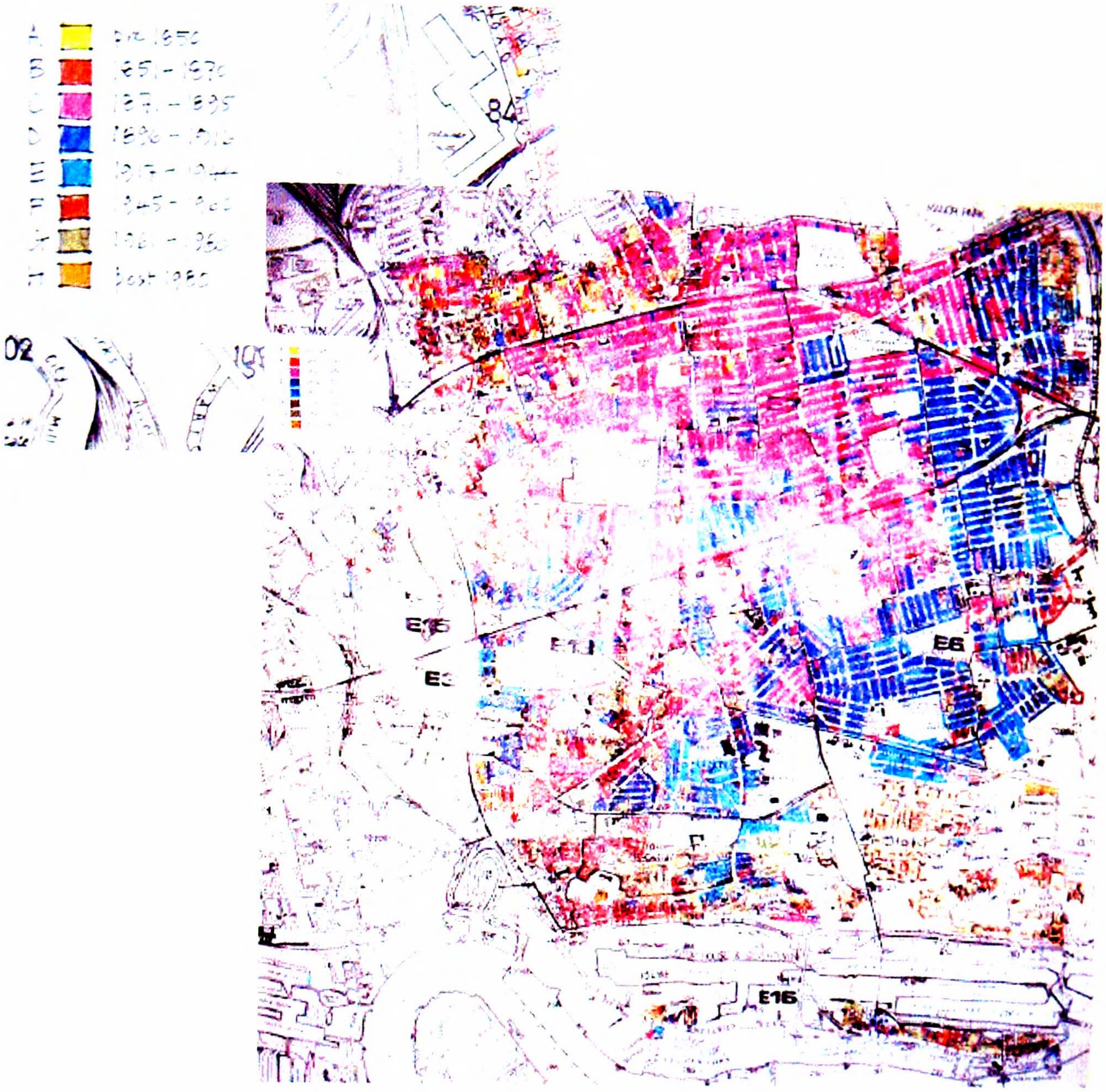

Figure 6-2: Map showing age of domestic buildings in Newham*, prepared from LBN Planning Department data

*Note that EDs to the south east of the borough are omitted because they contain only industrial buildings.

6.4.4 Building type

Computerised aerial photographic surveys of the area, which were available through the School of Surveying, University of East London, could, in theory, have been used to help identify recently constructed housing and to determine the storey heights and types of buildings. Some were initially examined, but their usefulness was found to be variable, depending on the position of the sun and the direction of shadows at the time of the photographs. It was decided that only a physical survey of the area would produce reliable confirmation of these details. This involved a considerable number of drive-round surveys of the area, marking street by street on a map as terraced, semi-detached, low or high-rise flats and so on. It was necessary to distinguish the relative size of terraced dwellings, as the EHCS used 70 square metres as a threshold definition for small and large terraced houses. The width of frontage, depth of terrace from the gable end and the size of offshoots (back extensions), where visible, served as a guide. Time only allowed for educated estimation on the basis of professional experience as an architect, so a degree of generalisation and error must be recognised.

6.4.5 Building tenure

Details of the distribution of various dwelling tenures in each ED were derived from the 1991 Census[33]. It was possible, in most cases, to match percentages of tenures with corresponding percentages of house types from census data (for example, local authority ownership to purpose-built flats, or owner-occupied status to terraced houses), particularly as only one or two tenures tended to predominate in each ED. . A spreadsheet was used where combination details of age, type and tenure were entered as percentages for each ED[34]. These were then matched against the EHCS combinations to produce a range of percentage SAP ratings for the ED. Tenure may have altered to some extent since 1990, as local authority properties have moved into owner-occupation or housing association ownership. However, if they were local authority owned in 1990, then it was assumed that the type would be largely comparable with those designated as that ownership in the EHCS case studies, data for which was gathered in 1991.

6.4.6 Building improvements and unfit dwellings

Evidently, changes in building energy efficiency could have taken place between 1993 and 1997 (the period for which health data was available), but historical information relating to building improvements presents further difficulties. It was considered using a list of properties that had received Home Energy Efficiency Scheme (HEES) grants, which are allocated to householders in receipt of certain benefits. However, the local authority advised that, in their experience, the accuracy of the postcodes and addresses obtainable from the HEES installers was questionable.

Newham Housing Department provided details of large-scale Estate Action schemes carried out over the period under study for properties in their ownership. However, the energy rating improvement resulting from various upgrading works could only be estimated. It was assumed that most of the estate properties which were indicated as improved by the local authority would have had a SAP higher than 35 before refurbishment. Therefore the improvements would not have altered their classification for the purposes of the calculations done here, where a low SAP was defined as less than 35. This benchmark figure was selected because it was the national

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[33] for variables used, see Appendix B

[34] *see* example sheet in Appendix D

average SAP rating according to the 1991 EHCS (DETR, 1996). Again, to collect data on all improvements in detail, if it were possible, was beyond the scope of the study. Once a completed energy efficiency database is in place with the local authority, this would be the preferred data source for the buildings indicator, but it could be anticipated that they would have similar problems in keeping it up to date.

There are a large number of unfit houses in Newham (*see* 6.2.2), which may indicate that lower SAP values prevail here than elsewhere and that some adjustment should be made to the estimated SAP ratings for Newham properties. However, it could be presumed that some unfit houses would have been included in the EHCS sample and could have influenced the resulting SAP averages but, if so, it is not known to what extent. Furthermore, in Newham, the high numbers of unfit dwellings are in the private rented sector, within which sector all dwelling types fall into the <SAP35 category (*see* Table 7-1). There would therefore be no need to make any adjustment to the EHCS categories to allow for high numbers of unfit properties, since they are already classified within the low SAP category for the purposes of this exercise.

6.4.7 Energy rating estimation process

The methodological procedure involved setting up a spreadsheet (*see* Appendix D for illustration) with fields entered as follows for all EDs:-

1. From the 1991 Census, percentages of all dwellings (to the nearest whole number) were found for each ED concerning *building types*, *i.e.* detached, semi-detached, terrace, purpose-built flat, converted flat (Census variable numbers listed in Appendix B).
2. Similarly, from the Census, percentages for EDs were found for *tenure* of dwellings: 1 = local authority; 2 = housing association; 3 = private rented; 4 = owner-occupied.
3. To take account of vacant properties, the census variables used for numbers of dwellings (or household spaces) was for those with residents (as at 1991).
4. The information derived from the completed map for *age of buildings* (Fig. 6-2) was entered as percentages estimated to the nearest 5% of age groups A-H (*see* Table 6-1) in each ED. Where a building age group constituted less than 5% of the dwellings in an ED, it was not noted.
5. From the physical survey data, the observed *building types* (a-h) were added to the spreadsheet against the building age groups:-

a = small terrace (<70m^2);	b = large terrace (>70m^2);
c = converted flat;	d = low rise flats or maisonettes (<6 storeys);
e = high rise flat (6+storeys);	f = bungalow;
g = detached;	h = semi-detached.

6. These percentages were then compared with the Census data (from 1 and 2), adjusted accordingly and the *tenure* added to house *type* and *age* matched as described above (*see* 6.4.5).

   N.B. Adjustment was necessary because areas on the map could not convey density of building. For example, the plan area for a terrace of two-storey dwellings is not readily comparable with a 22-storey block of flats in terms of numbers of dwellings, even if allowance is made by including the attached open space around the block. Comparison with the census data therefore allowed corrections to be made to the data taken from the map.
7. The groupings of age, type and tenure were then adjusted as percentages of dwellings in each ED with different *SAP ratings*. These were determined according to the EHCS case study types or approximated to the nearest type (*see* Appendix E for example spreadsheet page). For example, 30% of E.a.1. would indicate that 30% of dwellings in the ED were interwar (ageband E), small terraced houses (a) in local authority ownership (1) with, therefore, an estimated typical SAP rating of 29.6 (see Fig 6-1, Local Authority ownership, type 5).

   Figs. 6-3a – 6-3d on the following pages illustrate examples of Newham house types and their equivalent estimated SAP ratings.
8. Those EDs relating exclusively to hospitals were omitted from the list (4 no.), together with four others for which no Census data appeared and two which were transferred to another borough in 1994. The total number of EDs included was therefore 450, for which the total population (1991 Census figures) was 211,072.
9. In the spreadsheet the following were calculated for each ED:
   - an <u>average SAP</u>
   - the <u>mode SAP</u>, or the most common SAP rating (although some had two or three modes, with equal percentages, in which case the lowest was used)
   - the <u>percentage of households with a low SAP</u>, i.e. <35.

When comparing the energy rating prevailing across the borough, use of the mode seems to be more useful. It gives a greater range of SAPs than the use of the average, which brings most EDs into one limited band. In the event, the percentage of households with a low SAP was used in comparing EDs for fuel poverty risk. This is because rates, or proportions, are more useful for comparisons of geographical areas, with varying populations and dwelling numbers, than absolute numbers (*see* 5.3.3) and all fuel poverty risk factors were therefore calculated as rates (*see* 6.8.3).

Note: Assumptions made were as follows:

- where census data showed purpose-built flats for pre-1945 dwellings, these were classified as converted flats;

- where census data showed bedsits / rooms / non self-contained flats, these were classified as privately rented, converted flats.

There is a large number of unfit houses in Newham (see 6.2.2), which may indicate that lower SAP values prevail here than elsewhere and that some adjustment should be made to the estimated SAP ratings for Newham properties. It could be presumed that some unfit houses would have been included in the EHCS sample and could have influenced the resulting SAP averages but, if so, it is not known to what extent. Furthermore, in Newham, the high numbers of unfit dwellings are in the private rented sector, within which tenure all dwellings fall into the <SAP35 category (see Table 7-1). There would therefore be no need to make any adjustment to the EHCS categories to allow for the extent of unfit properties, since they are already classified within the low SAP category for the purposes of this exercise.

6.5 Underoccupancy score

Finally, it is necessary to take into account underoccupancy as a component factor of fuel poverty risk, for which a combination of census variables was used (*see* Appendix B). In the 1991 Census, a measure of density is available in terms of persons per room, although it appears to be aimed more towards indicating overcrowding rather than underoccupation. The minimum measurement option for this variable is '<0.5 persons per room (ppr)'. Rooms were defined as including all living rooms and bedrooms - and kitchens larger than two metres wide (Dale, 1993). Children under 10 are counted as 0.5 persons. However, this lowest density figure could equally well mean one person living in a 4-roomed house or two adults in a 5-roomed house and applies to approximately 50% of all households. It would not, on its own, therefore, appear to be a clear indicator of underoccupancy. (There is also a problem regarding accuracy of figures because the definitions are subject to interpretation and judgement by respondents as to the definition and size of rooms.)

According to Houghton and Bown, under-occupation

> *""...is often said to exist where a household occupies their home at less than 0.5 persons per (habitable room), or where it has 'a surplus' of 2 or more bedrooms in terms of the bedroom standard."* (Houghton and Bown, 2003, p9 – quoting Barelli and Pawson, 2001).

Low rise maisonettes
Local authority
Built 1945-1960*
Estimated **SAP 35.2**

*this example recently upgraded by LBN, so SAP would now be higher

High rise flats
Local authority
Built 1961-1980
Estimated **SAP 49.4**

Large terraced house
Private rented
Built 1850-1916
Estimated **SAP 25.7**

Figure 6-3a: House types identified in Newham, showing location on building age map

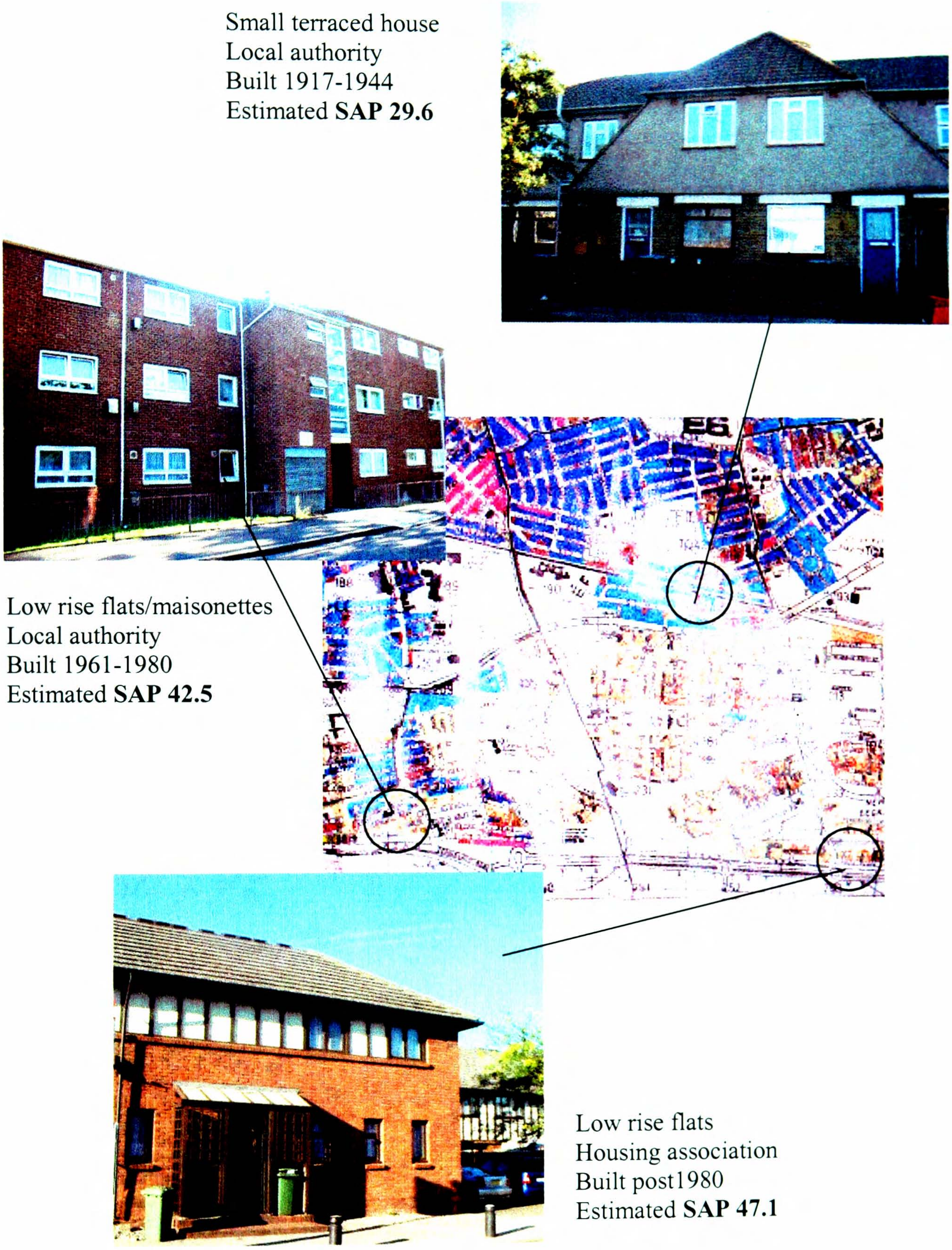

Figure 6-3b: House types identified in Newham, showing location on building age map

Figure 6-3c: House types identified in Newham, showing location on building age map

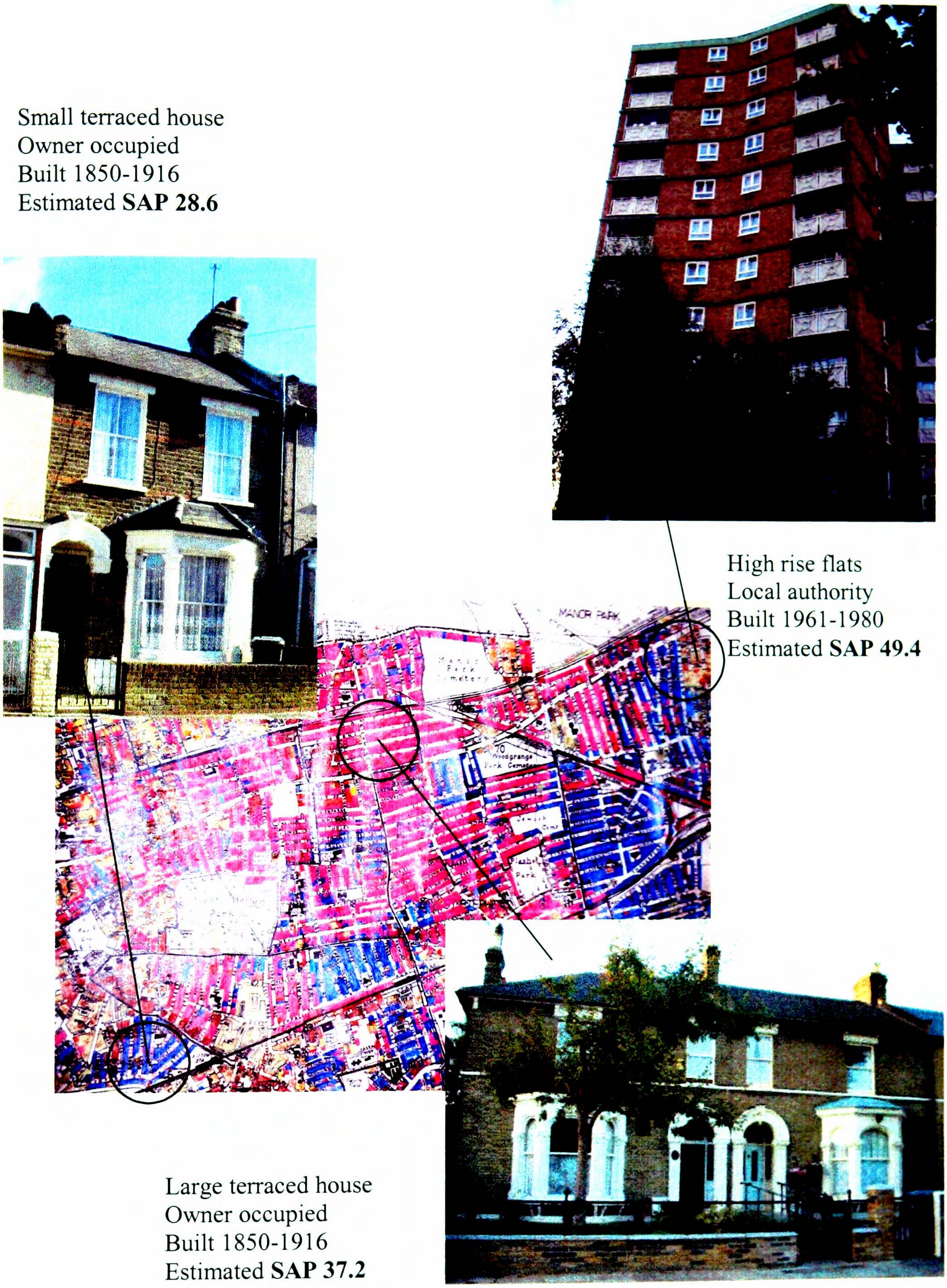

Figure 6-3d: House types identified in Newham, showing location on building age map

The EHCS definition is based on the number of bedrooms, assuming that pairs of children would share bedrooms, depending on their age and gender, and where the existence of one spare room is regarded as under-occupation. Again, as Houghton and Bown point out, this is the norm for all households. They suggest that in fuel poor households it could be more appropriate to look at an excess of 2 or more bedrooms. Thus, for either a single person or a couple, a 3-bedroomed house would be considered as under-occupied.

In Chapter 4, older people were identified as a section of the population particularly at risk of fuel poverty. Part of the reason for this is that the combination of fuel poverty and under-occupation is most common in older people's homes (Houghton and Bown, 2003, p14). Age is therefore a further risk criterion to be considered together with under-occupancy. Numbers of households with one or more pensioners were extracted from the census, as well as numbers of one or two person households. The combination of these 2 sets of variables, together with the number of households with 5 or more rooms were chosen to calculate an underoccupancy score. It would therefore represent the likelihood of underoccupancy amongst pensioner households of one or two people. The Census does not give numbers of bedrooms, so 5 rooms was taken to indicate a minimum of a three-bedroomed house with two 'living' rooms (one of which could be a large kitchen). It should be noted that, according to the 1991 Census, pensioners are 65 years old and over if male, but 60 years old and over if female.

Having identified the various components of fuel poverty risk that may be seen to overlap, the following section describes the method employed for applying a health marker to the borough's population that might reasonably be linked to fuel poverty.

6.6 Excess winter morbidity ratio: a cold-related health indicator

6.6.1 Excess winter morbidity

Excess winter deaths are regarded as an indicator of adverse health effects of low winter temperatures. Curwen (1997, p207) describes the definition of excess winter deaths (EWD) as the number of deaths in the four-month period from December to March (winter), less the average of numbers in the preceding four months (autumn) and the following four months (summer). This calculation method is more useful than dividing the year into quarters, which separates the month of December from the rest of the winter. The Excess Winter Death Index (EWDI) is defined as the *percentage* excess in winter compared with the average for the rest of the year.

For the purposes of monitoring effects of home improvements, however, it is suggested that it would be more appropriate to use a measure of excess winter *morbidity*, as described in Chapter 5. After all, in terms of the potential burden to the health services, once death has occurred there would no longer be any costs to bear. Excess winter morbidity may be calculated in the same way, so the same four-month winter periods are compared with the rest of the year as taken from August to July, but using hospital admission rather than mortality statistics. The methodology described here proposes the use of a ratio (similar to the EWDI), which does not therefore rely on absolute numbers for its value. Its calculation is described in detail below, following a description of the data obtained.

6.6.2 HES data

In June 1998, the East London and the City Health Authority (ELCHA) provided records of hospital admissions over a five-year period from January 1993. They advised that data held from earlier than this date was unreliable (and a small percentage of errors were found in what was provided). Because of the method of calculating seasonal morbidity described above, taking the year from August to July, a four-year period of study was therefore possible. The consultant epidemiologist appointed to the project (Dr Paul Aylin) advised on all aspects of health data acquisition, data handling and analysis.

Twenty-one fields of data were provided (*see* Appendix F for sample datasheet), including admission type and dates, episode beginning and end dates, diagnosis and specialty codes, age and gender. (This range of data gives scope for analysis beyond the initial parameters of the pilot study, with a view to pursuing the work further.) Postcodes had been converted to enumeration district numbers. The degree of error found in the data was less than 0.3% (845) of 291,048 total entries as import errors and about 3% (8,408) of records found without ED information.

It was explained earlier that respiratory disease is the most appropriate to use as a cold-related diagnosis. Curwen shows that mortality from respiratory disease accounts for about a half of all excess cold-related deaths, while ischaemic heart disease and cerebrovascular disease account for the rest (Curwen, 1997). Statistics for Newham as a whole revealed the greatest seasonal variation for hospital episodes attributed to respiratory disease when compared with ischaemic heart disease and cerebrovascular disease, or stroke.

The selected study period spans the changeover from ICD-9 to ICD-10 for diagnosis classification (*see* 5.4.1) and both code revisions appeared in the data. Since the accuracy of clinical coding has been thought to be suspect in the past, Damiani and Dixon (2001, p25) suggest that greater accuracy is likely at higher levels of coding (eg ICD-10 chapters and subchapters) than for specific diseases. According to advice received, respiratory episodes were defined by the use of all diagnoses classed as respiratory disease: ICD-9 codes 460-519 and ICD-10 codes J00-J99.

Although more than one diagnosis may be given for each patient, the primary diagnosis field in the data was used. Hansell et al recommend that a good approximation for counts of admissions is to use the primary diagnosis for the first episode because

> *"...counts of admissions will be increased if patients are discharged early only for them to be readmitted later....or patients go home for the weekend and are readmitted on Monday"* (Hansell *et al.*, 2001, p52).

In this case, emergency admissions only were counted, as these would be more likely to be related to prevailing weather conditions than planned or elective admissions. Disease *episodes* were counted rather than admissions, despite the possibility that numbers of episodes could be for the same individual. The episode order was not available, so the first episode for a single patient could not be identified. However, numbers of episodes would still be valid as a measure of the occurrence of illness related to cold. Patient identifiers could be used in future to link episodes for the same individual.

Although the research was to concentrate on older age groups, it was useful to be able to consider others for comparison, for which the data was first sorted by age band. It was suggested that five age bands were used above the age of 24 years old. Age groups younger than 24 are more likely to suffer asthma, which occurs in all seasons and could show as a summer excess. This would potentially confuse statistics for excess winter respiratory episodes. The age bands used were: 25-44, 45-64, 65-74, 75-84, and 85+. In fact, for the analyses carried out in the pilot study, only the age groups above 64 years old were used, being the population most affected by cold-related illness.

Years for illness episode dates were broken down into winter and non-winter periods. For example, 1993 winter was defined as December '93 to March '94 while 1993 non-winter included August to November '93 together with April to July '94. Thus the four years under scrutiny were labelled 1993, 1994, 1995 and 1996 but covered the period August '93 to July '97. The relevant dates used from the admissions data were those relating to the commencement of disease episodes.

The HES data was imported into a Microsoft Access database and was queried and analysed using first Access and then MS Excel software. Numbers of winter and non-winter respiratory episodes for each ED are included in Appendix A.

6.6.3 Calculation of Excess Winter Morbidity Ratio

The Excess Winter Morbidity Ratio (EWMBR) was calculated as follows:-

$$\frac{\textit{number of emergency winter respiratory episodes (December - March)}}{\textit{average number for other two seasons (August - November; April - July)}}$$

that is:

$$\frac{\textit{no. of winter episodes}}{\textit{(no. of non-winter episodes)/2}}$$

6.7 Winter severity

In Britain, the 1987 OPCS regression model showed that each degree Celsius by which the mean winter temperature falls below the average is associated with about 8,000 excess deaths (Curwen and Devis, 1988, p18). Since the major cause of excess winter deaths is respiratory disease (Curwen, 1997), it is reasonable to assume that the colder the winter, the greater the occurrence of respiratory illness. It was therefore decided to compare seasonal conditions for each of the years in the study period and investigate these for links with annual variations in hospital admissions for cold-related diseases. The investigation considered more features than absolute temperature alone.

Meteorological Office data were obtained for the London Weather Centre, which is the nearest observation centre to Newham. The data included daily records of temperatures, wind speed, rainfall, and sunshine hours between August 1993 and July 1997. From these, the relative severity of each winter (December to March) in the four-year period was determined and the winter conditions compared with those during the rest of the year. (As discussed in 6.3.4, the years were labelled as 1993 to 1996, with each year covering the period from August to July.)

First of all, the seasons were compared according to:-

- the seasonal mean temperature
- the seasonal mean minimum temperature

Then, different measures of winter severity were considered, including the following:-

the number of winter days (December to March) when

- the mean temperature fell below 5°C,

  (the average winter temperature for London is approximately 5.5°C, according to Page and Lebens, 1986)
- the minimum temperature fell to 0°C or below
- the daily mean wind speed was higher than 12 knots
- there were more than 4 hours of sunshine
- there was more than 2mm rainfall

Based on previous work concerning the relationship of temperature changeability to ill health (Rudge, 1996), two further indicators were measured:

- the number of winter days with a temperature change from the previous day greater than 2.2°C (the mean daily temperature change over 20 winters in Britain from 1946-1965 was 2.2°C – *see* Rudge, 1996)
- the temperature change between seasonal averages

The results of this analysis are tabulated in Tables 7-4 and 7-5.

6.8 Relating excess winter morbidity and fuel poverty risk

6.8.1 Preliminary building classification and analyses

In an analysis of data at an early stage of the study, before sorting of building information and the estimation of SAP ratings were completed, building energy ratings were approximated to building age. In most cases, lower energy ratings (*i.e.* less than SAP 30) are typical of pre-1945 dwellings, so this was the building age qualification used. The following characteristics for *each ED* were examined for correlations:-

- % pensioners in the population
- % dwellings with no central heating
- % pre-1945 dwellings
- % each kind of housing tenure
- % each house type
- % households in receipt of CTB
- EWMbR for respiratory disease admissions for the population over 64 years old for two periods of two years, one colder than the other.

No correlations of any significance were found in this first analysis, other than the expected relationships between certain house types and tenures and between lack of central heating and older properties.

6.8.2 Clustering ED data

Having accumulated all the data on income, buildings and health, various ways were considered of sorting and grouping the data to identify areas most at risk of fuel poverty, before the final FPR Index was derived. For example, by ranking EDs according to CTB benefit receipt/households (quintiles), then by SAP ratings (quintiles) and using a combination of these rankings, 25 groups were arrived at. However, this did not give a straightforward scale of fuel poverty risk between the extremes, without finding some method of weighting the relative value of low income and inefficient buildings. Furthermore, when these groups were broken down again by age and gender, the calculation of EWMbR for these groupings proved extremely complex and time-consuming and it was found that there were zero hospital admissions against many of the subsets.

It was evident, therefore, that the analysis depended on grouping the EDs to calculate the Excess Winter Morbidity Ratio. Since the validity of the ratio depends on the numerator and denominator having positive values, sufficiently large groupings of population are needed to achieve numbers above zero for both these (i.e. for respective numbers of winter and non-winter illness episodes). The more the sample population itself is limited by age, gender, diagnosis etc. for hospital admission, the greater is the need for aggregating EDs (Openshaw and Alvanides, 1996). Accordingly, having already assumed the limitations of age above 64 years old and respiratory disease as the qualifying diagnosis, it was decided not to disaggregate the data further by age or gender before clustering the EDs.

According to the results of comparing winter severity, data for the two years with milder winters were combined as if for one year and for the two years with colder winters as for another. This achieved an aggregation of data for greater robustness, but it could also allow testing of the excess winter morbidity data against winter severity for the two periods to see whether a relationship could be demonstrated similar to that found elsewhere for excess winter mortality. The second basis for data aggregation (*see* 7.6.1) was according to likelihood of fuel poverty risk in EDs as calculated from the Fuel Poverty Risk Index devised within the methodology.

6.8.3 Calculation of Fuel Poverty Risk Index

This measure of probability of fuel poverty risk finally determined was derived from the components described above, including the major components of low income and energy inefficient housing, together with age and underoccupation. Initially, for the pilot study, the calculated risk criteria used therefore were:-

Low income:-

- *households in receipt of Council Tax Benefit*

Energy inefficient housing:-

- *housing with low energy efficiency rating (i.e. SAP <35)*

Underoccupation among pensioners:-

- *households with one or more pensioners*
- *one or two person households*
- *households with five or more rooms*

Rates for each criterion were calculated as percentages of all households per ED, except for low energy ratings, which were taken as a percentage of dwellings with residents. As described in 5.3.3, rates, rather than absolute numbers, allow proper comparison of areas such as EDs, because area population numbers vary. The compounding, or overlap, of these various risk components in any one ED, should indicate an increased overall risk of it including older, low income households underoccupying energy inefficient dwellings who would, as a result, probably be experiencing fuel poverty.

An index of fuel poverty risk (FPR) was therefore calculated by multiplication together of these rates for each ED. The derived index number gave a comparative indication of the likelihood of risk factors and, therefore, of fuel poverty occurring in that ED. In order to arrive at numbers and a scale of a manageable size, these figures were then multiplied by 10^{-5} (*see* Appendix A, col. G).

In the very few cases where either component of underoccupation had the value '0', it was substituted with the value '1' to discount its effect and avoid an FPR value of zero. The zero value was retained for the FPR if it resulted from zero percentage dwellings with low SAP ratings, however, as energy efficiency is regarded as a primary factor of fuel poverty and FPR would not exist without this component. Underoccupation, on the other hand, is a less crucial factor. There were no instances of EDs without any households that included at least one pensioner.

6.8.4 Statistical analyses

Investigations were made for associations between various derived ED characteristics, including FPR, and excess winter morbidity ratios calculated following aggregation. This was done using Pearson's correlation for continuous variables and Spearman's rho correlation for ranked categories, as appropriate. The analyses were conducted with SPSS (10.0) for Windows software. Regression analysis was carried out and presented in graph form, using both MS Excel and SPSS.

6.8.5 Mapping

The results of the analysis were also mapped using ArcView GIS (Version 3.1) software. Census EDs built for 1991 Digitised Boundary Data (DBD) for Newham were obtained through UKBorders on the EDINA[35] website. Different attributes of EDs (*see* Appendix A) were imported from MS Excel into ArcView as text files and linked to the EDs. These fields could then be classified by graduated patterns as required and displayed in maps of the borough.

Maps were produced to compare the distribution by ED of different fuel poverty risk factors in Newham with the EWMBR and to illustrate degrees of correlation. These provide a visual presentation of the analysis that is more accessible than graphs alone. The maps are also a means of locating the areas with greatest risk of fuel poverty and highest excess winter respiratory admissions for older people. They can be easily compared with other factors and known features of the area.

6.8.6 Revisions to the pilot study

Subsequently to the pilot study, the use of slightly different census variables was tried, to see whether this produced any different results. An alternative underoccupation score was calculated from the percentage of lone pensioner households living at less than 0.5 persons per room, combined with the number of one-person households with 5 or more rooms. (Ideally perhaps, in further development of the methodology, the under-occupancy score should be weighted for lower significance than other FPR components.)

Since the pilot study was completed, an updated lookup table for the 'PC2ED' conversion has become available on the CDU website. A second lookup process was attempted to see whether it produced a set of figures on CTB receipt with fewer apparent errors than the first.

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[35] available through the University of Edinburgh Data Library

In addition, the Townsend deprivation score was extracted for all EDs, for comparison with the calculated Fuel Poverty Risk Index. It was thought it could possibly be seen as a proxy for FPR, although it is calculated from variables with less relevance to housing condition or older households (*i.e.* relating to unemployment, overcrowding, non car ownership and non home ownership).

6.9 Summary

The methodology constructed in the previous chapter was developed further in its implementation for the pilot study. Although the data sources were not all ideal, or straightforward to access, the obtainable data was used to test the validity of the methodology, as far as possible, in demonstrating a relationship between fuel poverty and health. While recognizing certain limitations in respect of these difficulties, a Fuel Poverty Risk Index was calculated from the risk components, which could then be compared against the Excess Winter Morbidity Ratio. The results are explained in the next chapter.

CHAPTER 7 Results of the Newham pilot study

"I can't leave any heating on at all, so when I go in it'll be just like a fridge..."

Older person without central heating. (Salvage, 1994, p39).

7.1 Introduction

The results tabled here mainly relate to the pilot study carried out for Newham, but also include additional, subsequently tested, minor adjustments to the methodology. Firstly, some descriptive statistics are given for aspects of fuel poverty risk, as well as the calculated FPR Index and Excess Winter Morbidity Ratio (EWMbR). The potential for using a deprivation score as a proxy for FPR is also considered. Winter severity is then compared over the four year period for which health data was available, the findings of which suggest a basis for data aggregation. There follows an analysis of the relationships found between EWMbR, FPR and the component factors of FPR. This includes an explanation of the methods of data aggregation required for calculating the EWMbR. Correlation analyses are tabulated and, in some cases, are explored further with regression analyses, displayed in graphs. Finally, as part of the proposed methodology, the main findings are presented in maps produced in GIS format.

7.2 Fuel Poverty Risk factors

With reference to the methodology detailed in Chapter 6, this section sets out descriptive statistics for each of the various fuel poverty risk factors previously described. The main characteristics established for all 450 EDs are tabulated as percentages of dwellings or households (as appropriate) in Appendix A. This includes FPR factors and the calculated FPR as well as emergency hospital respiratory episodes for the population over 64 years old, which form the basis of calculating EWMbR. It also lists possibly related factors, such as dwellings with no central heating.

7.2.1 Low income indicator: CTB receipt

The total percentage of CTB recipients per number of households for the whole area was calculated as 42% in 1999. Although this figure appears high, it is probably realistic in view of the fact that 34% of households in Newham were receiving Income Support in 1992, as compared with 18% in the UK (Griffiths, 1994, p19). In 1993 figures for Newham had risen to 38%, while Housing Benefit receipt in 1992 was also at 38%, compared with 20% in England (Griffiths, 1994, p24). Qualification for CTB receipt is not as narrowly drawn as for IS, so the numbers would be expected to be higher. The uppermost map in Fig. 7-11 shows the distribution of percentage CTB receipt per households according to the mean of quintiles of EDs, according to the pilot study dataset.

However, in calculating the percentage of households per ED in receipt of CTB, there were some anomalous numbers found, five EDs apparently having more than 100% (including two over 300%) and five less than 3%. Fig. 7-1 shows the distribution of percentages per ED.

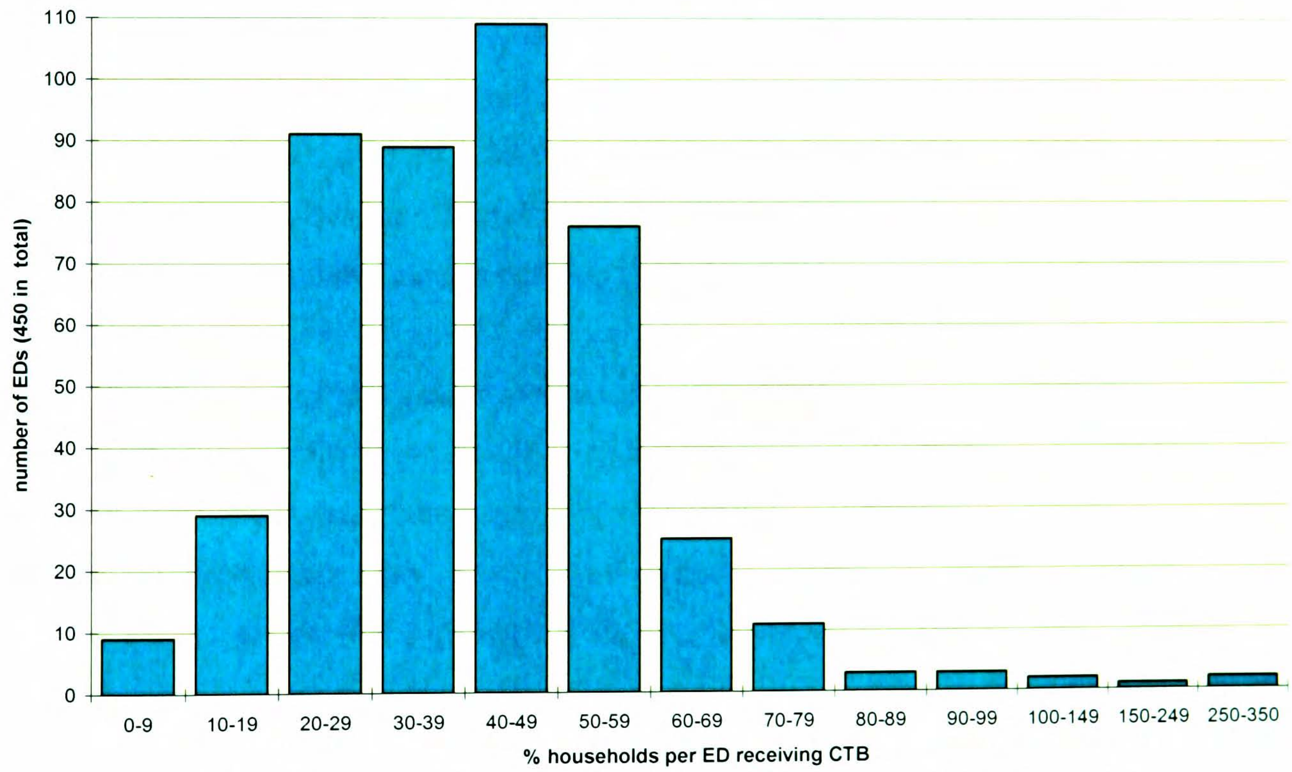


Figure 7-1: Distribution of percentage of households per ED receiving CTB in Newham (1999)

It is known that there is a margin of error in the postcode to ED conversion facility due to postcodes being designated to the best-fit ED, within 100m of the postcode centroid (Haining, 1998, p39). Therefore, when a postcode falls close to the junction of more than one ED, this can cause problems. From the results, it would appear that some EDs could be favoured in the conversion process over others since, in several cases (but not all), very low counts were found in EDs geographically close to those where very high counts occurred. It may be that when the EDs are aggregated (*see* 6.8.2) some of this error will be lost. A more accurate conversion system would have to be sought for a finalised methodology, but could not be found within the timescale or resources of the pilot study. In addition, as mentioned in 6.3, a percentage of postcodes in the given CTB data were not recognised in the 'PC2ED' conversion and either were erroneously recorded, or could have been altered or introduced since the census. Due to new building in certain parts of the borough, there may be an increased number of households in some EDs since the 1991 Census, which may also have contributed to the exceptional figures.

Following the pilot study, the results of using recently updated lookup tables from the CDU produced different figures, but there were still anomalous findings. Two EDs with results of 1%, initially, then became close to the average, but others previously found to be over 100% remained as very high figures, although not so high as before. In addition, some cases altered from less than to more than 100%. It was therefore decided not to alter the pilot study calculations on the basis of these updated figures, since they appeared not to have corrected the original anomalies.

Despite some excessively large values, the maximum percentage value for households in receipt of CTB was taken to be 100 (as the theoretical maximum possible value) in the FPR calculations used for the results presented here. However, this was not done in the initial published report of the pilot study (Rudge, 2001a). Therefore, there are repercussions for the calculated FPR and some consequent minor discrepancies between the two analyses.

7.2.2 Housing energy efficiency: estimated SAP ratings

Table 7-1 indicates the major house types and tenures found in Newham, equivalent to those listed in the 1991 EHCS and characterised by the typical SAP ratings shown in Fig. 6-1. These were estimated according to the process described in 6.4.7 and, in the table, they are grouped below and above the 35 SAP threshold, which is used to define a 'low' SAP rating, or poor energy efficiency. The minimum SAP estimated was 23.7 and the maximum 52.5, although those house types accounting for less than one per cent of dwellings overall are not listed in the table. The percentages of dwellings per ED with SAP ratings below 35 ranged from zero to 100%, with a mean per ED of 44%. In Fig. 7-12, the uppermost map shows the mapped distribution of SAP ratings in Newham, by mode of SAP in quintiles of EDs. Fig. 7-9 gives further illustration of the distribution of SAP ratings by mode per ED.

The major house type found below the low SAP threshold is the small, owner-occupied, Victorian or Edwardian terraced house. Larger terraced houses (including some converted into flats) of the same era, but mainly in the private rented sector, are also in this group, together with small, local authority interwar and some postwar terraces. (Examples of most house types are illustrated in Figs. 6-3a-d.)

Table 7-1: Main dwelling types and SAP ratings in Newham, grouped below and above low SAP threshold (35)

% Total dwellings	House type* *age*	*type*	*tenure*	Typical SAP §
1	1896-1916	Converted flat	HA	24.4
6	1850-1916	Large terrace >70m²	PR	25.7
4	1896-1916	Converted flat	PR	26.5
4	1850-1895	Converted flat	PR	27.4
16	1850-1916	Small terrace <70m²	O-O	28.6
7	1917-1944	Small terrace <70m²	LA	29.6
3	1945-1960	Small terrace <70m²	LA	31.1
2	1850-1895	Converted flat	HA	32.3
*Total dwellings at <35 SAP: approx 43% **				
8	1945-1960	Low-rise flat/ maisonette	LA	35.2
20	1850-1916	Large terrace >70m²	O-O	37.2
12	1961-1980	Low-rise flat/ maisonette	LA	42.5
4	1961-1980	Large terrace >70m²	LA	44.4
7	Post 1980	Low-rise flat/ maisonette	HA**	47.1
4	1961-1980	High-rise flat >5 storeys	LA	49.4
*Total dwellings at >35 SAP: approx: 55% **				

HA: housing association; PR: private rented; LA: local authority; O-O: owner occupied
* omits house types accounting for less than 1% of all Newham dwellings
** LA tenure in Newham for this house type assumed equivalent to HA ownership as EHCS table
§ according to 1991 EHCS – see Fig. 6-1

It can be seen from this table that the local authority maisonette blocks, many of which have undergone improvement schemes since 1991, were already typically above the low SAP threshold according to the 1991 EHCS. Therefore, the effect of upgrading would not cause them to be re-classified for the pilot study estimation of energy efficiency (see 6.4.6). Larger Victorian and Edwardian terraced houses in owner-occupation are estimated to be just above the low SAP threshold and, because of their numbers, could possibly make a significant difference to the energy efficiency profile of Newham if the threshold were taken as SAP 40, for example. This is a potential direction for further examination of the data.

7.2.3 Underoccupancy score

As described in Chapter 6, two different underoccupancy scores were tried. The underoccupancy score (1) for pensioners used as part of the FPR in the pilot study (see 6.5) was based on the following:

- *households with one or more pensioners*
- *one or two person households*
- *households with five or more rooms*

The later, alternative underoccupancy score (2) was calculated from the following factors, which give a narrower definition (see 6.8.6):

- *lone pensioner households living at less than 0.5 persons per room*
- *one-person households with 5 or more rooms.*

The different effects of the two scores on the FPR are discussed in section 7.6.2.

7.2.4 Central heating ownership

Although not taken as a component factor of FPR for the methodology, lack of central heating (derived from the Census) was examined for potential correlation with excess winter morbidity, because others have examined this aspect of buildings in epidemiological studies in relation to excess winter deaths[36]. The percentage of dwellings per ED with no central heating ranged from 0 to 82% (mean: 22%). The percentage of households per ED that are lone pensioners with no central heating ranged from 0 to 25% (mean: 5%). As would be expected, a relationship was found between lack of central heating and dwellings built before 1945, showing a strong and statistically significant correlation ($N = 450$; $R = 0.75$; $p = 0.000$).

7.3 Fuel Poverty Risk Index

7.3.1 FPR and variations

FPR was calculated with and without different criteria to test their relative importance and was designated accordingly as:

FPR_{all} – including all criteria;

FPR_{xSAP} – excluding low SAP factor;

FPR_{xCTB} – excluding CTB receipt factor;

FPR_{all2} – including all criteria, but with alternative underoccupancy score (2).

[36] *see* Chapter 3 (3.4.4) and further discussion in 8.2

As described in 6.8.3, the FPR Index (FPR_{all}) was derived as follows:

$$FPR = (HH_{>64} \times HH_{CTB} \times HH_{1/2P} \times HH_{5R+} \times DW_{<35SAP})10^{-5}$$

where

$HH_{>64}$ is the percentage of households per ED with one or more pensioners

HH_{CTB} is the percentage of households per ED in receipt of Council Tax Benefit

$HH_{1/2P}$ is the percentage of one and two person households per ED

HH_{5R+} is the percentage of households per ED with 5 or more rooms

$DW_{<35SAP}$ is the percentage of dwellings per ED with SAP ratings below 35

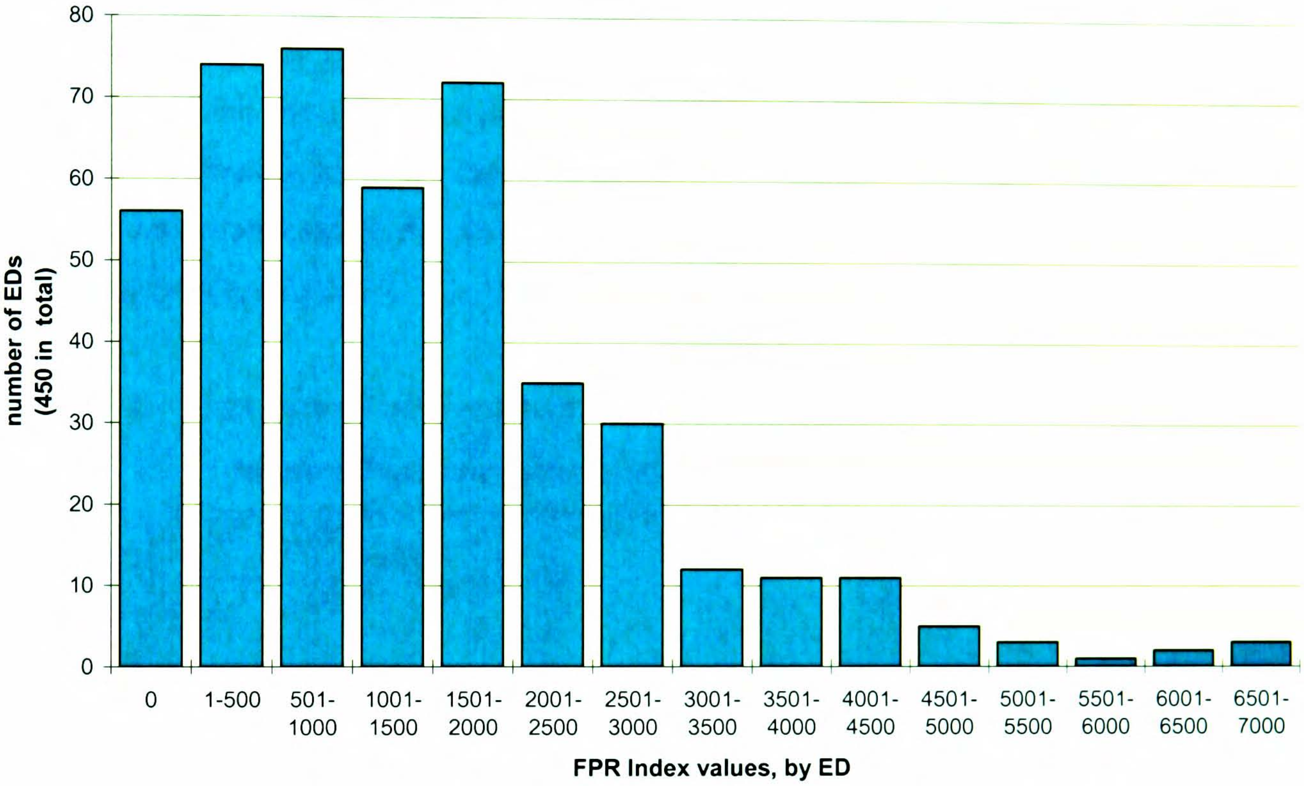


Figure 7-2: Distribution of FPR values across Newham EDs

The distribution of FPR values by numbers of EDs is indicated in Fig 7-2, the range of values being between 0 and 6876, with an average of 1423 (SD±1314). As shown, it is not a normal distribution pattern, because of the high number of EDs valued at zero and the wide range of high FPR values spread across small groups of EDs. The FPR values themselves serve only as a comparative measure between Newham EDs here, but could be used to compare the level of fuel poverty risk between boroughs, for example, if the process was replicated. In theory, the maximum possible FPR value as calculated this way would be 100,000.

In Fig. 7-13, the uppermost map also shows the distribution of calculated fuel poverty risk (FPR_{all}) in Newham, as derived from all the risk factors (and calculated in the pilot study). As the FPR Index is calculated by multiplication of these factors, the resulting FPR Index value is zero where an ED has zero poorly energy rated houses. Since the energy rating is a key aspect of fuel poverty definition, this should not require adjustment. However, because of the large number of EDs with zero FPR, the EDs are given a second order of ranking, according to the percentage of households in receipt of CTB. An alternative method would have been to assume the value '1' for the low SAP factor where a null value was recorded, which would have allowed the influence of all remaining factors to be taken into account for those EDs. The approximate range of FPR from the calculation method above is again indicated in Fig 7-7, where the mean value for 25 percentiles of EDs is shown.

7.3.2 Comparison of FPR with deprivation score

An analysis was carried out using Pearson's correlation for continuous variables, to look at the relationship between the Townsend deprivation score and FPR, its component factors and related variables, as characteristics of all EDs. Table 7-2 shows this analysis, which was made after the pilot study was completed, to examine whether the Townsend Index had potential as a proxy for fuel poverty risk (see 6.8.6).

Table 7-2: Correlations between deprivation score, FPR and fuel poverty risk factors

Pearson Correlations for continuous variables (N = 450)

ED characteristics		Townsend deprivation score	FPR(all)	CTB receipt	population >64 yrs old	dwellings with SAP <35	mode of SAP rating	underocc score (1)	underocc score (2)
Townsend deprivation score	R	1.000	-.001	.413**	.130**	-.099*	.143**	-.081	-.203**
	p	.	.978	.000	.006	.036	.002	.085	.000
FPR(all)	R	-.001	1.000	.234**	.277**	.714**	-.370**	.441**	.337**
	p	.978	.	.000	.000	.000	.000	.000	.000
CTB receipt	R	.413**	.234**	1.000	.220**	-.208**	.208**	.043	-.094*
	p	.000	.000	.	.000	.000	.000	.367	.047
population >64 yrs old	R	.130**	.277**	.220**	1.000	-.022	.023	.665**	.474**
	p	.006	.000	.000	.	.647	.623	.000	.000
dwellings with SAP <35	R	-.099*	.714**	-.208**	-.022	1.000	-.556**	.120*	.181**
	p	.036	.000	.000	.647	.	.000	.011	.000
mode of SAP rating	R	.143**	-.370**	.208**	.023	-.556**	1.000	-.241**	-.292**
	p	.002	.000	.000	.623	.000	.	.000	.000
underocc score (1)	R	-.081	.441**	.043	.665**	.120*	-.241**	1.000	.751**
	p	.085	.000	.367	.000	.011	.000	.	.000
underocc score (2)	R	-.203**	.337**	-.094*	.474**	.181**	-.292**	.751**	1.000
	p	.000	.000	.047	.000	.000	.000	.000	.

R is Pearson Correlation coefficient; p is significance (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

It should be noted that correlations between the FPR and FPR factors are inevitable because the one is derived from the others. However, no correlation was found between the Townsend score and FPR_{all}. When compared with FPR components, it showed a moderate, significant positive correlation with the income element (CTB receipt), as might be expected for a deprivation score (N=450; R=0.413; p=0.000). There was a low positive correlation with the percentage of population over 64 years old (N=450; R=0.130; p=0.006). A slight negative correlation was evident with the alternative underoccupancy score that includes the census variable for occupancy rate (N=450; R=-0.203; p=0.000), although not with the score used in the pilot study.

The correlation shown with low energy ratings was very small and negative (N=450; R=-0.099; p=0.036), while a small positive correlation was found with the mode of SAP ratings. Both of these associations were in a direction that is counterintuitive for a relationship between deprivation and poor housing, but this could be explained by the non-home-ownership component of the Townsend score. As Wilkinson *et al.* (2001) suggested (see 3.4.5), many local authority and housing association homes are relatively recently built and therefore tend to be more efficient than other dwellings.

7.4 Excess Winter Morbidity Ratios

The EWMbR for the whole Newham population, based on all emergency respiratory admissions over the four year period, was calculated to be 1.12, indicating that 12% more hospital episodes occur in winter than the average for the rest of the year, for this diagnosis. (An EWMbR of 1.00 would indicate no winter excess, or equal average numbers of admissions for all seasons.) The ratio is greater for the population aged over 64 than for those under 64, for respiratory disease diagnoses, indicating a 36% winter excess, as shown in Table 7-3. The linear regression for FPR_{all} in Fig. 7-6 shows a range for the older population of approximately 1.2 to 1.6 as fuel poverty risk increases (after data aggregation).

The EWMbR for all the Newham population over 64 years old, for different causes over the four-year period, are also shown in Table 7-3. These figures confirm that respiratory disease is likely to be the most useful diagnosis for calculating excess winter morbidity, as a greater seasonal difference is evident.

Table 7-3: Excess Winter Morbidity Ratio (EWMbR) by diagnosis
(based on emergency admissions only)

Cause (with Diagnosis Codes)	***EWMbR (1993-96)***	
	all ages	*>64 years old*
All cause	0.96	1.05
Ischaemic Heart Disease (ICD9: 410-414; ICD10: I20-I25)	1.06	1.14
Stroke (ICD9: 430-438; ICD10: I60-I69)	1.01	1.01
Cardiovascular (IHD and Stroke as above, combined)	1.05	1.08
Respiratory (ICD9: 460-519; ICD10: J00-J99)	1.12	1.36

The sample population for the study was the total aged 65 and over, *i.e.* 25,091 for the 450 EDs under consideration (for exclusions see 6.4.7). Total respiratory episodes resulting from emergency admissions over the four year period were 4,738, which amounts to 47 per 1000 population (>64 years old) per year. The average population for this age group per ED is 56 (compared with 469 average total population), so the *average* expected number of respiratory episodes per ED would be 2.6 per year, or about 10 over the period 1993-1996.

It is not surprising, therefore, as explained in 6.8.2, that when subsets of age and gender for episodes within EDs were examined, it was found that frequently there were no episodes in single EDs for the relevant group and a ratio could not be calculated. This was also the case in many instances where the calculation was made for the whole ED population. The average number of winter respiratory episodes per ED for 1993-96, for the population over 64 years old, was 4.2 (SD±4.5), while the average for the nonwinter seasons per ED was 3.1 (SD±3.2). However, as is evident in Appendix A, there are a few EDs with comparatively high numbers which might be attributable to repeated admissions for particular individuals. For example, the maximum figure for winter episodes was 30 for one ED over 1993-96 and, in another, 24 was the maximum for nonwinter seasons. Such figures contribute to the outliers for EWMbR values found in later graphs, depending on the grouping of EDs for calculation of EWMbR.

7.5 Winter severity

7.5.1 Comparison of four winters

Meteorological data indicated that both years 1995 and 1996 had colder average seasonal temperatures and seasonal mean minimum temperatures than both 1993 and 1994. On the basis of these differences, further distinctions were examined and revealed the following in total, as illustrated in Tables 7-4 and 7-5, for 1995-6 compared with 1993-4:

- *average seasonal temperatures colder*
- *seasonal mean minimum temperatures lower*
- *higher number of winter days with a mean temperature less than 5°C*
- *higher number of winter days with a mean minimum temperature of 0°C or less.*
- *greater number of windy days overall in winter (mean wind speed > 12 knots)*
- *fewer days with more than 4 hours sunshine*
- *fewer days with more than 2mm rainfall*
- *greater contrast of temperature between seasons*
- **but** - *fewer days with a greater than average temperature change from the previous day*

Therefore, it appears that 1995-6 was a relatively cold period compared with 1993-4, which was milder overall, but wetter, with more changeable winter temperatures day to day. In view of these distinctions, it was decided initially to group the data for each pair of years in calculating the excess winter morbidity ratios. This allowed a more straightforward comparison between two periods of differing winter severity (see Fig. 7-8) to test the relationship between temperature and excess winter episodes. At the same time, it was attempted to achieve more robust results by aggregating data across two-year periods.

Table 7-4: Seasonal comparisons for 1993 - 1996
(Daily weather data supplied by the UK Meteorological Office)

Year	*Mean temp (°C)*			*Mean min temp (°C)*			*Seasonal mean temp change (°C)*	
	A	*W*	*S*	*A*	*W*	*S*	*A - W*	*W - S*
1993	11.3	7.3	14.9	8.9	4.7	11.2	4.0	7.6
1994	14.2	7.6	15.4	11.6	4.8	11.4	6.6	7.8
93-4 average		**7.4**			**4.7**		**5.3**	**7.7**
1995	15.1	5.0	14.1	12.0	2.7	10.3	10.1	9.1
1996	13.7	6.6	15.1	10.6	4.2	11.0	7.1	8.5
95-6 average		**5.8**			**3.5**		**8.6**	**8.8**

A = Autumn (Aug – Nov); W = Winter (Dec – Mar); S = Summer (Apr – Jul)

Table 7-5: Comparisons of winter characteristics, 1993 - 1996
(Daily weather data supplied by the UK Meteorological Office)

Year	*Number of winter days when:*					
	Mean temp <5 °C	*Min temp <0.1 °C*	*Mean wind speed >12 knots*	*> 4 hours sunshine*	*> 2mm rainfall*	*>2.2 °C change from previous day*
1993	6	0	27	37	32	20
1994	6	3	18	49	48	31
93-4 average	**6**	**1**	**22**	**43**	**40**	**25.5**
1995	20	7	31	28	22	23
1996	19	9	>17*	38	17**	16
95-6 average	**19**	**8**	**>24***	**33**	**20****	**19.5**

* *incomplete data;* ** *1 day's data missing*

7.5.2 Fuel poverty risk, excess winter morbidity and winter severity

The total population aged over 64 years was divided into two approximately equal groups above and below a level of FPR, so that one could be regarded as at higher risk of fuel poverty relative to the other. The EWMbR was calculated for the two groups, as shown in Table 7-6, for the two periods of contrasting winter severity and for the whole four-year period.

Table 7-6: Comparison of health indicators in population >64, according to FPR

Health indicators relating to respiratory diagnosis hospital episodes (emergency admissions)	*Population aged >64 years old*		
	low risk (<1380 FPR)	*high risk (>1380 FPR)*	*total*
Nos. of population >64 yrs. old (1991 Census)	12574	12517	25091
Av. no. episodes per yr, 1993-96	624	561	1185
Av. no. episodes per 1000 population per yr, 1993-96	49.6	44.8	47.2
Av. no. **excess** winter episodes per yr, 1993-96	49	**75**	125
EWMbR 1993-94 (milder period)	1.26	**1.42**	1.34
EWMbR 1995-96 (colder period)	1.25	**1.52**	1.37
EWMbR 1993-96	1.26	**1.47**	1.35

Although there were similar numbers of episodes over the whole year for both groups, with slightly more among those at 'low risk', the level of excess winter episodes was evidently higher among the 'high-risk' group. Thus the low-risk group had 26% more winter episodes than for the rest of the year, while the high FPR group was shown to have 47% more, or a winter excess 81% greater than those at lower risk of fuel poverty. Furthermore, the high-risk group shows a larger excess morbidity in the colder period of 1995-96, whereas it is slightly less for the group at low fuel poverty risk, producing an even greater disparity between the groups. (The higher figures for the high-risk group are emphasised in bold format on the table.)

Alternatively, these results can be shown graphically, as in Figs 7-3 and 7-4. According to a t-test calculation for the 1993-96 EWMbR for the low and high risk groups (two-sample t-test, assuming unequal variances), the probability P is shown to be 0.019, *i.e.* the probability that the difference between the groups is random is less than 2%.

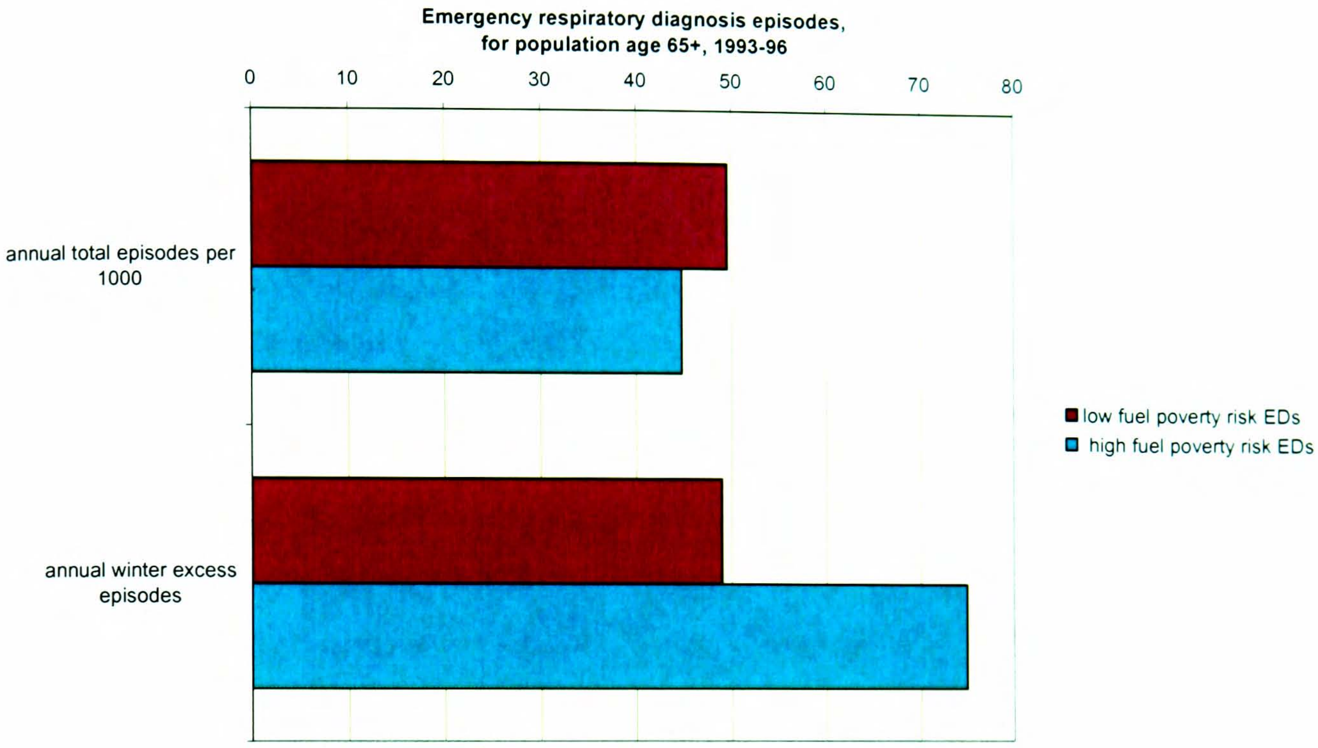


Figure 7-3: Comparison of respiratory hospital episodes in population aged 65+, according to FPR

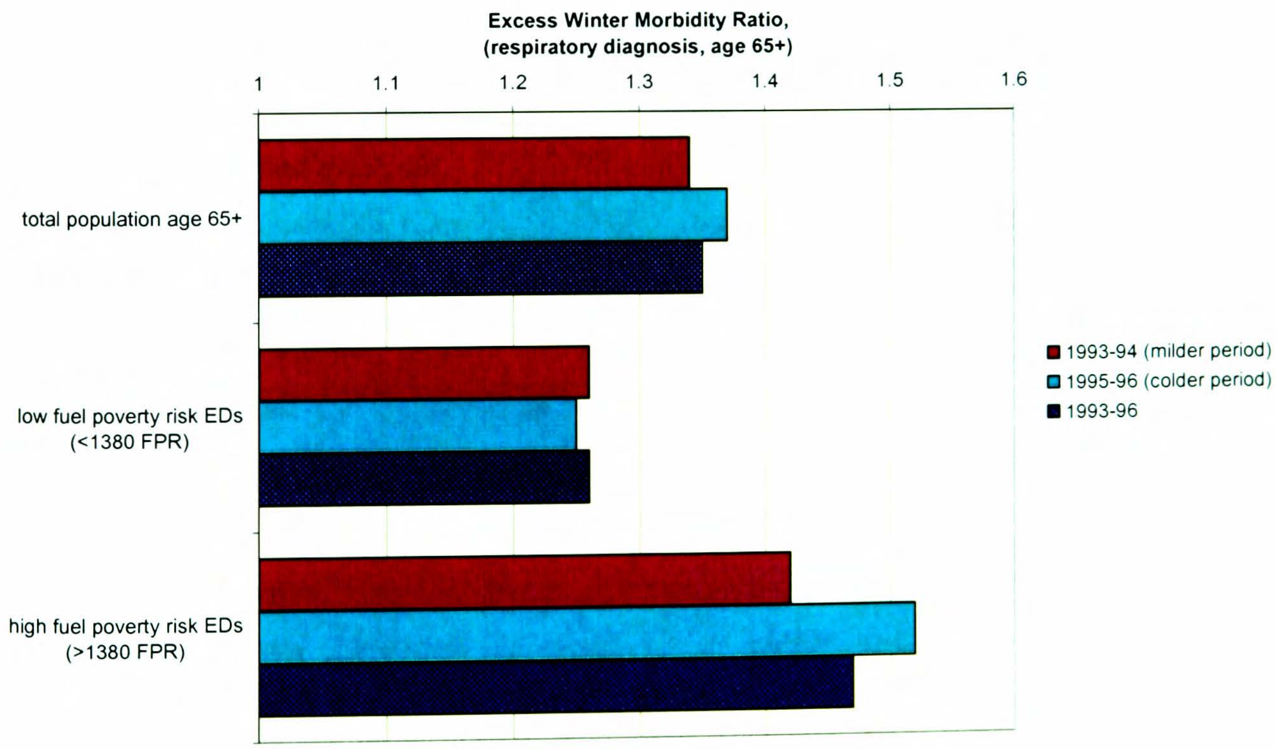


Figure 7-4: Comparison of EWMbR (respiratory diagnosis) in population aged 65+, according to FPR

7.6 Statistical analysis of relationships between EWMbR and FPR factors

7.6.1 Data aggregation for calculation of EWMbR

Correlations were then sought between fuel poverty risk, its component factors and excess winter morbidity, using SPSS analysis software. It was decided, for this purpose, to group the EDs as ranked ED percentiles to calculate the EWMbR, as the FPR index scales were unevenly spread and did not allow useful comparison with each other when different sets of criteria were used in the FPR calculation. In calculating the EWMbR to compare with FPR, the EDs were first ranked according to the values derived for FPR. A second criterion for ordering was also necessary, as already stated, because of the large number of EDs with zero FPR values (from zero low SAP ratings); the second order of ranking was by percentage of CTB receipt. The number of ranked percentiles used was 25, which approximates to the number of wards in the borough (*i.e.* 24). Each group then consisted of 18 EDs, with an average population of 1004 (SD$\pm$158), when ranked by FPR_{all}. A spreadsheet example to illustrate the calculations of EWMbR for ED groups after ranking can be seen in Appendix C.

As comparisons were made with individual factors, different rankings were produced, so that the groups of EDs for which the EWMbR was calculated altered as the FPR criteria, or other independent variables, altered. As explained previously, the calculations were done for:

- *episodes resulting from emergency admissions only*
- *respiratory disease diagnosis codes*
- *age groups of 65 years and above.*

7.6.2 Correlations analysis

The SPSS analysis shown in Table 7-7 uses Spearman's rho for correlation of ranked data, rather than for actual values. For comparison with the ranking by 25 percentiles of EDs according to FPR, the 24 wards are also ranked by FPR. There is clearly a significant association shown between the EWMbR for the percentiles of EDs and the ranking of the percentiles by FPR_{all} (N=25; R=0.602; p=0.001). However, when the low SAP rating factor is excluded from the FPR (ranking by FPR_{xSAP}) there is no association. When low income is excluded (ranking by FPR_{xCTB}) an association is still evident, although it is reduced. There is no association found between excess winter morbidity and ranking by individual fuel poverty risk factors or by the Townsend Index score. The grouping of EDs by ward produces no apparent relationship between FPR and EWMbR, which indicates that the grouping of EDs according to FPR ranking is more useful in exploring this association.

Comparison of correlations for ranking by FPR_{all} and FPR_{all2} indicates that the first underoccupancy score (1) was more closely associated with excess winter morbidity (significant at the 1% level) than the alternative, which was significant at the 5% level (N=25; R=0.488; p=0.193). Score (1) therefore appears to be more appropriate as part of the FPR Index. It could be that, having wider applicability, it would be more likely to show an association than would the second score that uses a narrower definition of underoccupancy.

Table 7-7: Correlations between ranking of ED percentiles according to Fuel Poverty Risk factors and Excess Winter Morbidity Ratio for 1993-96

Spearman's rho correlations for ranked categories (N = 25, except where ranked by wards, where N = 24)

Ranking factor for EWMbR calculation		*rank of ED percentiles (1-25)*	*FPR(all)*	*FPR(xSAP)*	*FPR(xCTB)*	*FPR(all2)*	*CTB receipt only*	*<35SAP only*	*Dwellings with no ch*	*Townsend index*	*H'holds with 1+ pensioners*	*Lone pens h'holds with no ch*	*Wards, ranked by FPR(all); NB. N=24*
rank of ED percentiles (1-25)	*R*	1.00	.602**	.304	.436*	.488*	.105	.338	.164	-.220	-.053	.138	-.028
	p	.	.001	.140	.030	.013	.617	.099	.432	.291	.800	.510	.896
FPR(all)	*R*	.602**	1.00	.224	.179	.269	-.173	.215	.163	-.340	.037	.328	.055
	p	.001	.	.282	.392	.193	.408	.301	.437	.097	.859	.110	.798
FPR(xSAP)	*R*	.304	.224	1.00	.393	-.107	.023	.493*	.359	-.137	-.199	-.221	-.115
	p	.140	.282	.	.052	.610	.911	.012	.078	.515	.339	.287	.593
FPR(xCTB)	*R*	.436*	.179	.393	1.00	.274	.382	.122	.400*	-.397*	.071	-.024	-.226
	p	.030	.392	.052	.	.184	.060	.561	.048	.049	.736	.909	.288
FPR(all2)	*R*	.488*	.269	-.107	.274	1.00	-.119	.246	.015	-.341	.020	-.025	.065
	p	.013	.193	.610	.184	.	.572	.236	.943	.096	.923	.905	.761
CTB receipt only	*R*	.105	-.173	.023	.382	-.119	1.00	-.152	.003	.099	.079	-.112	-.111
	p	.617	.408	.911	.060	.572	.	.468	.988	.638	.707	.593	.606
<35SAP only	*R*	.338	.215	.493*	.122	.246	-.152	1.00	.307	.033	-.052	-.327	.176
	p	.099	.301	.012	.561	.236	.468	.	.135	.876	.806	.111	.411
Dwellings with no ch	*R*	.164	.163	.359	.400*	.015	.003	.307	1.00	-.143	.311	-.119	.009
	p	.432	.437	.078	.048	.943	.988	.135	.	.494	.130	.571	.966
Townsend index	*R*	-.220	-.340	-.137	-.397*	-.341	.099	.033	-.143	1.00	.022	.010	-.320
	p	.291	.097	.515	.049	.096	.638	.876	.494	.	.916	.962	.127
H'holds with 1+ pensioners	*R*	-.053	.037	-.199	.071	.020	.079	-.052	.311	.022	1.00	.346	.206
	p	.800	.859	.339	.736	.923	.707	.806	.130	.916	.	.090	.335
Lone pens h'holds with no ch	*R*	.138	.328	-.221	-.024	-.025	-.112	-.327	-.119	.010	.346	1.00	.046
	p	.510	.110	.287	.909	.905	.593	.111	.571	.962	.090	.	.831
Wards, ranked by FPR(all); NB. N=24	*R*	-.028	.055	-.115	-.226	.065	-.111	.176	.009	-.320	.206	.046	1.00
	p	.896	.798	.593	.288	.761	.606	.411	.966	.127	.335	.831	.

R is correlation coefficient; p is significance (2-tailed)

**. Correlation is significant at the .01 level (2-tailed).

*. Correlation is significant at the .05 level (2-tailed).

The effect of winter severity was also examined for correlations with excess winter morbidity after aggregation of EDs, as indicated in Table 7-8. The results of the correlations analysis from

Tables 7-7 and 7-8 are clarified in more detail in the following section, with appropriate additional comments.

Table 7-8: Comparison of correlations between Fuel Poverty Risk and Excess Winter Morbidity Ratio for periods of different winter severity

Spearman's rho Correlations for ranked categories (N = 25)

ED percentiles ranked according to FPR(all)		rank of ED percentiles (1-25)	EWMbR 1993-94	EWMbR 1995-96	EWMbR 1993-96
rank of ED percentiles (1-25)	*R*	1.000	.426*	.296	.602**
	p	.	.034	.151	.001
EWMbR 1993-94	*R*	.426*	1.000	-.194	.711**
	p	.034	.	.353	.000
EWMbR 1995-96	*R*	.296	-.194	1.000	.490*
	p	.151	.353	.	.013
EWMbR 1993-96	*R*	.602**	.711**	.490*	1.000
	p	.001	.000	.013	.

R is Correlation coefficient, p is significance (2-tailed).

*. Correlation is significant at the .05 level (2-tailed).

**. Correlation is significant at the .01 level (2-tailed).

7.6.3 Further statistical analysis

Figures 7-5 to 7-10 show the results of the analysis in the form of graphs, with linear regression trendlines displayed. R^2 (the coefficient of determination) indicates the goodness of fit measure of the linear model (or the degree of correlation), where R is the regression coefficient. The value of R^2 can range between 0 and 1, to indicate the proportion of variation in the dependent variable that is explained by the independent variable. The significance level (p) is also shown. Where p is less than 0.05, there is a significant correlation. The null hypothesis, that there is no relationship between the two variables, is therefore rejected. Where R^2 is between 0.16 and 0.36 (*i.e.* R is between 0.4 and 0.6), there is a moderately good correlation in relation to the number of observations (N). These values would indicate that between 16% and 36% of the variance in the dependent variable (EWMbR) is explained by the independent variable (FPR or other). (The remaining proportion of the variance is therefore caused by other, unknown and unrelated, factors.) Values lower than 0.16 (R=0.4) indicate weaker or no correlation. The slope of the regression line indicates the rate of change of the EWMbR that is due to the FPR (or other), which is unaffected by the variance, or scatter.

Fig. 7-5 represents the comparison of correlation analysis according to winter severity indicated in Table 7-8. The EWMbR was plotted against percentiles of EDs, ranked according to FPR_{all}. The EWMbR was calculated both for 1993-4 (two winter and two non-winter periods), 1995-6 (two winter and two non-winter periods) and also for the whole period, 1993-1996 (four winter and four non-winter periods). The graph shows a significant, moderate correlation for 1993-4, with the milder winters, but only a weak correlation for the colder second period, with significance at the 10% level. However, the regression lines and slopes are very close, while the results put together - for the four years - produce a stronger relationship, as shown for FPR_{all} in the following graph, Fig. 7-6. Note that the graphs produce slightly different values for R than are indicated in the correlation table. This is because the calculations assumed by the software for making the graphs use Pearson's correlation and not Spearman's rho correlation for ranked categories.

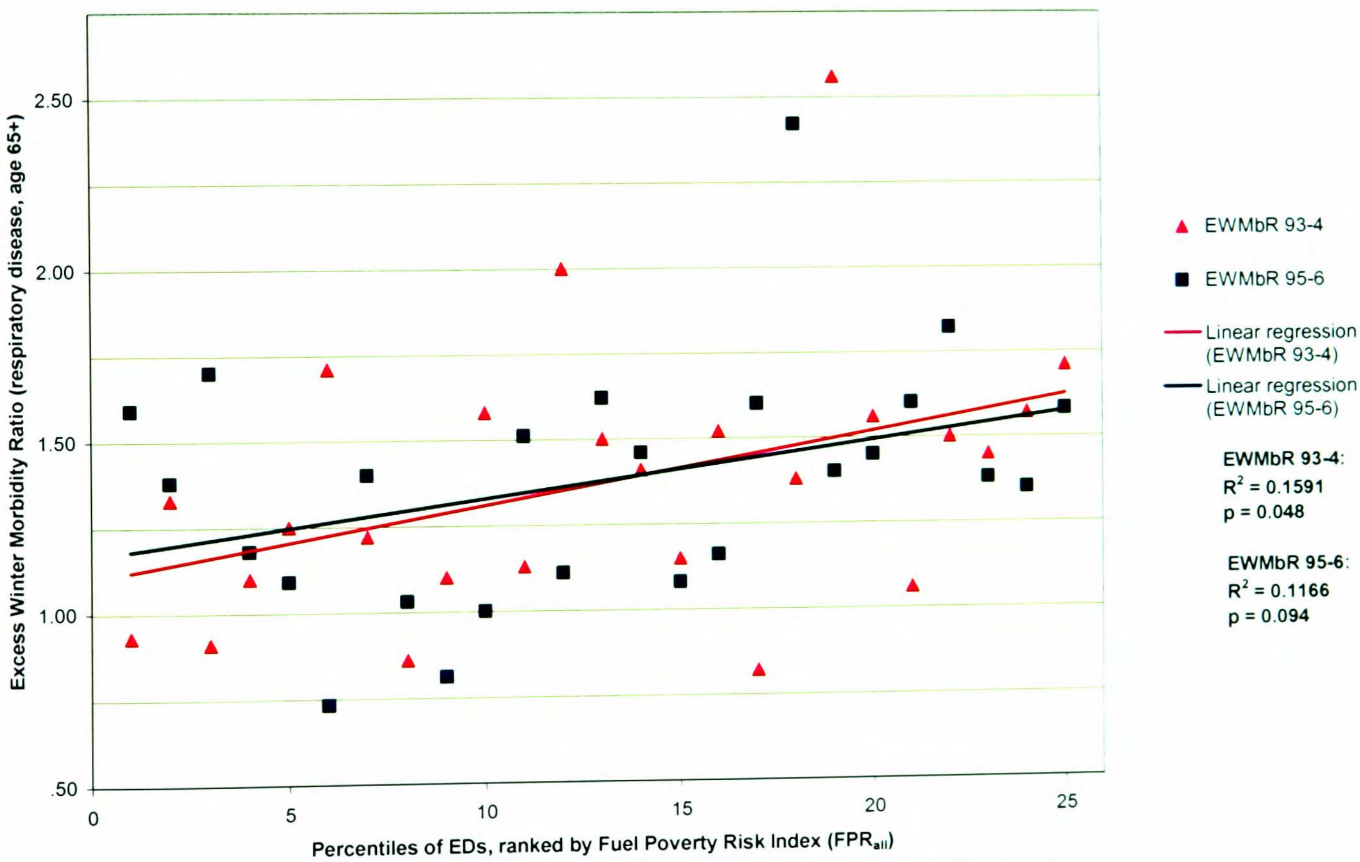


Figure 7-5: Relationship between excess winter morbidity, fuel poverty risk and winter severity

Fig. 7-6 shows the comparison of plotting the four-year EWMbR both when the FPR criteria include and exclude the percentage of low SAP ratings. The correlation between FPR and EWMbR is reduced to negligible when low energy ratings are not part of the criteria.

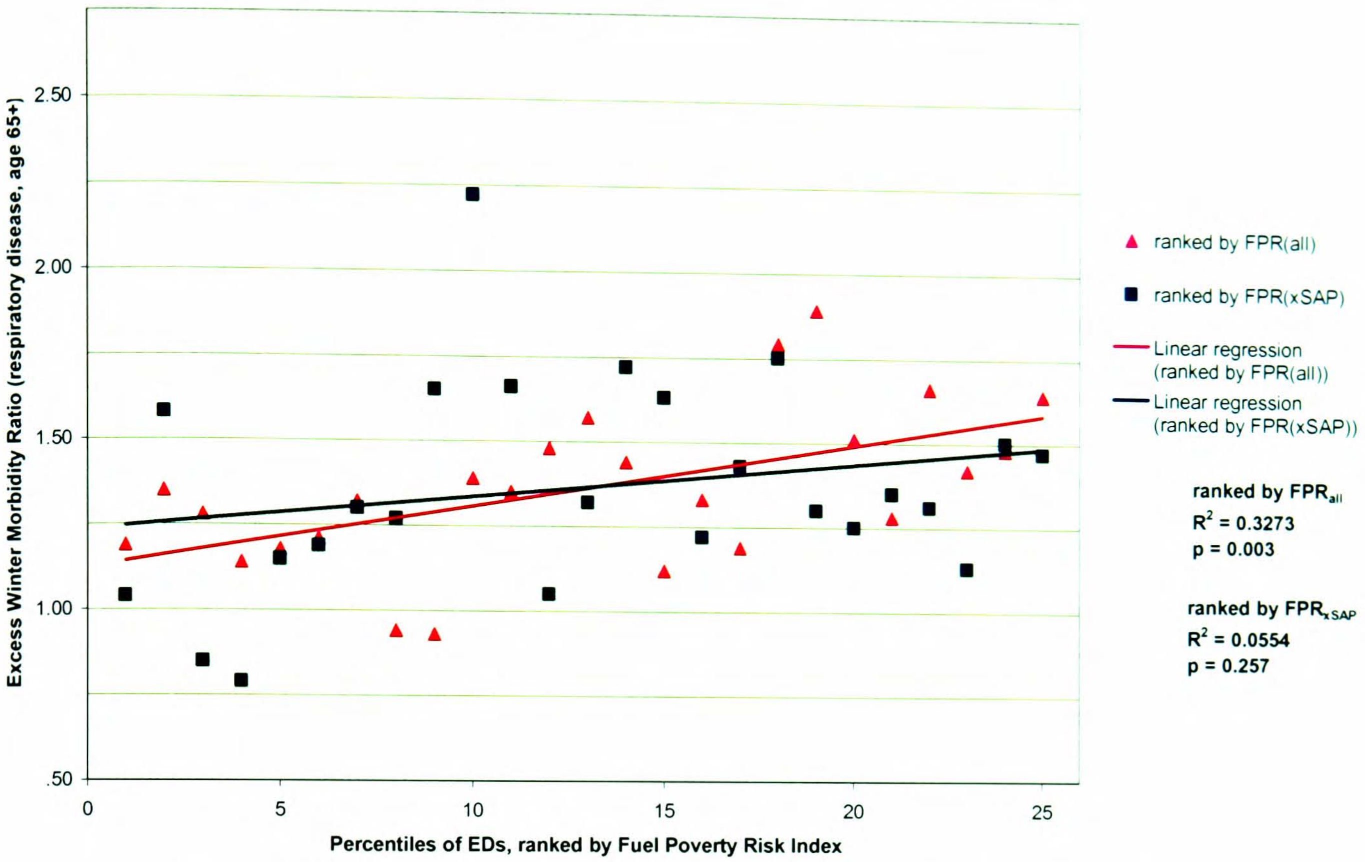


Figure 7-6: Relationship between excess winter morbidity and housing with poor energy efficiency

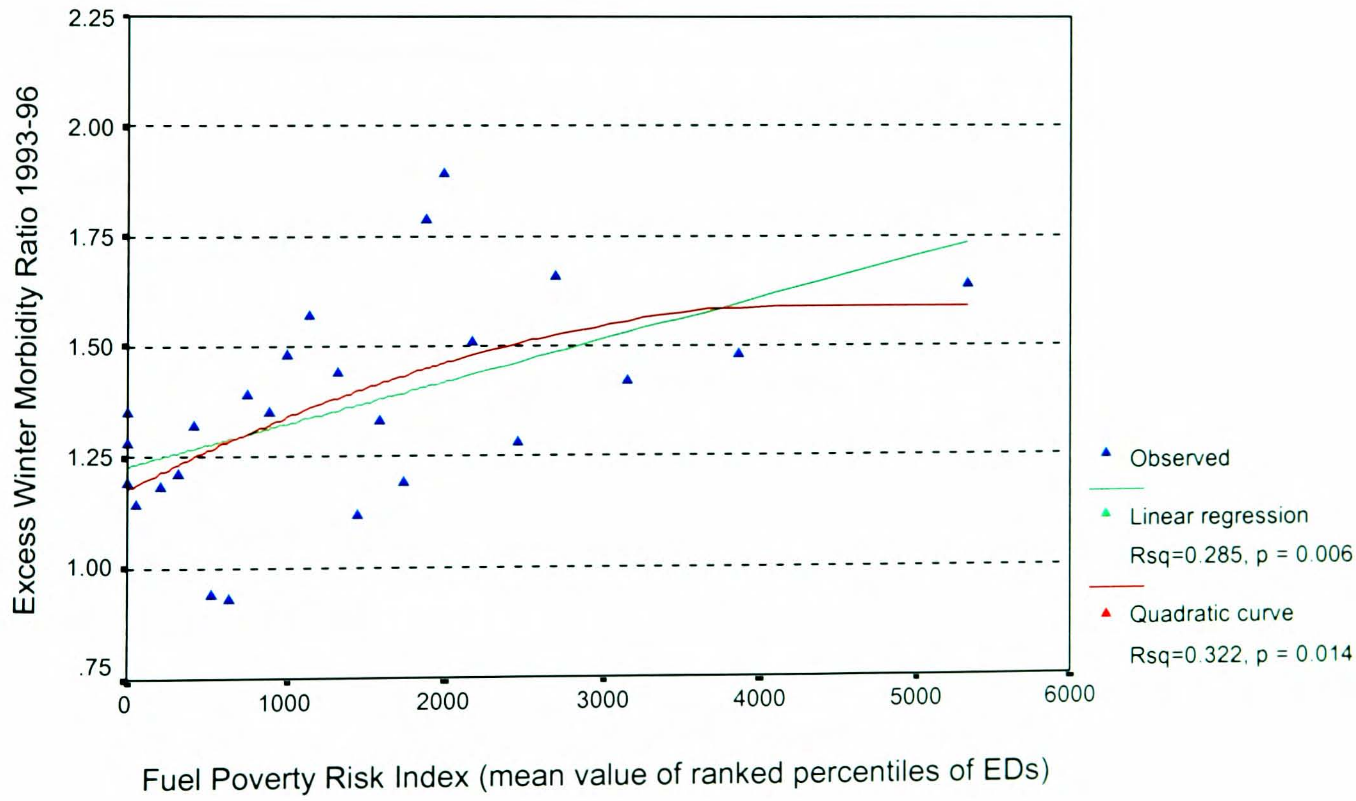


Figure 7-7: Relationship between excess winter morbidity and fuel poverty risk (produced in SPSS)

Alternatively, Fig. 7-7 shows the four-year EWMbR plotted against the mean value of FPR (including the SAP ratings factor) for the 25 percentiles, with a trendline for a quadratic regression. The value of R^2 in Fig. 7-7 indicates that 28% of the variation of EWMbR is explained by the Fuel Poverty Risk Index, while the value of p indicates that the correlation is moderately significant.

Fig. 7-8 demonstrates the difference in correlation when the low-income factor is not included in the FPR Index. Although the correlation is reduced, it is still significant.

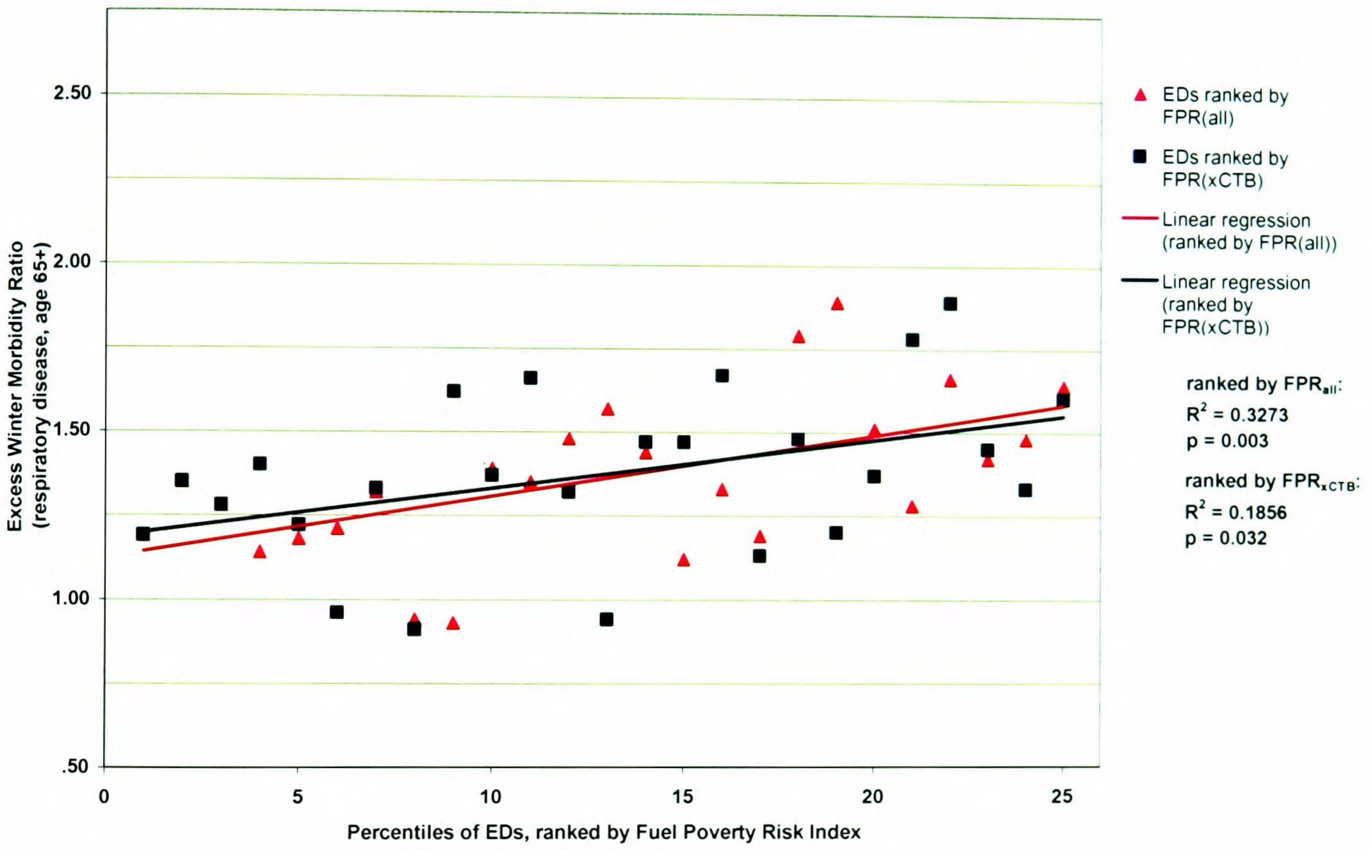


Figure 7-8: Relationship between excess winter morbidity and fuel poverty risk: effect of including low income indicator in FPR

Fig. 7-9 shows the relationship between EWMbR and SAP ratings, where EDs are ranked according to the SAP rating of highest frequency, or mode. Where there are two or three modes for one ED (equal percentages of different SAP ratings), the lowest SAP is taken. Again, EDs are grouped in 25 percentiles for the calculation of EWMbR. There is no correlation indicated with SAP rating, or poor energy efficiency, alone.

Fig. 7-10 shows EWMbR plotted against the percentage of households with no central heating. Again, there is no significant correlation found.

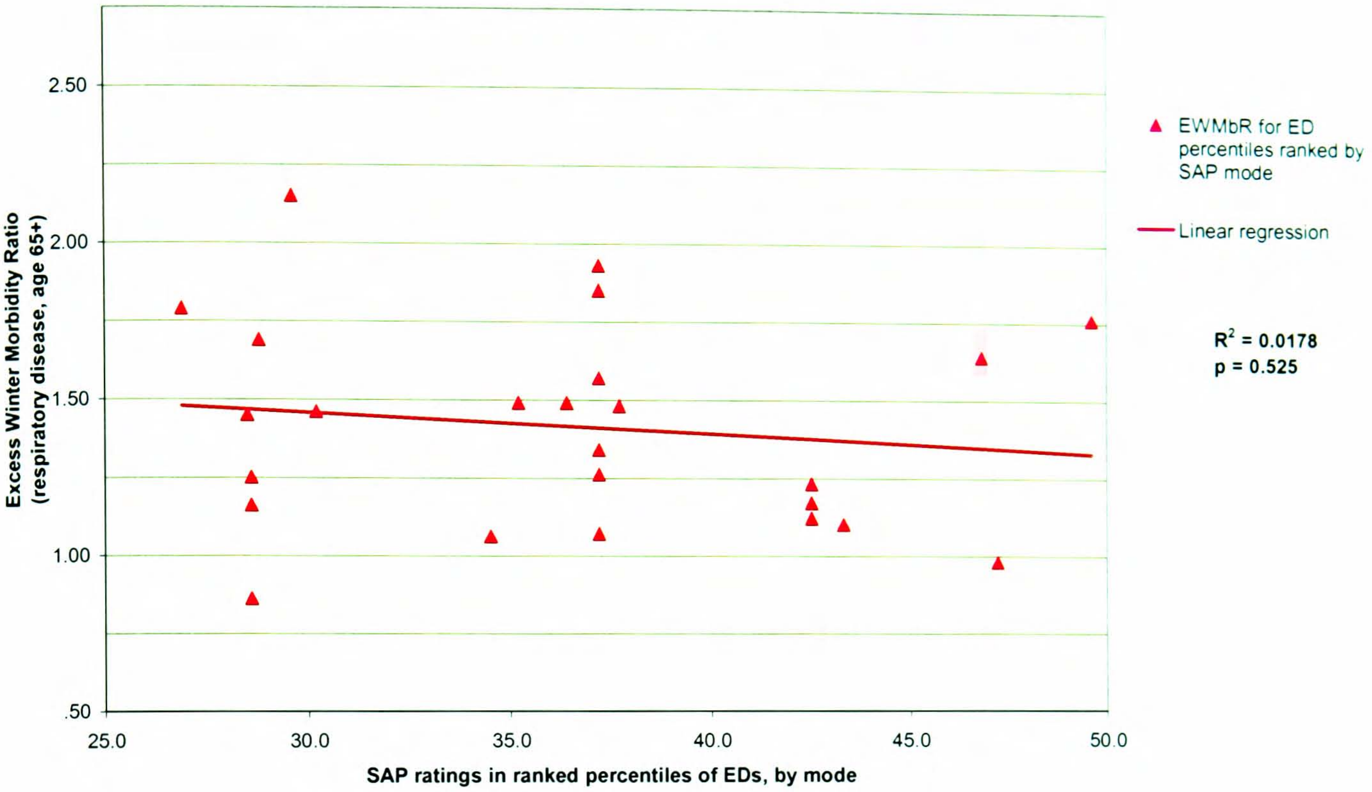


Figure 7-9: Relationship between excess winter morbidity and SAP ratings

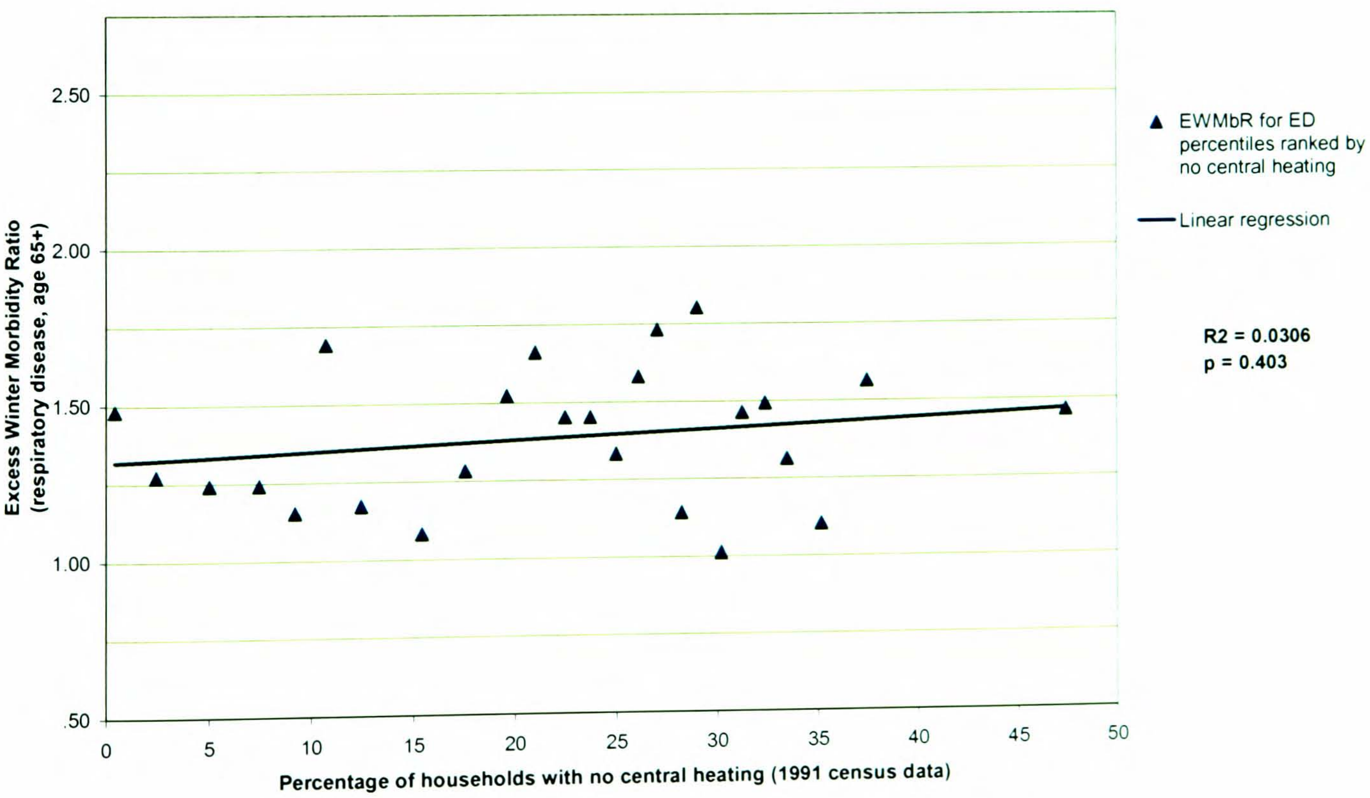


Figure 7-10: Relationship between excess winter morbidity and lack of central heating

7.6.4 Presentational use of mapping

Finally, the pairs of maps in Figs. 7-11, 7-12 and 7-13 demonstrate a method for visual presentation of the analysis, carried out using ArcView. The geographical distribution of each ED attribute considered can be compared with the resulting calculation of EWMbR, either by 25 ranked percentiles or by ranked quintiles. The distribution of EWMbR is shown against CTB receipt, SAP ratings and the FPR. The EWMbR is calculated in each case after ranking EDs according to the factor under scrutiny.

Here, quintiles are used for indicating distribution because it is difficult to distinguish more than five different patterns from one another in one map. It is evident from Figs. 7-11 and 7-12 that there is little or no relationship between the single attributes of low income, or poor energy characteristics of housing, and excess winter morbidity. However, Fig. 7-13 shows very clearly the correlation to be found between quintiles of Fuel Poverty Risk and of Excess Winter Morbidity Ratio for respiratory disease in the population over 64 years old. Although the correlation is not complete, four out of five quintiles are equivalent between the two maps in the order of ranking.

7.7 Summary

The results presented in this chapter provide material towards further discussion of the methodology and its potential future wider application, to be pursued next.

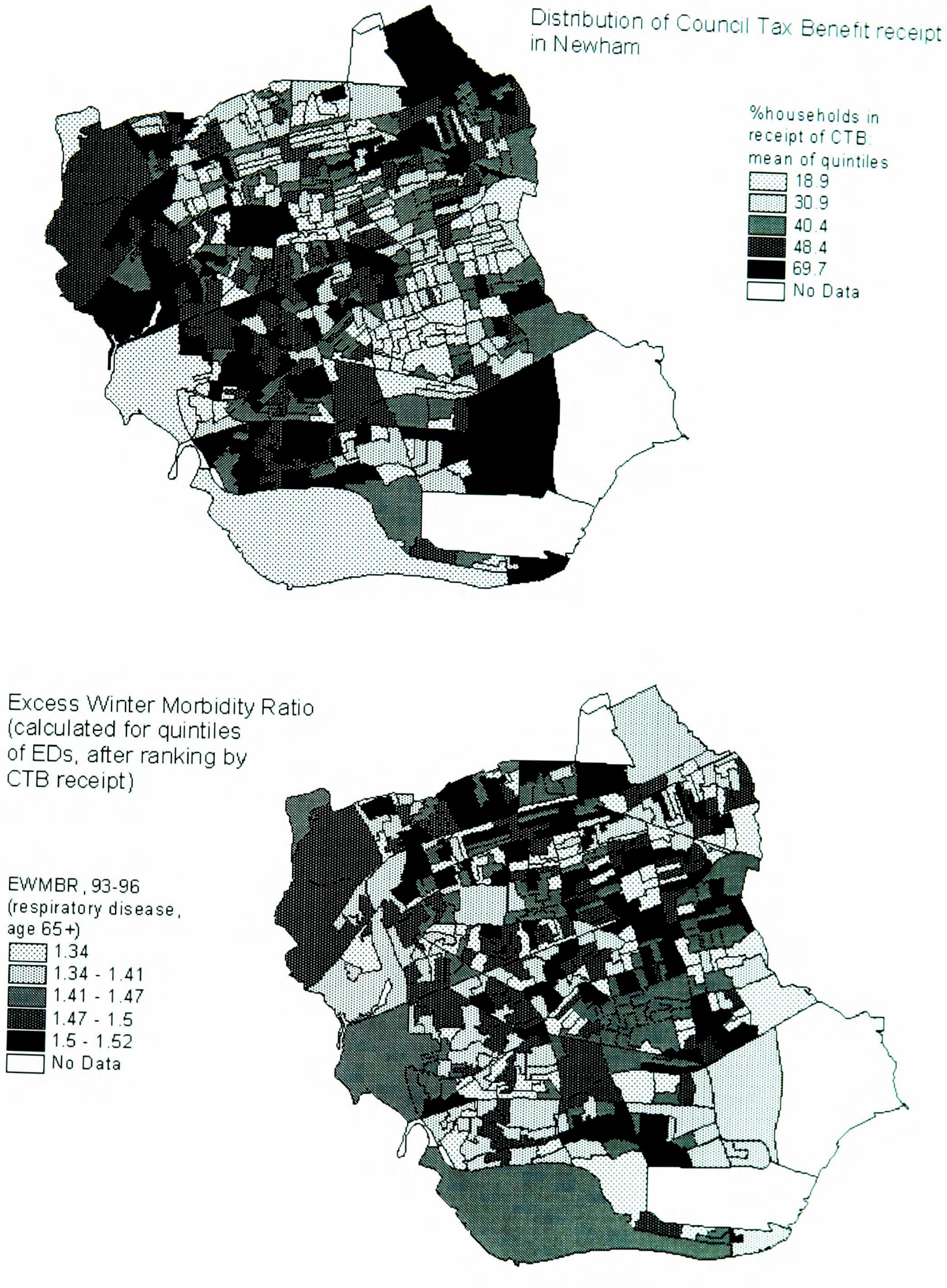
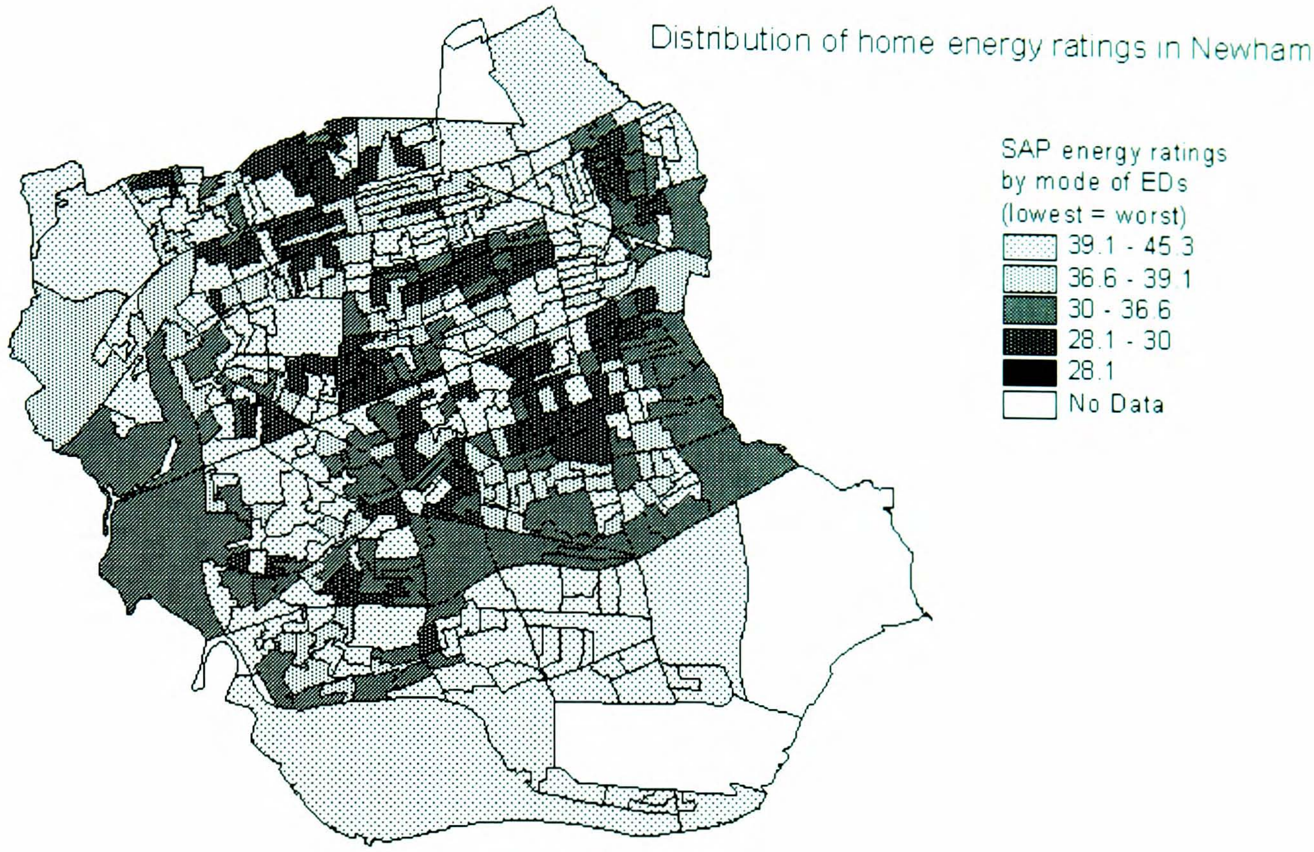


Figure 7-11: Newham enumeration districts: showing relationship between Council Tax Benefit receipt and excess winter morbidity for over 64 year olds



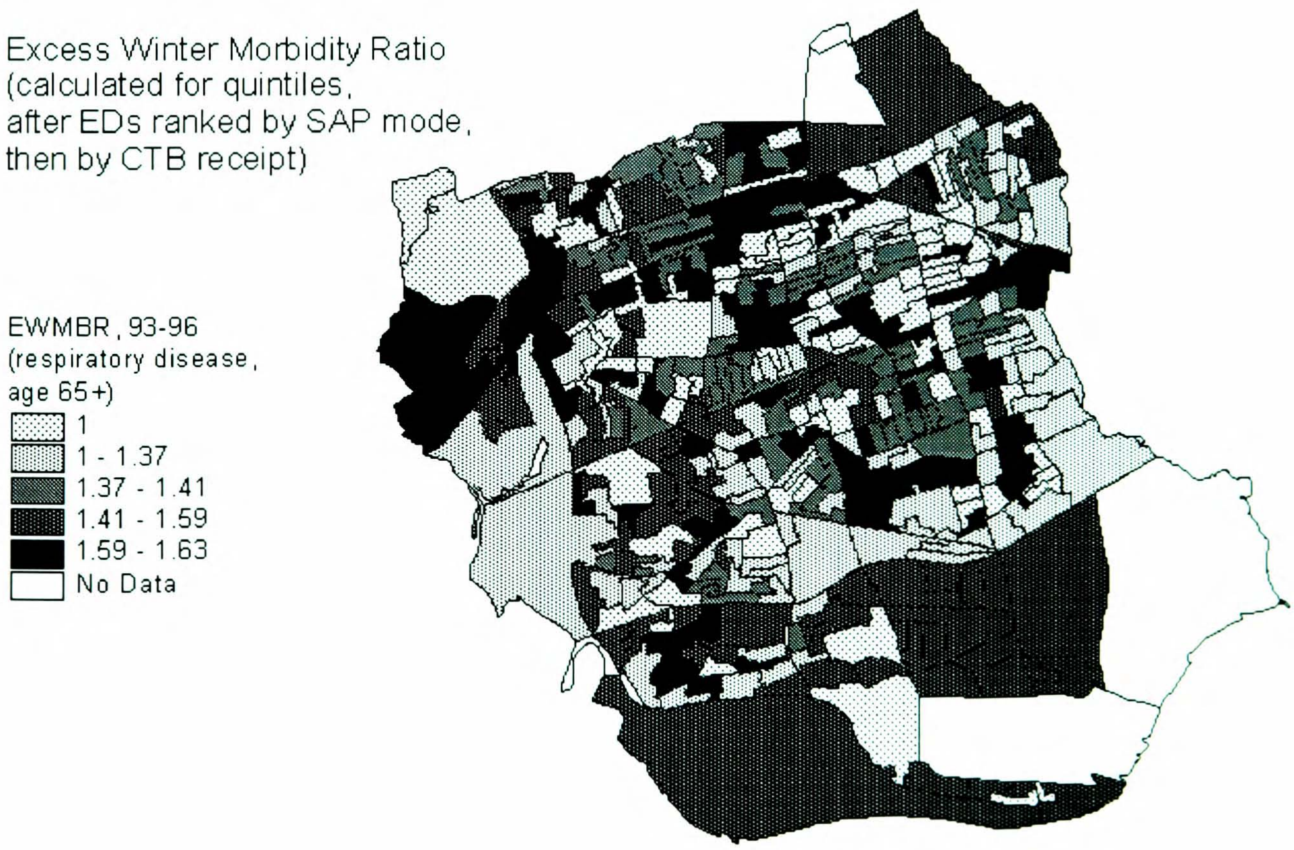
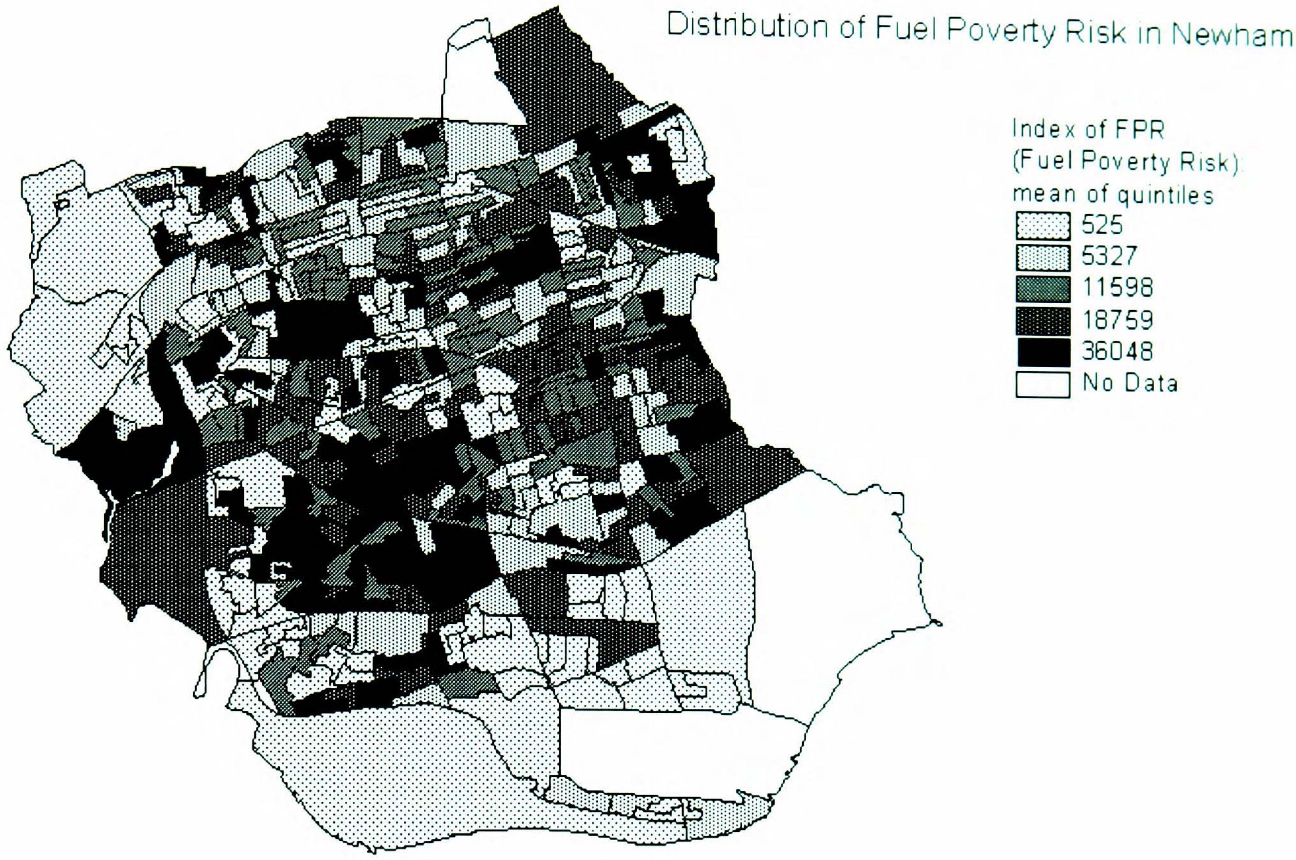


Figure 7-12: Newham enumeration districts: showing relationship between home energy ratings and excess winter morbidity for over 64 year olds



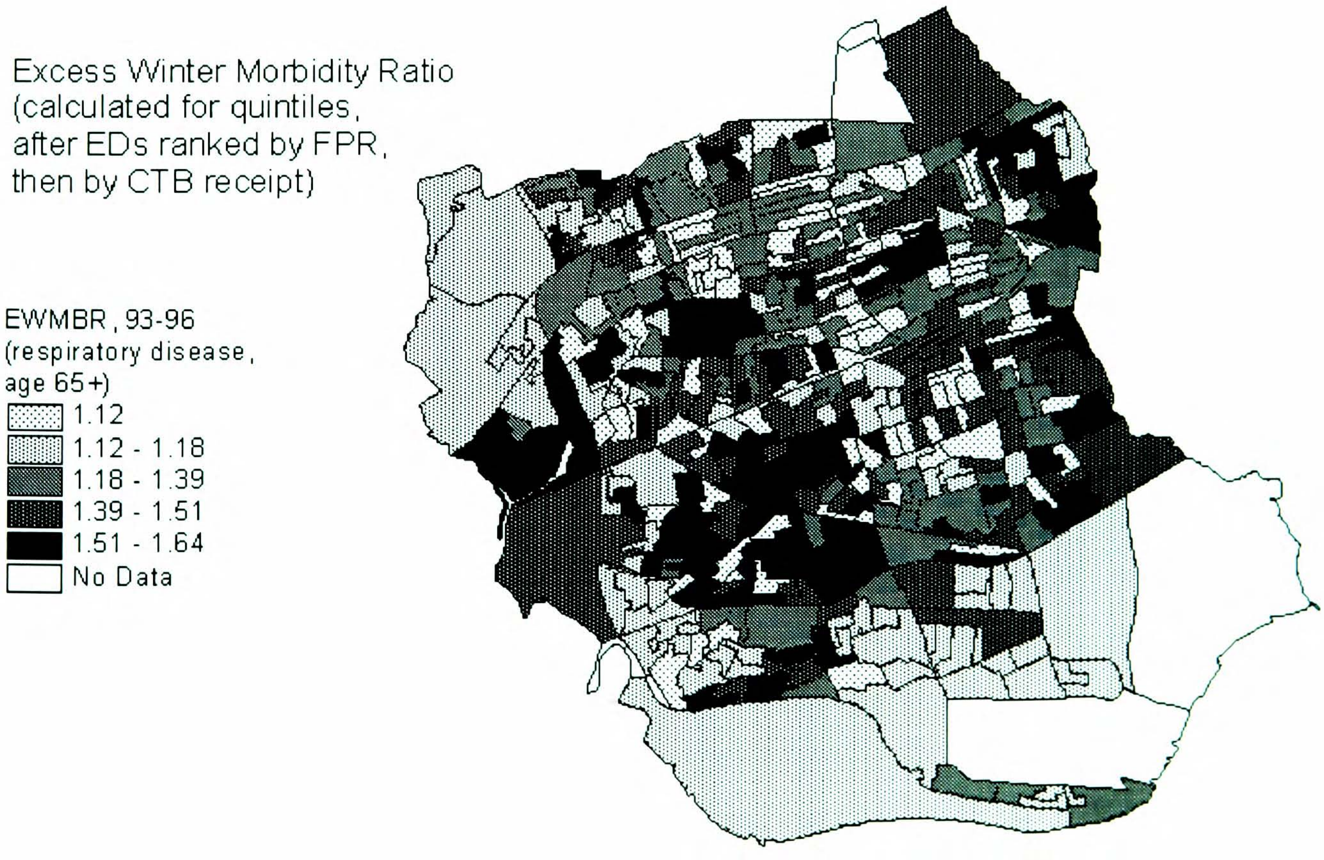


Figure 7-13: Newham enumeration districts: showing correlation between fuel poverty risk and excess winter morbidity for over 64 year olds

CHAPTER 8

Discussion: a critical review of the methodology

"..I come in and it's really like just coming in out of the street..it's just as cold in my flat because there's no-one living above."

Older person without central heating. (Salvage, 1994, p39).

8.1 Introduction

This chapter contains a review of the pilot study results and the extent to which they offer justification for the initial hypothesis through implementation of the proposed methodology. Advantages and disadvantages of the selected approach are discussed, together with possible confounding factors and potential improvements to the methodology. In the context of the themes explored throughout this thesis, there is an analysis of the usefulness of the methodology as a tool for policy making around fuel poverty and its effects. Thus it is considered in light of the need to address inequalities in health and housing, the needs of older people as a group vulnerable to the effects of cold housing and low income, and the desirability of 'joined-up' approaches to government strategy in this area. Its potential contribution towards health impact assessment of energy efficiency investment is also examined. This is a procedure for which guidelines are still being developed, but which is increasingly demanded for government policies. Finally, there is a review of future possible applications and limitations of the methodology in support of central and local government fuel poverty strategies.

8.2 Fuel poverty risk and health: is the hypothesis justified?

The hypothesis tested here, using the pilot study, is that a relationship can be shown between fuel poverty and the health of older people in Newham, employing an epidemiological approach and drawing on morbidity data. In the first place, excess winter hospital episodes for respiratory diagnoses are about 80% more amongst the half of the older population at greater fuel poverty risk than among the remainder and the likelihood that this difference occurs by chance is less than 2%. The difference is increased during the colder two years of the study period, in line with expectations of increased health risk during colder weather. However, the results of the regression analysis, as illustrated in Fig. 7-7, show a moderate, but significant, correlation between the Excess Winter Morbidity Ratio for respiratory disease in the Newham population over 64 years old and the calculated index of Fuel Poverty Risk. This measure of correlation is demonstrated when all the criteria for FPR are taken into account, including housing with poor energy efficiency ratings.

In order to test the contribution of individual components of fuel poverty risk, the EWMbR is calculated for clusters of EDs ranked according to different combinations of risk factors. When the percentage of dwellings with low SAP ratings is excluded from the FPR criteria (FPR_{xSAP}), there is no correlation, as the comparison in Fig. 7-6 demonstrates. The results of this comparison suggest, therefore, that there is indeed a clear relationship between buildings and hospital episodes of cold-related disease in winter, linked to the poor energy efficiency of the buildings and, by implication, their increased risk of low indoor temperatures in winter. On the other hand, no correlation is found between excess winter morbidity and SAP ratings alone (Fig. 7-9). Hence, the likely ability to afford heating, age and size of household and the size of the property seem to be confirmed as factors that, in combination, underpin the apparent association between energy inefficient housing and health.

This is borne out further by examining the relative effect of the low-income factor as part of the FPR Index. The income, or benefits, data was found not to be totally reliable, as discussed earlier, either because of the postcode conversion problem, or because of inaccuracy of recorded postcodes in the supplied data. However, when the income element of the FPR Index is excluded (Fig. 7-8), there is still a significant, although lower, correlation shown between the EWMbR and the FPR (FPR_{xCTB}). Thus the remaining criteria for FPR (poor energy efficiency, age and underoccupancy) together correlate with the EWMbR, but the correlation is enhanced by the low-income factor. This may indicate that the benefits data is broadly accurate and that the aggregation of EDs is correcting for some of the anomalies.

There is little difference in correlation shown between FPR and EWMbR for the two-year period with more severe winters than the two-year period with milder winter temperatures and smaller seasonal temperature change. Correlation was low for both periods, although one is significant at the 0.05 level and the other is not. Although it might be expected that correlations would be stronger for the colder years than the warmer because of the known association between temperature and excess winter mortality, in fact the reverse was found (Fig. 7-5). This could mean that winter severity does not make a difference, or that the winter severity measures used for comparison are not the most influential. For example, there is a case to be argued that day-today temperature changes are a key factor for health, rather than absolute low temperatures (Rudge, 1996). In fact, the winter temperatures in 1993-4 were overall more changeable day to day than in 1995-6 (see Table 7-5). Winters were also wetter, however, which seems to reflect the findings by Aylin *et al.* (2001) of small positive correlations between the amount of rainfall and measures representing milder temperatures[37]. On the other hand, it seems likely that there may not have been sufficient hospital episodes over the two-year periods for any excess winter morbidity to register significantly, since there is an evident relationship with fuel poverty risk when data is aggregated for the whole four-year period.

Aylin *et al.* (2001) found some association between lack of central heating and excess winter deaths. Here, however, when EDs are clustered according to the percentage of dwellings without central heating, there is no significant correlation with excess winter morbidity (Fig. 7-10). Although this deficiency is often a feature attributable to older properties, which also tend to fall into low SAP rating categories, possession of central heating does not indicate ability to afford its use, nor its effectiveness in a poorly insulated house. Results here indicate that more important factors for cold-related health are those of low income and poor building characteristics, in combination. Yet again, however, there may not be sufficient instances of homes without central heating for a relationship with excess winter morbidity to be manifest, considering that, on average, only 5% of lone pensioner households did not have it.

The comparison of the Townsend deprivation score with the FPR and the resulting lack of correlation demonstrated that one could not be regarded as a proxy for the other. Also, there was no association with excess winter morbidity. The fact that the Townsend score did show correlation with CTB receipt, and to a small extent with age over 64 years old (both part of the FPR), emphasizes the apparent lack of its relationship with low energy ratings for dwellings and the overall FPR. When the underoccupancy score was tested using a factor of households with an occupancy rate of less than 0.5 persons per room, there was a slight negative correlation found. The explanation for this could be that the Townsend score includes an element to signify overcrowding, which would be derived from the same set of census variables, but representing the opposite effect.

It was pointed out earlier that Aylin *et al.* (2001) found no correlation between excess winter mortality and deprivation, as measured by the Carstairs index, which they described as unrelated to housing variables (3.4.2). Nevertheless, according to Bardsley and Morgan (1996, p14), there are generally apparent links between ward levels of deprivation and rates of hospital admissions,

[37] *see* 3.4.2

in particular, emergency admissions. Their conclusion was derived against the Jarman UPA score, which includes a lone pensioner household indicator. It may therefore be more likely to correlate with the FPR than the Townsend score but, like Carstairs, it is only available at ward level, so a proper comparison across all the scores is not possible. Reid *et al.* (1999) found that the Jarman UPA8 score was less useful in predicting admission rates than individual census variables and therefore had limited value in reflecting deprivation.

However, the lack of association between deprivation scores and excess winter morbidity or mortality may be explained by the essential distinction, due to energy inefficient buildings, between fuel poverty and poverty in general, as discussed in Chapter 2. If low indoor winter temperatures are key to the relationship between FPR and health, then a deprivation score that does not include a highly weighted housing variable would be less likely to correlate with excess winter disease events.

8.3 The epidemiological approach

8.3.1 Meeting the criteria

Do the results suggest that the epidemiological approach is justified? The basis for drawing conclusions from epidemiological studies is that differences in disease rates are observed in different groups of population. If the rate differences are large enough, it must be shown whether this is due to a particular exposure or to random statistical fluctuations. The criteria for verifying the effect of the suspected exposure are *temporality*, *consistency* and *dose-response*.

The criterion of *temporality* means that exposure must precede disease. In this case, the relevant exposure involves the combination of energy inefficient housing, low income and underoccupancy. Housing conditions must, by definition, meet this condition, although length of exposure could obviously vary. The assumption has been made that the older population and their circumstances will have been relatively stable over the four-year period. For radical alteration of home energy efficiency, significant capital investment would have been required, which is unlikely at a large scale in an area as generally deprived as this. Therefore, on the basis that the building characteristics would probably have remained largely unchanged, a significant aspect of fuel poverty risk exists whether or not the population is static. Where the local authority has carried out estate refurbishment, it has been done to buildings that would have already been above the low SAP rating threshold at the beginning of the period considered.

Consistency demands that the same type of effect is shown in a variety of studies. The accumulation of research findings discussed in Chapter 3, whether from epidemiological studies on excess winter mortality, or smaller, intervention studies on health effects of energy efficiency improvements, points towards similar conclusions to those shown here. A *dose-response* relationship requires that the greater the exposure, the greater the health effect that is observed. By testing the different component factors of fuel poverty risk against excess winter morbidity, evidence of such a relationship is apparent. The greater the risk of fuel poverty, depending on the full combination of known factors, the more likelihood of excess winter morbidity is shown among the population over 64 years old, as indicated by the slope of the regression analysis (Fig 7-7) and by the comparisons in Table 7-6, Fig 7-3 and Fig 7-4. (It was found that approximately 33% of the variance in EWMbR could be explained by the FPR, from Fig. 7-6, or 36% from correlations shown in Table 7-7.)

Epidemiological investigations are usually observational, rather than experimental, and their function is normally to identify potential associations for further investigation into direct causal links. The inherent danger of the ecological fallacy[38], where it is assumed that relationships observed between areas apply equally to individuals, means that these relationships should be verified by different kinds of study. The conclusions to be drawn from the results here are that a possible association *is* demonstrated between fuel poverty and health. On this basis, further specific studies would need to include observing the health effect of interventions to alleviate fuel poverty, particularly those involving improved energy efficiency of dwellings.

8.3.2 Potential confounding factors

Notwithstanding these conclusions, the complexity of the possible relationships between housing and health, together with the nature of the epidemiological approach that compares populations, means that the occurrence of confounding influences is highly probable. It is known that chance, bias and confounding can offer spurious explanations for associations between environmental exposure and disease, or for causal relationships (Strachan, 1993, p95). A number of specific confounding factors could be operating with respect to the relationships under examination in the Newham pilot study and are reviewed here. These should be considered in addition to those generally applicable to this research area, as discussed earlier.

Although the energy inefficient housing attribute seems to be key to the results, there could be some other factor present associated with housing, or its spatial distribution. Haining points out

[38] *see* 3.4.2

that a 'spurious correlation' can occur when confounding variables show the same regular spatial pattern. An example given is that the air pollution effect on respiratory disease is difficult to separate from poor housing conditions, as most deprived groups often live in city centres where air pollution is also greatest (Haining, 1998, p35). In Newham, it may therefore be advisable to further investigate the location of the low SAP rated housing and its proximity to major roads, for example, to establish whether this could be a possible additional source of aggravation for respiratory disease. (However, some epidemiological research by Livingstone *et al.* (1996), based on GP practices in East London, found no increase in risk of asthma with living close to busy roads.)

Furthermore, some parts of the borough are noted for high rates of overcrowding (*see* 6.2.1), which is associated with communicable disease. Some of this may take the form of respiratory infections, thereby confounding the apparent relationship with fuel poverty, although it is quite likely that overcrowded households may also be in fuel poverty. Since fuel poverty risk is assumed to be partly dependent on *under*occupancy, however, if the overcrowding confounder does operate it would probably weaken potential correlations of the FPR with excess winter morbidity.

Respiratory disease, including asthma, is related to damp, mould and the presence of allergens such as house dust mites, as well as to cold. As described earlier, the house dust mite flourishes in warm and damp conditions and poor ventilation is often a key factor in mould resulting from condensation, rather than low temperatures alone. These are building-related problems, but not necessarily directly connected with energy ratings and should be recognised as possible confounders of health and buildings data.

The age profile of the Newham population shows a strong weighting towards younger age groups, compared with the national picture (Griffiths 1994, p84), and a relative under-representation of those over 65 years old. This may dilute the strength of relationships found for the older population by comparison with other areas.

Some research illustrates the possible influence of confounding variables on variations in hospital admission rates, which could be of particular relevance for the pilot study. One study found significant correlation between hospital admission rates and many measures of chronic illness and deprivation (Majeed *et al.*, 2000). Since Newham suffers high levels of deprivation (*see* 6.2.1), this might provoke some confounding of the results, as different combinations of deprivation factors could be influencing hospital admissions rather than simply fuel poverty.

which has its own specific combination. However, this was allowed for by taking out different sets of factors in testing for correlations, as described. A further consideration is that the generally high levels of deprivation in the borough could help to obscure relationships between poor housing and health, whereas a more polarised population in socio-economic terms, as found in Camden for example, would be likely to display greater contrasts.

A study that was specific to Newham considered hospital admission rates for asthma in Asian and white patients (Griffiths *et al.*, 2001). Differences in rates were found to vary with the confidence of the patient over controlling their asthma. Those with confidence were frequently white, with good access to primary care, which in itself was associated with reduced risk of hospital admission. This could indicate that ethnicity is a factor in high rates of admission for asthma. It may be advisable, therefore, to look more closely at ethnicity as a characteristic of ED populations with consequent effects on excess winter hospital admissions. This is similar to the findings by Reid *et al.* (1999), where socio-demographic differences influenced hospital admissions rates because of apparent inequities in access to health care services.

8.3.3 Data aggregation

The need for data aggregation has been discussed previously, but when this is done there is necessarily some consequent loss of information, which must be weighed against the advantages. Again, the *ecological fallacy* has implications for interpretation of the strength of relationships found at aggregated levels, in terms of how they may apply to individuals. Haining points out the need to take into account the particular form of spatial aggregation (the '*modifiable areal units problem*'), which will itself affect estimated relationships. It seems that measures of association tend to increase as the size of areal units increases, and their number decreases, the effect being similar to the smoothing effect of data when a mean value is used to represent a frequency distribution with a large spread (Haining, 1998, p34). (This is evident when comparing results for the study population as two groups and as 25 groups.) Haining explains further that:

> *"...aggregation of health event data to an areal framework involves the loss of some of the original detail although the benefits are that it may then be possible to look at associations between health events and socioeconomic and environmental variables that cannot be studied at the level of individual cases.... However, one of the consequences of following this route is that the choice of areal aggregation becomes critical"* (Haining, 1998, p37).

The balancing act has to be borne in mind, but the necessity for dealing with epidemiological data in this way is unavoidable. Limitations are imposed not only from the level of data available, for reasons of privacy and confidentiality, but also by the frequency of events that is required to differentiate the studied effect across populations.

For the pilot study, because of the method of calculating excess winter morbidity. areal divisions were altered according to different ED characteristics. It is reasonable to argue that the chosen method of data aggregation supports the research hypothesis, because the fuel poverty and health association is evident when EDs are clustered in 25 percentiles according to the degree of FPR, but not when the 24 wards are ranked by the same factor. Since wards are simply geographical groupings of EDs, it can be assumed that they would not necessarily be distinguishable according to FPR because they could contain a cross-section of population and house types. However. it should be recognized that wards varied in size and number of EDs, whereas the 25 clusters each included the same number of EDs. The population numbers would still have varied in both cases, since EDs themselves vary in numbers of households (*see* Appendix A).

Could the pilot study results derive from a statistical artefact to do with data aggregation? It may be asked whether the FPR is simply representative of general deprivation effects attached to those who live in poor housing on a low income and who, being older, are likely to become ill more often than younger people? Do low SAP ratings, which are strongly connected with the age and fitness of buildings, serve as a proxy for general deprivation and a poor standard of living - apart from the possibility, already mentioned, of representing some other environmental hazard? This may well be possible, but then fuel poverty is indeed a sign of deprivation, or, in fact, multiple deprivation, as the discussion in Chapters 2 and 3 made clear. The lack of its relationship with other measures of deprivation has already been considered in this chapter, including the fact that no association is found between the Townsend score and the EWMbR.

To reiterate Boardman's argument (1991), it is the factor related to building characteristics that distinguishes fuel poverty from general poverty and deprivation. One of the likely effects of deprivation compounded by living in inefficient housing is inadequate warmth in winter. From the available evidence described throughout the thesis, it is reasonable to assume that low indoor temperatures could contribute to cold-related disease in winter. This appears to be confirmed by the differences in correlation between excess winter morbidity and FPR, depending on the inclusion or exclusion of the low energy efficiency factor. As pointed out in Chapter 3 (3.4.5), although housing tenure may be highly related to income levels, it is not necessarily a reflection of inefficient housing. Ownership by social landlords is often indicative of relatively high energy ratings (Wilkinson *et al.*, 2001). Therefore the relationship between income and energy efficiency is not straightforward and FPR is not a direct proxy for deprivation in terms of low income.

In addition, the EWMbR was based on the incidence of emergency respiratory disease episodes, as more likely to be representative of cold-related ill health than other diagnoses. Indeed, the EWMbR is greater for respiratory disease than other diagnoses (Table 7-3). There is no correlation evident between EWMbR (for those aged over 64 years old) and the percentage of households including at least one pensioner, despite the fact that older age groups are most likely to be admitted to hospital for respiratory conditions. Furthermore, as Table 7-6 shows, within the older population of Newham alone, there is a clear difference in excess winter respiratory episodes according to FPR, despite the similar annual numbers of episodes among high and low risk groups. These features of the data indicate that the association found between FPR and EWMbR does not depend on age alone.

In view of these arguments, it seems unlikely that FPR, or low SAP ratings, are approximating for general poverty, or the older population itself, to produce a statistical artefact. The latter two attributes do not, individually, display any association with excess winter morbidity as measured here by the EWMbR. Once again, therefore, it is emphasised that the interaction of all the relevant risk factors for fuel poverty, as reflected in the FPR Index, appears to be key to the statistical relationships found.

8.3.4 Mapping and GIS

Mapping the results of the statistical analysis has met the objective of providing accessible, visual information, which can be read by professionals of whichever disciplines are concerned, as well as by non-experts. Although some interpretation may also be necessary, it could form a starting point for inter-disciplinary discussion and strategy development. Wilkinson *et al.* (1998, p181) describe the most basic function of GIS, which is mapping, as one of the most useful in relation to public health. This function also serves the epidemiological approach to investigating the health of populations well.

> *"The main purpose of disease mapping is usually to gain insights into the spatial distribution of disease determinants, or to develop hypotheses that may be tested using other methods"* (Wilkinson *et al.*, 1998, p182).

As described throughout, the intention here is to combine the mapping of excess winter morbidity with the wider health determinants of housing energy efficiency and income to illustrate any relationships found. The problem of varying densities of population across geographical areas is dealt with by the use of rates rather than absolute values.

It is recognised that the way in which GIS has been used for the methodology is largely for presentational purposes, whereas there is potential for exploitation of its further attributes in the statistical analysis itself. The mapping process could also incorporate the FPR Index calculation.

for example, using the overlaying of risk factor data, although this was done as a separate procedure for the pilot study, while testing how different combinations of variables might be appropriate for the methodology. One of the directions for further exploration and refinement of the methodology would be a more sophisticated development of the statistical analysis together with the GIS capabilities. The potential value of the methodology and mapping analysis as a tool is described later in this chapter.

8.4 Designing and implementing the methodology: problems encountered and potential remedies

What seemed at first to be a relatively simple idea for mapping and overlaying certain data for one borough, proved to be far more complicated than was initially envisaged. The various logistical and ethical problems and obstacles encountered around the methodology have been described in previous chapters, but the main difficulties may be summarised under the following headings:-

- gathering energy ratings data at a sufficient level of accuracy or detail, particularly data on past improvements carried out;
- accessing income, or benefit, data and, in particular, obtaining relevant historical data;
- the inherent problems associated with hospital admissions data;
- obtaining data in a sufficiently anonymised status with regard to ethical issues;
- obtaining contemporaneous data (*e.g.* census predates study period by up to 7 years; matching energy ratings information to period of hospital data);
- obtaining data in comparable form (*i.e.* similar geographical level)

Energy ratings were necessarily approximated at this level of study, their calculation at even a basic level requiring more resources than were available. It would be helpful if, in future, the census could be used for collecting more information relevant to energy ratings of properties. This has not been done for the latest survey (in 2001), but there is a limit to the amount of reasonably accurate building details that the population can be expected to enter on a form that is already fairly complex. It also remains a process that is only carried out once in ten years. Meanwhile, the local authorities continue to gather information for completion of their energy databases for domestic properties. It is likely that it will take some time before this exercise is finished for all privately owned properties. Furthermore, authorities may find it difficult to keep such a database up to date with completed improvements, if it ever should be completed by present methods (personal communication, local authority Energy Officer, 2003). However, there is potential for energy ratings data, once available, to be fed into borough GIS systems.

Alternatively, it would be possible to adapt a GIS system of the kind already developed by the Welsh School of Architecture for an energy and environment prediction model for sustainable city planning (EEP), as described by Jones *et al.* (2000). It includes a domestic sub-model, which has been designed to identify energy ratings at postcode level for typical house types in Cardiff. This is based on calculation of energy characteristics of a range of sample houses within a region by survey, following which remaining properties can be assigned to appropriate groups. Physical dimensions, exposed surface area and building age are the characteristics used for 'forcing' properties for that region into clusters of the designated energy efficiency classifications. For wider application, such as in the thesis methodology, the house types would have to be adjusted to local conditions for the particular borough under scrutiny.

Because of the anomalies thrown up in the 'PC2ED' conversion of addresses relating to CTB receipt, the accuracy of the data concerning the percentage of households receiving CTB is slightly suspect. This may be due to inaccuracies within the address database, or to the conversion process itself, as described earlier (*see* 7.2.1). There is a need for ensuring accurate identification of CTB receipt according to ED for future use. If the local authority could add the ED to their address database by a reliable method then, by relating total numbers of households in receipt of CTB to total numbers of households from the census, these data could be input to a GIS system for the borough. It may be possible to test other census variables, in place of CTB receipt, as potential indicators for low income.

Haining (1998, p39) comments on the problems of accurately assigning health events to EDs, for similar reasons to do with the postcode conversion process. Unfortunately, the cheaper directories for converting postcodes to EDs are only accurate to within 100 metres which, as he points out, is clearly a problem in urban areas where EDs are not geographically very large. Problems also arise where postcodes overlap 2 or more EDs. Alternatively, the assignment process can be done using the OS ADDRESS_POINT data, which is accurate to within one metre, but this is expensive to use.

The health data was already provided at ED level but it is believed that the assignment process used by the Health Authority was not based on the expensive data source. It is unlikely that all local authorities would yet have access to this either, although this may change as they extend their use of GIS. Hansell *et al.* (2001, p54) draw attention to the problem of 'dump postcodes' in HES data, where missing or unknown postcodes are assigned to a local postcode such as that of the hospital. There is also some difficulty with the fact that postcodes can be altered over time.

Both of these problems could therefore also affect the accuracy of ED information to some extent. As Haining suggests,

> *"where EDs are grouped into large contiguous areas the risks of inaccurate assignment are reduced"* (Haining, 1998, p39).

To rely on this principle may compromise the desired level or method of data aggregation, however. It may have operated fortuitously, to some extent, in the case of Newham, but the methodology depended on clustering EDs according to fuel poverty risk, rather than contiguity.

As has been discussed in detail in Chapter 5, it is recognised that there are various problems attached to the use of hospital admission data. Among these is the 'provider effect' where, for example, diagnoses on admission may differ, depending on which hospital or which doctor admits the patient. Numbers of beds available or local clinical practice could also influence which patients are admitted. According to Hansell *et al.* (2001, p54), there are methods to incorporate the 'provider effect' into small area analyses. It may be appropriate to employ these in any development of the methodology that used more sophisticated statistical analyses.

Since emergency admissions are to be used as indicators of seasonal effects, it could be argued that, as emergency cases, they might be less likely to be influenced by the provider effect than elective admissions would be. However, the research on differences in asthma admissions raised the issue of ethnicity and it could be assumed that these would often be emergency cases. Census data could be used to identify the range of different ethnic groups by ED as a potential influencing factor for variations in EWMbR, but this exercise would be subject to the usual problem of how far census attributes are likely to change over the period between surveys.

Whereas there are acknowledged questions surrounding hospital admission data, others would be presented when using a different information source. It is only possible to work with data that is available, where the ideal cannot be obtained. This principle must also operate with regard to census data, with shortcomings due to the infrequency of the surveys, its potential for inaccuracies at small area level due to inbuilt confidentiality measures (*see* 5.3.3) and undercount problems. However, as Wilkinson *et al.* comment, for most purposes in relation to population data for geographical studies, *"the census remains the 'gold standard'"* (Wilkinson *et al.*, 1998 p180).

The problems involved with lack of contemporaneous data would be eliminated once a methodology was set up for continuous data acquisition by the local authority and health authority. This would then be fed into the GIS mapping analysis tool on a regular basis.

There are potential problems with gathering both the benefit and the health data in a form that is strictly non-identifiable and anonymised. The difficulties for epidemiological research, arising from interpretation of the recently implemented Data Protection Act, are discussed by Strobl *et al.* (2000), as mentioned earlier (*see* 5.5). Working at ED level would seem to counteract these, but this depends on the data being supplied at that level by the source agencies. It would be necessary to clarify the position with relevant ethics committees well in advance of the research or implementation of the methodology.

Beyond the suggested remedies to the problems found in implementing the pilot study, there are other possibilities for improving aspects of the methodology. In order to investigate further any relationships between the EWMbR and meteorological variables, or the relative effect of winter severity, it is suggested that data should be examined for a wider area than the borough, such as a health authority, or spanning a longer period. The data included for the pilot study was evidently insufficient to show up significant differences according to winter severity. Nevertheless, when making comparisons of excess winter morbidity from year to year, winter severity should be taken into account.

It may be that a more sophisticated calculation method is necessary for the FPR Index, to reflect the complexity of relationships between risk factors and their relative degrees of influence. For example, a simultaneous regression of EWMbR could be made against the different variates for further examination of relationships between FPR and EWMbR. No weightings were given in the FPR calculation and, according to Noble *et al.* (1999, p11), these are required when items are combined to produce one index. Houghton and Bown (2003) acknowledged, for example, the fact that under-occupancy is not a prime cause of fuel poverty, so this factor would need to be weighted for lower significance than would those relating to low income and energy efficiency. In future development of the work, a multi-variate analysis could be a means of assessing a weighting of the importance of each factor within the Index. Further statistical investigation was beyond the scope and focus of the thesis in terms of time, length, resources and available expertise. However, it was advised that the analysis shown here is a robust technique and appropriate to the task (pers. comm., Gilchrist, 2004).

Further refinements of criteria for fuel poverty risk could be tested such as, for example, including a definition of lower SAP ratings. However, a balance is necessary for criteria thresholds. They cannot be narrowed down so far that qualifying numbers would be reduced and the likelihood of potential relationships to be found would be diminished. When it comes to finding alternative indicators of fuel poverty risk, the fact that there are already different deprivation scores for use in different contexts, indicates the possible need for one that prioritises building conditions, rather than the desirability of using a proxy.

8.5 Further potential for methodology in the policymaking context

8.5.1 Policy relevance

It is proposed that the methodology tested through the pilot study, subject to the suggested improvements, could be of value beyond its primary intended purpose for offering evidence towards links between fuel poverty and health. Once the building, income and health data collection requirements were set up, they could be updated on a regular basis and fed into a borough GIS system. This could potentially constitute a monitoring and evaluation tool with respect to a number of policy areas and with relevance to various stated government aspirations. These have been raised as themes throughout the thesis, while their profile has been progressively raised in government policy documents produced during the development of this research and its writing up. Here, the research methodology is put into the context of recent developments in policy and strategy relating to fuel poverty and health.

8.5.2 Joined-up policymaking

As described in Chapters 2 and 3, the government now officially recognises fuel poverty as an issue to be addressed and acknowledges the links with excess winter deaths and ill health. It has presided over the introduction of the Warm Homes and Energy Conservation Act 2000, which requires the publication and implementation of a strategy for reducing fuel poverty and the setting of targets for its implementation. The UK Fuel Poverty Strategy has been published[39] in partial fulfilment of the terms of the Act and compiles the myriad existing policies and strategies which have some relevance for fuel poverty, demonstrating the complexity of the issue and the multi-disciplinary character of its required solutions.

In view of the wide range of these policies, it is not intended to examine them in detail. However, as well as specific fuel poverty programmes, the list includes housing investment programmes, proposed enhanced standards for dwellings, energy and energy conservation policies, income support measures under the social inclusion remit and health improvement and modernisation plans. The targets set out in the Strategy suggest that the government

> *"will seek an end to the blight of fuel poverty for vulnerable households by 2010. Fuel poverty in other households will also be tackled once progress is made on the priority vulnerable groups. The specific interim target for England (is) by 2004, to*

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[39] November 2001

> *have assisted 800,000 vulnerable households through the ... Warm Front Team and to reduce the number of non-decent social sector homes by one third (though not all of these will be occupied by fuel poor households)"* (DEFRA/DTI, 2001).

The Fuel Poverty Advisory Group (FPAG), which is sponsored by DEFRA/DTI to report on the progress of delivery of the government's Fuel Poverty Strategy, has recently produced its first Annual Report. It claims that current fuel poverty programmes are not sufficient to reach the targets laid down for 2010 and need increasing by at least 50%. It expresses concern over an

> *"apparent contrast between Government's clear commitment to the Fuel Poverty Targets and the level of priority and drive on fuel poverty in practice"* (FPAG, 2003, p4).

The Group further recommends the better integration of the several different programmes in operation. In the light of their comments overall, it appears that the necessary 'joining up' of departmental strategies related to fuel poverty is largely confined to their combining as a list in the Strategy document. Indeed, the Strategy itself referred to the need for tackling the problem on many fronts, but did not include proposals for co-ordinating actions.

In Chapter 3, reference was made to the Acheson Report on tackling health inequalities and its recognition of the link with poorly insulated housing with inefficient heating systems. The Department of Health has now produced a programme for action on tackling health inequalities (DOH, 2003a) in which it suggests that, among other things, this could result in the end of fuel poverty for vulnerable groups. It also emphasises that narrowing the gap in health outcomes could be achieved through *"joined up policy making and implementation across departmental boundaries"*. Four government departments are cited as responsible for action to tackle some of the causes of ill health associated with living in poorly insulated homes and reduce excess winter deaths, *i.e.* DEFRA, the DTI, DOH and ODPM. Local authorities would be the delivery mechanism, with a key role for housing officers, health professionals and social workers. The DOH document does not explain the means by which the joining up would be achieved. The FPAG has suggested the involvement of yet another department in tackling fuel poverty, the DWP, because of its role regarding benefit take-up and therefore in raising income levels for low-income households.

Furthermore, the DOH National Service Framework for Older People, referred to in Chapter 4 (4.6), proposes a multi-sectoral approach to promoting health, independence and well-being in old age, which would be assisted by improving housing quality and thereby reducing fuel poverty (DOH, 2001). Again, the mechanisms through which such an approach may be encouraged are not spelt out. However, from all the policy documents described above, it is clear that the government aspires to the goal of joined-up, multi-sectoral policymaking and strategies for action on fuel poverty, with reference to vulnerable households, health inequalities and well-being in old age. The potential role of various departments is also recognised, but the level of priority given to their different fuel poverty related targets has been queried by the FPAG.

The British Medical Association recently produced a report that examined evidence in relation to health and housing, highlighting the risk to health of many older people living alone in old, damp and cold homes (Mayor, 2003). In the report, the BMA concluded that the government should create a 'healthy housing taskforce' to address changes in housing policy that would reduce adverse effects on health. Despite all the government references to concerted approaches to the housing-related health problems therefore, it seems that more structural changes are desirable, where housing and health responsibilities may, once again, be more closely combined. It is suggested that the proposed mapping tool, which requires reference to housing, health and welfare agencies for the collation of relevant data, could assist in promoting joined up decision making and strategic development. If the data collection exercise were carried out regularly, as a monitoring tool, it could help to increase inter-sectoral awareness, at a local level, of the links between housing, income and health. It could provide a basis for the delivery mechanism required by the DOH at local authority level, to tackle the causes of ill health associated with cold homes. As previously mentioned (5.4.2), there was the advantage in Newham that the local authority boundaries fell within those of the single health authority which, at the time, was not always the case elsewhere. This may be less of a problem since the new, larger, Strategic Health Authorities were introduced in 2002.

8.5.3 Identifying fuel poverty

The FPAG recognizes that the numbers being removed from fuel poverty under the current specifically directed schemes, such as Warm Front, are 'disturbingly low'. It suggests that greater emphasis should be made on numbers lifted out of fuel poverty, rather than numbers 'assisted' by the programmes, since it is estimated that over 50% of those benefiting from the schemes are not in fuel poverty, according to the Strategy's definition (FPAG, 2003, p5). Some research mentioned previously (3.7.2) suggested that part of the reason that the Warm Front programme lacks effectiveness in targeting fuel poor households is that it gives no priority to dwelling conditions. This is because the eligibility criteria are primarily based on benefit receipt (Sefton, 2003). There is no provision for remedial work to buildings in too poor a condition to benefit from draughtproofing, for example, so the worst homes are unlikely to be dealt with.

Although it is not proposed as a means of identifying *individuals* in need, the Fuel Poverty Risk Index, as developed for the mapping tool, places equal emphasis on home energy ratings as on low incomes. It is suggested rather that it would indicate *areas* of risk that should be targeted or prioritised for energy efficiency improvements, due to a combination of these factors that is likely to produce homes that are insufficiently heated in winter. (In this respect, it is very similar to an area deprivation score, or index, as discussed in 5.3.1). Energy efficiency improvement and remedial work to housing often benefit, in financial terms, from the economy of scale, where work is carried out for whole streets, for example, at a time. The mapping presentation is therefore appropriate for identifying the greatest concentration of need geographically, as a means of prioritising area implementation of efficiency measures.

The fact that the FPR is calculated at a small area level, *i.e.* for enumeration districts, rather than by postcode or individual households, is dictated by the availability of data and confidentiality issues. The need to aggregate health event data for calculation of the EWMbR has been discussed in previous sections, so that EDs have to be grouped accordingly. This is because of the low level of expected annual numbers of emergency respiratory episodes for older people in single EDs (*see* 7.4). In order for any difference in such episodes to be discernible between areas, there needs to be an expected level of episodes appreciably greater than zero. So, although the use of percentiles of EDs in the correlation analysis loses some detail with respect to health events, data aggregation allows scrutiny of associations that would not be possible at individual case level (*see* 8.3.3). Thus the means of analysis is governed by the characteristics of the obtainable data and the variables being studied.

An alternative proposed method of fuel poverty identification has been published very recently by the Centre for Sustainable Energy (CSE). A group funded by SWEB, the main electricity supplier for south-west England, has also researched the development of a methodology for predicting fuel poverty at a small area level (Baker *et al.*, 2003). It would enable a similar method of prioritising areas for action. Their proposed Fuel Poverty Indicator is based on the 1991 Census and data from the 1996 EHCS, from which weightings were derived for eight selected component census variables at ward level, although it can also be made available at ED level. It is currently undergoing a validation process, although this is meeting some difficulties because of the shortcomings of schemes against which validation is possible. Most were based on surveys that elicited limited response and are themselves not accurate or yet validated. In developing this indicator, many similar problems were found to those encountered in the thesis research. For example, they had difficulties obtaining appropriate housing and income data and a range of assumptions had to be made. They also noted a lack of correlation with the Index of

Multiple Deprivation score, because the housing domain of this index is based on homelessness and overcrowding.

The Affordable Warmth Index (*see* 5.3.2), also published since this research was initiated, is another alternative means of identifying fuel poor households. Whereas the FPR and the Fuel Poverty Indicator are small area tools, the AWI has a different function, in that it is designed to classify individual households as fuel poor and is tied to the definition of fuel poverty according to the percentage of income required to achieve certain heating standards. It therefore requires information concerning both individual households and specified dwellings for its calculation. Although it may be possible to calculate an average AWI from a regional profile of housing and occupancy types, the current database and stock profiling products of National Energy Services do not do this (pers. comm., Baggett, 2004). Assumptions would have to be made regarding the type of occupant that would live in a certain type of home and, because of the complex relationship between SAP ratings, household types and income, the number of necessary assumptions would compound the degree of errors inherent in an area calculation. However, the AWI would be an appropriate tool to be used with detailed household surveys, following the identification of areas at risk by the FPR.

8.5.4 Monitoring progress

The government has established a Fuel Poverty Monitoring and Technical Group, whose remit is to examine and propose indicators for measurement and monitoring of progress in dealing with fuel poverty. Current indicators, drawn from existing data sources, are listed under the headings of income, fuel prices and housing, mostly available through different agencies with their own priorities for data use. Among the housing-related indicators are SAP ratings, temperature and excess winter deaths. Unfortunately, the EHCS data that would have been used for the temperature indicator is no longer going to be available, as temperature measurements were not collected for the 2001 survey, nor will they be in future. Despite the limitations of the spot readings method (discussed in 2.3.2), this was a valuable regular data source in relation to the effect of fuel poverty on housing conditions, considering that there is no other similar.

As referred to earlier (2.2.5) Boardman has pointed out the lack of routinely collected data that combines relevant factors for identifying fuel poverty. The mapping tool proposed in this thesis is based on several, largely existing, data sources (although the energy ratings classification requires development), converted to a format that allows an appropriate combination of factors. The further - and important - advantage is that it includes the health element for comparison with fuel poverty risk, in the form of the EWMbR. This provides a measure for monitoring progress in tackling fuel poverty in terms of health, as well as improved energy ratings. The progress measured might be evident over a shorter time scale than if measured by numbers of excess winter deaths.

The Fuel Poverty Indicator proposed by Baker *et al.* was also tested for any association with excess winter deaths. A seasonal mortality ratio was produced for all wards in the South West for 5 years of data. It showed no correlation with the Fuel Poverty Indicator, which the report suggests is counter-intuitive (Baker *et al.*, 2003, p43). From the experience of developing the EWMbR for the thesis methodology, it is suggested that this could be due to a number of reasons. Firstly, excess winter deaths are far fewer in number than morbidity episodes. On the other hand, the seasonal mortality ratio was not diagnosis specific, so numbers would be greater than for single diagnoses. However, any relationship with mortality from cold-related disease would have been 'buried' within numbers due to all causes. The thesis research also found that at ward level there was no relationship between excess winter morbidity and fuel poverty risk, apparently because the aggregation of data to that level diluted or confounded variations in fuel poverty risk too far. A possible confounding factor prevalent in rural parts of southwest England that is different from Newham circumstances is the distance from hospital, which could affect mortality figures. It should also be pointed out that the CSE Indicator is based on eight census variables found to be associated with fuel poor households, which include under-occupancy and lack of central heating, but no component directly representative of building energy efficiency. This may be the key point of difference from the FPR Index proposed in this thesis.

'Warm Zones' is a government-sponsored initiative designed to combine local partnerships in a co-ordinated effort to tackle fuel poverty across a locality. Five pilot zones, of which Newham is one, were set up across England to run for 3 years from 2001 and test the potential of the concept in different types of region, but the final report is not anticipated until 2005. Following on from the pilot study in Newham, the mapping tool could potentially be used towards evaluation of the local Warm Zone effectiveness in delivering improvements to fuel poverty and associated health risk in older people. Since it should be implementing energy efficiency improvements on a large scale over a relatively short period, it may be anticipated that the EWMbR would reveal a corresponding health benefit. The pilot study could possibly be regarded as the baseline position for comparison, although it does predate the initiation of the Warm Zone activity by some years. The FPR Index could be used together with the Warm Zone approach if it were repeated elsewhere, in order to help identify areas at the outset for priority action within a designated Zone.

Thus the research methodology could be used, in several respects, in support of policies and strategies being developed to tackle fuel poverty, or achieve affordable warmth: towards a first stage, area identification of fuel poverty, in monitoring and evaluation of policies and in assisting a multi-sectoral approach to policy implementation.

8.5.5 Health impact assessment of investment in affordable warmth

In Chapter 5 (5.2.1), it was pointed out that there is increasing demand for health impact assessment (HIA) of government policies to inform the decision-making process in all areas, for which an extensive evidence base is required. Morgan (2003) suggests that impact assessment should ideally provide a continuous process of prediction, monitoring and evaluation, or auditing, of policy effects.

Thus the roles already outlined for the research methodology point to its possible value as a health impact assessment tool. Firstly, it is designed to contribute to the evidence base for health effects of fuel poverty and cold homes, allowing some prediction of the impact. Accordingly, it could also be used for the monitoring and evaluation of the implementation of energy efficiency measures, as part of a policy designed to achieve affordable warmth. In this way, it could potentially strengthen evidence of the links, by allowing measurement of their impact in practice, as long as the building efficiency upgrading were carried out on a scale sufficiently large to achieve a measurable effect. Since fuel poverty is now regarded as part of the wider determinants of health and a contributing factor to health inequalities, measures to tackle fuel poverty should be seen as part of health policy as well as under the housing and energy remit. It has already been suggested that the methodology could incorporate the EEP energy rating software, which is also described by its authors as having potential for an impact assessment model (Jones *et al.*, 2000).

The use of evidence to inform health policy is discussed in a paper published by Macintyre *et al.* (2001), who formed the evaluation group for the inquiry reported by Acheson (1998). They found that little empirical evidence currently exists on the effects of interventions on health inequalities. They suggest a number of criteria for judging policy recommendations, which include the cost of policy implementation and the need to consider potential for harm or increasing inequalities, as well as possible benefits. They also strongly recommend that the impact of any policies implemented should be monitored.

In fact, the government has commissioned an evaluation of energy efficiency measures installed through the Warm Front programme, which is currently under way and is referred to in Chapter 3

(3.7.2). The study is being done at individual household level, involving an attempt to monitor two thousand households before and after interventions during two winters. The outcomes under examination are health, quality of life, risk of cold-related death and use of health care services, but results are not yet available. As mentioned above, there is the likelihood that households in receipt of Warm Front measures are not always in fuel poverty, or in the worst housing, so there may be difficulties in generalising from the results of this study.

The FPMTG suggest excess winter deaths as one of the indicators for the UK Fuel Poverty Strategy, which would evidently be regarded as measuring health impact. However, it has been argued throughout the thesis that a more useful indicator is that of excess winter morbidity, relating to respiratory disease as a recognised cold-related diagnosis. Arguments in favour of the population, or epidemiological, approach have also been addressed in Chapter 5 (5.2.3). The proposed EWMbR would be a comparative measure that could be replicated relatively easily. This offers the possibility of building up evidence from different localities, such as the five pilot Warm Zones.

When considering the health impact of policies to upgrade housing energy efficiency measures, and noting the possible disadvantages, potential health implications of houses that are over-sealed should be borne in mind, as described in Chapter 3 (3.7.2). Current research into this area would need to be examined for possible confounding effects on excess winter episodes of respiratory disease.

In a report by den Broeder *et al.* (2003) on an HIA of the national Housing Policy for the Netherlands, they discussed the problems attached to lack of so-called 'hard data'. They recognised that hard evidence is not always available or possible to obtain, in which case they

> *"...concentrated more on the effects of the policy on health determinants than on the 'health' itself. (They) showed how changes in these determinants will influence health and, although exact figures were not given, the direction of the health effects was outlined."*

The EWMbR is an epidemiological tool that does not provide evidence at an individual level, while there are a number of confounding factors to be considered. It could therefore perhaps be regarded as offering 'soft data', indicating a general direction of health effects of energy efficiency policies.

8.6 Costing the health impact of cold housing

In addition to contributing to the evidence base for estimating potential health impact, could the research methodology be used to attach costs to health risks of inefficient housing, since costing is an inevitable part of the impact assessment process? The health impact of investment in energy efficient building improvements may have intrinsic significance, but might also contribute to the cost benefit of such a policy.

Bardsley summarizes some of the health service costs previously attached to poor housing quality in various studies (*see* 5.2.2), although he points out that they are inevitably imprecise (Bardsley, 2000 , p225). For example, in an unpublished report, Carr-Hill *et al.* (1993) found that costs to health services of 203 adults living on one poor estate were found to be around 50% more than for a sample matched for income from the General Household Survey. They extrapolated from these results to estimate that, in 1994, costs to the NHS of the 10% of all homes with damp would be £600m. Another study estimates the cost of health services for residents in poor housing as compared with non-poor housing as £2.4 billion (National Housing Federation, 1997), whilst elsewhere it is suggested that the annual cost to the NHS of excess deaths and morbidity associated with cold housing is £220 million (Lawson, 1997, p74).

Peters and Stevenson (2000, p145) have attempted to model costs of damp and cold housing to the health services, more specifically, by selecting key health conditions shown to be directly associated with these housing conditions. They point out that there is otherwise no quantifiable evidence that these households' use of health care differs from people in warm dry homes. The health conditions include limited diagnoses of respiratory and cardiovascular conditions and mental health problems associated with damp housing. Cost savings were estimated on the assumption that all houses were made energy efficient (to SAP 60), taking into account costs of hospital services, primary care, prescriptions and community care. These costs were apportioned according to disease prevalence by housing condition and prevalence of damp housing stock, informed by data from the EHCS. A central estimate of £77.24m was produced. It was expected to be an under estimate because of assumptions made and the small number of health conditions selected for costing limited to those with clear documented evidence of association.

It is possible that the EWMbR could be used to make an alternative estimation of health service costs attributable to cold and damp housing. On the basis of the pilot study, this calculation could be made for the Newham population of 65 years old and over. NHS Reference Costs are published annually by the DOH in various tables, listing, for example, typical costs and average length of stay for treatments. This information is given separately for non-elective patients, *i.e.*

those generally admitted for emergency treatment that requires a hospital stay for longer than one day. The average length of stay is also given for primary diagnoses of admissions. The total cost of an episode is made up from the component elements of treatment and bed day (or 'hotel') costs, both of which depend on the consultant specialty.

However, it may be necessary to take advice from a medical economist, or other health professional, to arrive at the cost of a typical hospital stay for a respiratory hospital episode, for the relevant age group. (Knowledge of which treatments are typically associated with respiratory diagnoses for older age groups would be necessary, for example.) This would provide a basis for assessing the cost per excess winter respiratory episode, but it may also be appropriate to incorporate additional associated health service costs for prescriptions, primary and community care, as included by Peters and Stevenson. The excess winter costs would have to be measured against an expected average, which would need to be determined.

Some hint of potential costs can be deduced from the pilot study. The total annual number of excess winter respiratory episodes for the Newham population aged over 64 years old is 125, based on 1993-96 figures (*see* Table 7-6). The relationship shown between fuel poverty risk and excess winter morbidity for respiratory diagnoses in older people suggests that these excess winter episodes could be attributed to colder winter weather and associated with buildings that are more likely to be cold because they are harder to heat. As one example of a typical treatment related to respiratory disease for older people, '*complex elderly with a respiratory system primary diagnosis*' is listed as £1,857 in 2003, as the national average unit cost, with an average length of hospital stay of 10.8 days (DOH, 2003b). There are 60,091 Finished Consultant Episodes (FCEs) recorded nationally in 2003 for this treatment, taking up as many as 646,949 bed days as non-elective inpatient cases.

Based on the figure of 125 annual excess winter respiratory episodes among the older population in Newham, then the current associated secondary care treatment costs, derived from this example, would be £232,125. A further element of cost to the NHS would be the total of 1,350 bed days, because of the added winter pressure on hospitals. Furthermore, the significance of costs of respiratory diagnoses among this age group to the NHS can be gleaned from the fact that of 687,000 Finished Consultant Episodes (FCEs) for this diagnostic group in the year ending March 1998, 256,000 were for people aged 65 or over, *i.e.* more than one third (DOH. 1998). From the evidence found in the pilot study, addressing fuel poverty and energy inefficiency would help in tackling the causes of winter respiratory disease, from which there are clearly financial gains to be made.

With reference to the discussion in Chapter 2 (2.2.4), although part of the short-term solution for fuel poverty may depend on income support measures, the main concern in this thesis is for improving domestic energy efficiency as the principal remedy for fuel poverty. This would provide the most effective long-term solution, as Boardman argues (Boardman, 1991) but requires capital investment on a large scale to deal with the country's ageing and inefficient housing stock. The many older buildings in the stock with solid walls are regarded as a particular problem, since it is more expensive to apply insulation to an external or internal surface than to inject into cavity wall construction. Older buildings tend to be associated with poor energy ratings. The cost effectiveness of such investment would therefore have to be justified to the Treasury.

Thompson *et al.* consider that there is a lack of comparative information on the cost effectiveness of specific housing improvements, which is the type of evidence *"likely to be most valuable to policy makers and housing providers"*. They call for

> *"large-scale studies (to) investigate the wider social context of housing improvements and their comparative effectiveness and cost effectiveness"* (Thomson *et al.*, 2001).

Ambrose *et al.* emphasise the costs of poor housing that are not likely to be measurable:

> *"A more subtle way in which costs arise is from the effect of housing on people's ability to participate in society and in the economy. We have a significant section of our population living in inadequate and insecure housing, a whole group of people unable to contribute fully"* (Hooton, 1995, quoted in Ambrose *et al.*, 1996, p7).

However, in a more recent paper, Goodacre *et al.* (2002) use a cost-benefit analysis framework to assess the potential scale of some benefits from comprehensive upgrading of heating and hot water energy efficiency in the English housing stock over a 15-year period. They include an evaluation of potential health gains from fewer cases of cold and damp related illnesses, based on some of the earlier published calculations mentioned above, as well as environmental benefits from reduced carbon dioxide emissions and employment gains from the upgrading programme. Social benefits to households are emphasised as the annual savings on fuel costs and improved thermal comfort. The conclusions are that, depending on the time-horizon of the analysis, the net social benefit of such an upgrading programme exceeds its costs.

This work is important with regard to the discussion over 'takeback' (see 2.2.8) where environmental priorities would favour investment in homes of the fuel rich over the fuel poor if the sole aim is to reduce carbon dioxide emissions. It is anticipated that any costing exercise enabled by the thesis methodology could provide further evidence in support of these conclusions.

8.7 Future applications: capabilities and limitations

As a key part of its Fuel Poverty Strategy, the government currently spends, on average, £150 million a year in England for the Warm Front programme, aiming to reduce fuel poverty in vulnerable households by providing grants for insulation and heating to owner-occupied and privately rented homes. However, the National Audit Office's recent report on the programme (NAO, 2003) found that only 30% of grants reach fuel poor households, while only 14% reach the most energy inefficient homes (with a SAP rating under 20). The Report recommends, therefore, that consideration should be given to concentrating resources in the least energy efficient homes where the most cost effective improvements can be made (NAO, 2003, p5).

It is important that the resources made available for Warm Front, already recognised as insufficient for the task, are as well directed as possible. The better targeting of Warm Front, as demanded by the NAO, could be assisted by using the FPR Index to identify EDs at greatest risk of fuel poverty as a first step in advance of more detailed surveys. HECA specifically does not require that local authorities assess fuel poverty in individual households because it recognises that the task is too onerous, but the FPR brings together the factors of both buildings, income, age and underoccupancy that combine to increase the likelihood of fuel poverty in an ED. These are not all picked up by the current means of allocating Warm Front grants through marketing, self-referral and eligibility according to passport benefits that are not necessarily fuel poverty indicators. The FPR, however, would help to focus on the energy inefficient buildings part of the equation, as part of a local authority fuel poverty strategy and promotion of Warm Front measures.

It is evident that the FPR Index would not solve the perennial problem of detecting single or small numbers of fuel poor households occurring in amongst middle-income areas of reasonable housing stock. However, no method has been found of doing this to date, short of knocking on every door and extracting accurate income details from residents whether given willingly or not. This is a prohibitively expensive and resource intensive exercise, as the experience of the Warm Zones has confirmed. The NAO Report (2003, p19) refers to Newark and Sherwood District Council as a case study example, where an important part of their fuel poverty strategy (which has gained them 'Beacon Council' status) is to identify *dwellings* that are unable to deliver affordable energy to vulnerable householders. Their energy performance database depends on detailed survey forms, but will take some years to complete. Their strategy also emphasises the contribution of partnership working and multi-agency funding, including housing, health and social services to maximise resources. The FPR Index could contribute to such a strategy that highlights buildings as much as household circumstances, as a first stage area analysis before a more detailed approach is taken. Again, the GIS format would facilitate the overlaying of multi-sectoral data and presentation of results that have relevance for all stakeholders.

The NAO Report (2003, p31) also recommends formalising arrangements for priority cases for Warm Front grants on health grounds. Although the methodology could not be operated at individual household level, it has the advantage of offering a platform for co-ordinated data gathering from different service providers. At a regional level, the EWMbR may be used for monitoring health improvements where fuel poverty risk among older people had been targeted for intervention.

It is difficult to suggest how much it would realistically cost to set up the FPR and EWMbR methodology in a fully workable format, taking account of the multi-sectoral and inter-departmental inputs required. Furthermore, the potential refinements that could be achieved with appropriate expert advice would also come at some cost. However, since much of the data is routinely collected and, assuming GIS systems to be in place in most local authorities, it is likely to be a relatively inexpensive operation.

Against this cost, there would be savings to the health services as demonstrated by the EWMbR, depending on the extent of action taken and how far energy ratings were improved. (For instance, a SAP of 35 would be unlikely to provide affordable warmth to the most vulnerable households.) This would therefore justify investment by health services towards energy efficiency measures. As suggested in the previous section, the cost of excess winter hospital episodes for respiratory disease among older people in Newham could be in the order of £235,000, annually. This is the only part of the cost that can be realistically estimated, based on the example of average expenditure for one relevant treatment, without accounting for associated pharmaceutical, primary or community care costs, for example. By scaling up this health cost element alone to the 365 local authorities in England, national costs could be in the order of £86M (equivalent to almost 60% of the current Warm Front budget), assuming that Newham is typical in terms of excess winter hospital admissions[40]. Treatments of this kind may be relatively

[40] Newham has higher than average rates of respiratory admissions compared with London as a whole, but it is not known whether higher numbers are also reflected in terms of seasonal variations. Newham is an area of high deprivation, which may influence excess winter admissions but, on the other hand, other parts of the country experience colder weather conditions that could also affect the scale of seasonal effects of fuel poverty in those areas.

inexpensive, but it is quite possible that the associated costs to other sectors of the health service are at least as much again. Furthermore, the number of bed days linked to these treatments represents significant costs to hospitals in terms of delays to accommodation of elective admissions. It should also be remembered that respiratory disease is the only diagnosis under consideration here, while cardiovascular disease is also implicated in seasonal morbidity and would add further to associated health costs. The FPR is a tool that would allow targeting of buildings in EDs at greatest risk of fuel poverty, in order to achieve savings against excess winter episodes.

The EWMbR might be regarded as a potential proxy for FPR, now that a relationship has been shown between the two. However, it would be dangerous to assume that the one approximates for the other and that the relationship would work equally in either direction, considering the number of possible causes for respiratory disease and how many confounding variables are involved.

It may be asked whether the FPR could be used to identify vulnerable priority groups other than older people, such as lone parent families or children with asthma. Evidently, the FPR includes some factors that do not relate to older age groups alone, *i.e.* energy ratings and CTB receipt, so to some extent it could reflect risk of fuel poverty among other families. It would be part of further development of the work to test links between FPR and EWMbR for different age groups, also allowing for varying FPR factors according to different family characteristics. Lone parent households can be identified through the census but this population is probably more changeable than older age groups would be and, taking account of the ten-year interval between surveys, the data would be less accurate as the interval passed. It is more likely that this group could be pinpointed through some other means, such as receipt of free school meals, for example.

An EWMbR could be calculated for children with asthma to attempt further extension of the evidence for links with fuel poverty. However, this is a far narrower target group than the population over 64 years old with a respiratory diagnosis and would therefore require data aggregation on a wider area basis than shown here, because expected levels of incidence would be lower. Furthermore, there are many problems surrounding asthma diagnosis, such as summer peaks due to hay fever allergies, air quality issues and the changes in susceptibility that can occur through childhood. This affects both longitudinal and cross-sectional comparisons. The methodology described here focused on older age groups partly because there would be fewer confounding factors involved.

The system used here for estimating the SAP ratings is not advocated for its accuracy or desirability. It was a necessary expedient for testing the methodology, while the local authority energy database is incomplete. For this reason, the EEP extension is suggested in the meantime for any replication of the methodology (*see* 8.4), as even Newark and Sherwood, the Beacon council who have made considerable progress in this area, do not anticipate completing their energy performance database before 2006. Hopefully, this extension of the methodology would allow a more detailed and accurate scale of energy ratings to be identified since, in the process of developing representative house types for an area, more information would be gained than it was possible to access in this piece of research.

There are still further permutations of the FPR that warrant investigation. One option may be to test removing the under-occupation element (which could merit comparatively low weighting), to reduce the number of variables used and, possibly, the potential for error in the Index. Another would be to prioritise energy ratings below different thresholds. (Should lower SAP ratings than 35 be targeted first, or higher SAPs be included in the low rating definition because 35 would not guarantee affordable warmth for every household?) However, any version of the FPR would first need to be validated by replicating the process for other areas with different characteristics, preferably where there was a reasonable amount of information on the extent of fuel poverty, such as an existing Warm Zone area. This would involve a further research project with greater resources than were available for this one but, since Newham itself is a Warm Zone, it would be useful to start by comparing the FPR results with the findings of the Newham Warm Zone process.

8.8 Summary

In this chapter it is suggested that the initial research hypothesis is justified by the results of the pilot study, bearing in mind the provisos of possible confounding factors and limitations of the data sources and quality. A moderate degree of association is apparent between fuel poverty and the health of older people in Newham, which is clearly dependent on the energy efficiency of buildings to a greater extent than the other component risk factors.

The difficulties encountered in sourcing appropriate data for the methodology serve to confirm the problems with this type of research into housing and health in general or, specifically, fuel poverty and health. They illustrate why the latter remains limited in extent and why attached conclusions are hedged with provisos, assumptions made and 'health warnings'. From the experience of the pilot study, it is proposed that the methodology could benefit from incorporating certain improvements for greater accuracy and better co-ordination of data.

Nevertheless, the discussion attempts to show that it has potential in a number of roles, beyond the initial objective of adding to evidence of fuel poverty and health links. These can be combined into the single function of the health impact assessment tool, which also provides a means of supporting the cost-effectiveness argument in favour of policies for large-scale investment in domestic energy efficiency. Despite some limitations, there are possibilities for extending the FPR Index to support national and local fuel poverty strategies and to increase their effectiveness. The lessons from designing and implementing the methodology will be summarised in the following, concluding, chapter.

CHAPTER 9 Conclusions

"We're living in an age where old people are neglected, and I think the government should pay for (insulation); otherwise they'll have to pay for it in other ways...hospitals, health..."

Older person, 75, interviewed for *Energy Wise?* (Salvage, 1992, p71).

The purpose of this chapter is to summarise the broad debate sustained throughout the thesis around housing, health and affordable warmth, while assessing the effectiveness of the research and its potential applicability for future research and practice in this field.

9.1 The research gap

The motivating force behind this work was an interest in energy efficiency for housing, initially with respect to climate change priorities. However, the inevitable conclusion, after considering how far the British housing stock is inefficient, is that serious inequities arise where disadvantaged population groups occupy the least efficient housing. These 'fuel poor' groups lack affordable warmth because poor housing costs more to heat than energy efficient homes *and* they have low incomes by comparison with the rest of the population. Academics and policy makers now generally recognise that the resulting cold and damp housing conditions can lead to poor health, although there remains a lack of direct confirmation through research evidence.

Thus, a major theme to emerge from the thesis concerns *inequalities* that operate among the population, in the context of fuel poverty, with regard to housing, income and health. A secondary theme is that of *older people* who are frequently, for a multiplicity of reasons, the most vulnerable to fuel poverty and cold-related ill health. Meanwhile, *multidisciplinarity* is a key aspect of the fuel poverty issue itself and of necessary solutions, as well as research into its effects, because of the interacting factors of inefficient housing and low income and its apparent links with ill health.

Central government has, relatively recently, made official acknowledgement of fuel poverty, of health inequalities and their links with the well-being of older people, which all now feature in different government policy areas, as do calls for inter-sectoral action with respect to these matters. However, resources are not attached specifically to targets and aspirations in a co-ordinated manner. Housing and health remain separate areas of responsibility and public policy making. There are no structural links as there were when housing policy was formerly part of the health remit between the wars. Nevertheless, because of the acknowledged associations with health inequalities and older people, the Department of Health has described fuel poverty as a public health issue.

While for many years central government did not recognise fuel poverty as a problem distinguishable from poverty in general, there were moves to encourage energy efficiency and energy conservation, apparently stemming from varying motives. Targets originally set by government for local authorities to address domestic energy efficiency, under the Home Energy Conservation Act 1995, emphasised the scale of reduced energy use. This would be most effectively achieved by investing in properties where high levels of energy use are curbed by the least cost intervention, possibly through campaigns offering advice, as much as through government-aided energy efficiency measures. However, Boardman made the case for solving the needs of the fuel poor in the long term through large-scale capital investment in the housing stock and its energy efficiency, principally to improve thermal comfort and achieve affordable warmth, with energy conservation as a potential additional bonus. The fuel poor are relatively low energy users but frequently require significant housing interventions. With respect to resources, the question arises: which of these two strategies would be more cost-effective – and what is the nature of the cost benefits to be counted?

The tension between these conflicting priorities for investment is at the heart of the research question. Energy conservation targets are not sufficient for measuring the effectiveness of an affordable warmth strategy and a wider perspective should be taken, in view of its bearing on public health. However, the government requires evidence for the effectiveness of specific interventions on health. At the same time, the FPAG, sponsored by DEFRA/DTI to report on the progress of delivery of the government's UK Fuel Poverty Strategy[41], submits that the Strategy has given insufficient priority to the targets set under its remit.

The difficulties surrounding housing and health research are widely acknowledged. They have been confirmed in the review of evidence (Chapter 3) showing associations in the fuel poverty context, because of the many layers and interconnections of confounding factors attached to environmental and socio-economic determinants of health. To date, a number of studies,

[41] *see* 8.5.2

published within several areas of professional interest, make up a body of evidence pointing towards possible links. However, this is not sufficient to have provided 'hard' quantitative data to justify the scale of resources that could be argued as necessary to address the fuel poverty question.

The relative lack of studies specifically looking at *fuel poverty* and health suggested the need for research into providing a way of demonstrating a relationship, while the difficulties associated with confounding factors presented a particular challenge. The Newham pilot study was thus intended to explore the potential of a methodology that would supply evidence to support further investment in affordable warmth by establishing a relationship between the energy performance of buildings and the health of older residents. A different approach was taken from previous research, in that an epidemiological study was used to look at excess winter morbidity rather than excess winter deaths. Morbidity gives a better and more immediate picture of health service use resulting from cold housing than mortality does, although data is more difficult to access. The epidemiological approach is appropriate for an observational study, dependent on available data, where resources are limited. By making seasonal comparisons, some confounding factors are eliminated.

9.2 The pilot study outcome

The borough of Newham is classified as one of the most deprived in England and the extent of deprivation would suggest that there may not be sufficient contrasting circumstances amongst the population, particularly in older groups, to show up differences in health conditions according to fuel poverty risk. Nevertheless, the pilot study results revealed a moderate correlation between the chosen indicators of health and fuel poverty, which indicates the potential for finding stronger associations in areas with more polarised older populations. By testing the data in different ways, the relationship found between excess winter morbidity and fuel poverty risk was confirmed as being particularly dependent on the building energy efficiency factor.

The intended objective of the research has been fulfilled, therefore, in that it provides new evidence pointing towards links between fuel poverty and the health of older people. The experience confirmed some of the difficulties of this type of research. The problems of data sourcing and co-ordination that were brought to light would need to be investigated further and remedied before the methodology should be implemented on a larger scale. The details of the proposed mapping depend on confirmation of the particular indicators developed, which could be tested for robustness across a wider geographical area with a more diverse population profile.

However, the mapping produced for Newham achieves the desired objective of conveying the correlations found by the data analysis in an accessible, visual presentation.

Based on the pilot study results, the proposed methodology justifies its further development, proceeding from the correlations apparent between home energy ratings, as a factor in FPR (Fuel Poverty Risk), and hospital episodes. These results reinforce the expected relationship, notwithstanding the provisos to be attached to some of the data. They show potential for monitoring the effectiveness of energy efficiency improvements in terms of health benefits and for costing these benefits, making best use of what data is available. The tool would therefore be of use to both housing and health authorities and could help to promote a partnership approach to dealing with fuel poverty and aspects of health inequalities.

If the local authority and health authority could co-operate over their respective data gathering, a borough-wide GIS database could be set up including:

- hospital admission data for different age groups and disease classifications,
- domestic property energy ratings, and
- the incidence of CTB receipt.

By including the census variables discussed and, once more accurate data on buildings and income was accessed, a baseline map of fuel poverty risk distribution and excess winter morbidity ratios could be established.

Geographical areas down to ED level could be identified as at risk and needing prioritising for improvement, rather than individual properties, which could be confirmed on further investigation. However, it does make economic sense to tackle improvements at a street scale rather than single properties. In the long term, for several reasons, large-scale improvement of the housing stock is necessary. It should be possible to calculate what could be achieved in terms of savings to the health service if all housing had its energy rating increased to above 35 SAP. This would be part of the next stage in developing the methodology, as a predictive model. The further potential of the methodology can now be considered in terms of officially stated objectives.

9.3 The potential for new evidence

The government seeks to promote evidence-based medicine and health care, based on the evidence of 'what works'. Discussion in Chapter 3 illustrated the danger that, in the area of housing and health, the demand for proof of direct cause and effect may be unrealisable as a criterion for accepting evidence of what works. The interdependence of confounding variables is inevitably too complex to unravel and research tends to be limited to considering single risk factors, which are easier to measure.

However, there are logical arguments against 'fragmenting' layers of influence, which should be regarded as part of a whole (Byrne and Keithley, 1993; Hunt, 1993). Others argue in favour of accepting 'soft' data, where 'hard' evidence is impossible to gain, concentrating on the effect of policy on health *determinants,* which indicate the *direction* of health effects (den Broeder et al, 2003). Alternatively, Thunhurst suggests that an *accumulated* understanding of housing and health is what counts, as opposed to the scientific 'proof' of relationships between specific housing factors and specific health factors. In practice, while recognising that housing factors are interwoven with social and environmental influences on health, this could mean that it is necessary to consider acting on lower margins of 'proof' (Thunhurst, 1993, p 36). Furthermore, Hunt proposes identifying a 'general susceptibility' to ill health effects of housing, which acknowledges the inclusive influences of social and economic factors (Hunt, 1993, p71). It appears that the Acheson Report (1998) took on board some of these arguments, which have been followed through into government policy documents, if not into strongly resourced strategies.

In view of these points, in what ways could this piece of work therefore contribute to evidence of what works? As stated, it bears out the proposal that risk of fuel poverty, indicated by the combined conditions of low income and inefficient housing for older people, is associated with excess emergency winter hospital episodes for respiratory disease. The observed strength of the building energy ratings factor means that, by association with poor insulation qualities, cold homes are implicated in the relationship. This helps to confirm the influence of indoor, as opposed to outdoor, temperatures, adding to the existing body of evidence. Clearly, there is value in promoting domestic energy efficiency for reducing energy use or increasing thermal comfort alone. Its wider significance, in terms of public health, is corroborated by supporting evidence that *inefficiency* contributes to inequalities of health for older people. Such evidence is therefore valuable for both housing and health professionals.

If the work were to be replicated for elsewhere, it could potentially strengthen the findings and build up additional evidence for cold housing and health links. Since the suggested EWMbR is a comparative measure, it offers the possibility for further investigating the reasons behind any differences found between areas.

Results from the pilot study may be regarded as 'soft' data, because they do not offer proof of direct cause and effect, but they do point in the direction that was expected. The methodology combines data from different sources and professional areas of interest and, through regular updating of the combination of housing and health data collection (in the mapping analysis), would be a means of consistently linking these data that has not been previously managed. It would work in the opposite way to 'fragmentation' and could *promote* multidisciplinary activity.

The suggestion is that it could also provide a base model for an area, from which to monitor effects of future action towards improving energy efficiency in deficient housing, but also from which to develop a predictive tool.

9.4 Policy matters

On the face of it, the existing accumulated evidence of fuel poverty and health links is already accepted to some extent, so apart from materially adding to the evidence, could the research outcome offer anything further towards policy development? As demonstrated, the FPAG has concluded that existing UK Fuel Poverty Strategy (FPS) targets are insufficiently prioritised. It would appear that suitable resources have not been made available to support the targets published, while the aspirations towards joined up thinking and practice are not structurally grounded. The number of initiatives, under different departments, listed as part of the FPS, may be dissipating energy and resources that could be more effective if these programmes were better co-ordinated. Although the FPS justifies their number for the reason that it is necessary to tackle the problem on several fronts, it is possible that more opportunities are thereby created for people to fall through gaps between closely targeted eligibility criteria. After all, the Warm Front programme is shown not to be effective in consistently reaching the fuel poor.

Furthermore, set targets can skew activity inappropriately unless carefully managed, as occurs, it is often suggested, in other areas such as education, hospital performance and management, or even tackling crime figures. The conflict arising between energy conservation targets and dealing with the most vulnerable fuel poor is a clear example. For a given level of resources and a target number of homes to improve, the tendency would be to avoid dealing with those requiring the most measures. This strengthens the argument in favour of a universal programme for energy efficiency improvement.

The BMA have called for a 'healthy housing taskforce' and this would seem to be a logical approach for taking on board the public health implications of energy inefficient housing. Again, it is in line with government demands for interdisciplinary working and joined up decision making. The capabilities of the methodology in predictive, monitoring and evaluation roles offer a function as a health impact assessment tool. This could promote multidisciplinary research and practice that is often difficult, for organisational and other reasons, whereas, according to den Broeder et al (2003), Health Impact Assessment *"paves the way for intersectoral co-operation for health"*.

The ability to demonstrate the cost-effectiveness of policies is clearly crucial to the amount of resources placed at the disposal of local authorities or health agencies to implement energy efficiency measures. The research methodology could be used towards a more realistic assessment of the cost implications of fuel poverty to the NHS than have previous estimations. It would therefore allow a proper cost benefit analysis to be made of anti-fuel poverty measures, taking into account more than energy saving and environmental issues alone. In relation to older people in particular, the EWMbR would be linked to the winter pressures experienced by hospitals, caused not only by increased admissions, but also the fact that patients cannot be discharged if their homes are too cold or if they are, they may then be readmitted.

9.5 Looking ahead

The methodology proposed here covers a fundamentally multi-disciplinary subject, where knowledge is demanded in several distinct areas that could not be found within the experience of one researcher. It is therefore recognised that a finalised design would inevitably benefit from further input from appropriate experts in the contributory fields of study, beyond the limitations of the PhD exercise where the work is required to be attributable to a single researcher. Many important research questions have not been addressed before now precisely because of the difficulties attached to complex and multi-disciplinary topics. The subject area of fuel poverty and health provides several examples of important research gaps, while there are many such difficulties associated with its exploration. (This raises interesting issues of how to deal with subjects that require a multi-disciplinary approach and whether changes to the traditional PhD structure are needed to enable such topics to be studied at this level.)

Having considered the results and the implementation of the methodology through the pilot study, specific possible improvements or extensions are proposed to strengthen the methodology and broaden its applicability:

- to incorporate the EEP model[42] for predicting energy ratings, subject to adjustment of the original model to local housing types and conditions;
- that access to an improved postcode to ED conversion system (such as ADDRESS_POINT) would improve accuracy of data;
- that if the local authority would set up data collection on energy ratings and income receipt as a regular procedure, a number of problems could be solved – there could be better data co-ordination, increased accuracy and more contemporaneous data accessed;
- that a statistical analysis could be incorporated into the GIS presentation of data;
- to arrive at a cost estimation of increased health services use due to excess winter morbidity in connection with fuel poverty;
- to develop a predictive model for savings to the health service from increasing energy efficiency.

To date, the work has been based principally on expertise grounded in architecture and low energy buildings, although with valuable, and necessary, advice from experts in epidemiology and GIS. In order to gain the most from the methodology and its refinements, financial resources and multidisciplinary input would be necessary to develop and extend it further – such as training for the EEP extension, statistical and GIS expertise, and health economics for the costing function.

There are a number of possible alternative extensions and developments that have been summarised in the previous chapter and which could be investigated following validation of the proposed FPR Index. However, its limitations must also be recognised. It is proposed as a small area indicator, focusing on older people at risk, rather than other vulnerable groups that probably constitute far smaller numbers as a proportion of the general population. It should help to target areas of inefficient housing combined with low-income risk, whether or not these households include older people, but it would probably be more difficult to demonstrate the health effects for younger age groups. Other means than the census may be better for identifying single parents or families with young children, for example, and these would need to be explored.

As a small area score, the FPR cannot be used to target, or define individual households in fuel poverty in the same way as the Affordable Warmth Index, for which more detailed information would be necessary. Nevertheless, it offers a relatively cheap method of targeting areas at risk in the early stages of embarking on a fuel poverty strategy, before detailed surveys are done. Once

[42] *see* 8.4

in place, it could be easily updated (and its accuracy enhanced) as energy efficiency data is gathered and affordable warmth interventions are carried out.

It is not possible to use the EWMbR as a proxy for the FPR for good statistical reasons (it being unwise to reverse the independent and dependent variables), as well as the fact that the data aggregation necessary for calculating the EWMbR depends on first determining the FPR. Rather, the EWMbR would have the role of maintaining awareness of the links of energy efficiency with health across both health and housing agencies, and serve as a monitoring and evaluation tool for energy efficiency investment in the long term.

Validation of the FPR may prove to be difficult, in the same way as the CSE's Fuel Poverty Indicator (*see* 8.5.3), because of the lack of data already available on actual incidence of fuel poverty and because, to some extent, it is a changing phenomenon. People can move in and out of fuel poverty as their circumstances change, or as they move house. However, the FPR can help to identify where the risk areas are and, in particular, where there is (immovable) inefficient housing stock. The buildings could then be upgraded to a sufficient level of energy efficiency to provide affordable warmth for any vulnerable household. Validation may be achieved by replicating the pilot study work in further research, this time with a multi-disciplinary team, preferably in an area with a high profile fuel poverty strategy and a good level of available data.

In summary, this piece of research has confirmed some of the difficulties attached to work in this area due to possible confounding factors, data sourcing and measurability of indicators. However, the challenge of demonstrating links between housing and health in relation to fuel poverty has been met, within the limitations of the study size, data availability and resources. Conclusions drawn from the review of related research and the results obtained in the pilot study point to the value of evidence that may be regarded as 'soft', but is indicative of the *direction* of health effects and supports an existing body of evidence.

The Excess Winter Morbidity Ratio would be a useful new measure: a predictive tool for attaching costs to the health impact of providing affordable warmth for vulnerable older people. This would provide important information towards cost benefit analyses of energy efficiency investment, taking into account a wider outlook than for energy use alone and including the effect on health inequalities. It could further illuminate the argument for centrally resourcing significant capital investment in the housing stock for multiple long-term gains, for which joined up research, strategy and practice is required.

Although it is reasonable to argue that the most vulnerable should be targeted first, the narrow, short-term, view would suggest treatment only for buildings presently occupied by fuel poor households, using low cost measures to raise SAP to average levels. Boosting targeted household incomes in cold periods is the other side to the short-term approach, although this does not ensure that individuals might not prioritise other pressing needs over that of affording more warmth. Alternatively, investment in the energy efficiency of the whole housing stock would guarantee its longer lifetime and reduced maintenance costs, as well as reduced national levels of energy consumption. It could save the task of screening populations for income qualification, which government advice to local authorities recognises as burdensome. In addition, as a further long-term measure, it would ensure that fuel poverty should not occur as a result of the condition of a dwelling, or its capacity to be 'affordably' heated, whoever occupied the building. This would require that target SAP levels were, in fact, well above average, since affordable warmth could not otherwise be guaranteed. Boardman (1991) proposed a large-scale investment programme such as this in 1991. The political outlook on fuel poverty has changed somewhat since 1991, to a more sympathetic stance, but the large-scale resources and specific targets beyond dealing with the most vulnerable individuals are still lacking.

In 1994, the Watt Committee Report (Markus, 1994) advocated the *rational use* of energy, as opposed to merely *saving* energy. By taking this position, the needs of the fuel poor would be considered equally alongside, rather than in competition with, environmental targets and priorities. However, it clearly demands the multidisciplinary approach to which the government aspires but which is not widely evident in practice.

In support of increased investment by the Treasury for rational use of energy, therefore, the research methodology developed here offers the following benefits:

- potential information to add to the health care evidence-base towards the links between fuel poverty and health in older people
- it provides a predictive tool for measuring the health cost benefits of energy efficiency investment
- as a monitoring and evaluation methodology, it could support the widely promoted partnership approach between agencies responsible for ameliorating inequalities in both health and in housing through provision of affordable warmth.

Glossary of terms

Deprivation indices: (*Townsend Index, Carstairs Deprivation Score, Jarman UPA (Under Privileged Area) Score*) – indices of deprivation set against certain indicators (*e.g.* Townsend uses unemployment, overcrowding, non-owner occupation and non-access to a car).

Dry-bulb air temperature: Temperature that represents a combination of ambient air temperature and radiant temperature of surrounding surfaces.

Energy rating: a measure of the energy efficiency of a dwelling (*see* SAP below).

Excess winter mortality: the percentage by which the mortality rate for the period December to March exceeds the average of the previous and following four months.

ICD Codes: International Classification of Diseases, Injuries and Causes of Death. In the ICD coding system each disease/cause of death has an ICD number, thus enabling consistency of definition internationally.

Relative humidity: the ratio between the amount of moisture in a body of air and the maximum amount which it could contain at that temperature (%).

SAP: Standard Assessment Procedure – the government's preferred method of assessing the energy efficiency of a dwelling, prevoiusly on a scale of 0 (poor) to 100 (good). (The maximum rating has recently changed from 100 to 120.) It is based solely on space and water heating costs per square metre and is independent of location.

Seasonal mortality: Seasonal fluctuation in deaths.

SMR: Standardised Mortality Ratio is calculated as the number of deaths observed within an area divided by the expected number if national age and sex specific mortality rates were to apply. The ratio is then multiplied by 100. Scores over 100 suggest higher than average mortality.

SF-36: Short Form 36 a health survey measuring health perceptions via 35 items measuring health across 8 dimensions and one item measuring health change, usually self-completed.

Townsend Index: Deprivation score calculated from census variables (*see* 'Deprivation indices').

Warm Front *(formerly New HEES)*: a government funded grant scheme for home insulation and heating improvements. Grants of up to £1,000 are available for those in receipt of certain income related benefits and meeting the qualifying criteria. Increased grants of £2,000 are available for those over 60 and in receipt of benefit, enabling more extensive heating improvements to be made in their homes.

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Appendix A:

Data processing / analysis: Tabulation of ED characteristics for all EDs (450 no.)

(Six pages)

NB: Averages / standard deviations / maxima / minima/ totals indicated on p 6

Appendix A:
Main characteristics for Newham EDs, taken from 1991 Census, HES statistics, survey data and calculated indicators

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	ed	% hh w 1+ pensioner	% hh w 1 or 2 persons	% hh w 5+ rooms	% dwlgs w low SAP (<35)	% hh w CTB receipt	FPR_{all} (assuming col.F max value =100) $=(B*C*D*E*F)*10^{-5}$	Townsend Index	% dwlgs w no CH	SAP mode	% dwlgs pre-1945	93-4 winter resp. count >64yrs	93-4 non-winter resp. count >64yrs	95-6 winter resp. count >64yrs	95-6 non-winter resp. count >64yrs	EWMbR 93-96 = (L+N)*2/(M+O)	total dwlgs w residents (91 Census: S610015)	total households (91 Census: S270031)	total persons (91 Census: S270032)	% population >64 yrs	% hh w lone pens + no ch
2	01AKFA01	24	66	28	15	61	403	6.34	11	49.4	0	0	1	1	2	0.7	218	219	477	11	3
3	01AKFA02	40	74	28	15	47	588	6.84	17	35.2	0	0	5	1	11	0.1	227	227	481	22	12
4	01AKFA03	35	61	63	10	59	794	3.93	9	42.5	15	9	4	4	1	5.2	233	234	563	15	4
5	01AKFA04	45	67	49	10	64	934	6.47	9	35.2	0	5	13	15	24	1.1	242	242	566	21	10
6	01AKFA05	32	55	46	30	52	1264	7.05	11	35.2	0	3	3	14	7	3.4	239	239	603	14	0
7	01AKFA06	9	36	49	0	52	0	7.56	11	42.5	0	0	4	1	0	0.5	216	217	698	3	2
8	01AKFA07	10	33	60	0	60	0	6.14	8	42.5	0	0	3	1	3	0.3	182	183	584	3	1
9	01AKFA08	21	40	68	0	46	0	6.31	17	42.5	0	0	0	5	1	10.0	188	189	573	9	0
10	01AKFA09	28	51	60	60	61	3125	5.72	10	29.6	60	1	4	0	2	0.3	202	201	543	10	3
11	01AKFA10	39	60	50	40	50	2305	7.19	6	35.2	20	5	7	9	7	2.0	148	148	364	18	0
12	01AKFB01	28	61	52	70	64	4037	5.19	19	35.2	40	4	12	6	8	1.0	193	199	511	10	7
13	01AKFB02	35	63	53	95	32	3597	2.48	37	28.6	95	2	4	1	2	1.0	187	189	465	15	23
14	01AKFB03	29	44	63	75	58	3510	4.01	17	31.1	55	5	16	2	0	0.9	166	167	469	13	5
15	01AKFB04	31	58	47	70	44	2571	3.61	30	31.1	65	2	1	0	5	0.7	127	131	331	15	9
16	01AKFB05	36	68	39	70	45	3050	4.8	31	28.6	65	5	6	3	3	1.8	205	209	473	16	19
17	01AKFB06	34	63	33	60	30	1302	5.19	12	28.6	60	2	1	1	6	0.9	167	171	420	18	6
18	01AKFB07	29	63	57	100	23	2479	2.55	28	28.6	100	0	1	0	0	0.0	151	154	369	12	16
19	01AKFB08	23	68	43	100	20	1337	0.81	29	28.6	100	2	1	0	0	4.0	190	190	438	12	15
20	01AKFB09	39	58	47	40	43	1872	4.25	34	42.5	35	5	18	2	3	0.7	158	159	408	18	12
21	01AKFB10	29	55	48	15	37	416	2.85	37	37.2	95	1	2	4	5	1.4	196	195	496	13	24
22	01AKFB11	20	64	42	100	36	1934	2.51	34	28.6	100	0	1	1	2	0.7	201	208	504	9	15
23	01AKFB12	30	60	47	100	49	4035	1.26	33	28.6	100	0	0	0	0	#DIV/0!	168	169	431	14	16
24	01AKFB13	31	57	38	90	23	1430	1.25	29	28.6	95	1	2	0	1	0.7	186	185	453	14	19
25	01AKFC01	31	54	57	80	26	1946	4.28	16	29.6	80	3	1	2	3	2.5	206	208	555	15	13
26	01AKFC02	12	56	44	10	46	135	6.33	11	37.2	70	0	0	1	0	#DIV/0!	172	179	481	4	3
27	01AKFC03	4	78	32	30	58	182	6.21	2	35.2	70	3	4	0	1	1.2	172	289	382	3	0
28	01AKFC04	5	43	54	5	52	28	7.06	2	44.4	40	0	0	0	0	#DIV/0!	64	64	212	1	0
29	01AKFC05	21	35	77	70	76	2917	6.93	26	29.6	70	0	0	1	3	0.7	111	112	355	8	3
30	01AKFC06	24	58	48	50	44	1442	4.96	15	35.2	40	0	0	0	4	0.0	183	186	453	10	4
31	01AKFC07	36	59	49	50	68	3490	4.63	19	42.5	40	1	0	1	9	0.4	191	191	481	16	11
32	01AKFC08	35	80	23	30	52	1008	1.86	6	42.5	10	0	3	3	1	1.5	213	213	383	21	5
33	01AKFC09	42	63	40	30	50	1620	7.35	12	42.5	0	8	7	8	9	2.0	249	251	599	18	6
34	01AKFC10	29	57	44	35	0	12	6.3	9	47.1	30	4	7	5	10	1.1	202	202	492	14	6
35	01AKFC11	30	48	62	20	315	1799	4.87	6	37.2	30	7	1	2	5	3.0	286	288	847	12	4
36	01AKFC12	50	71	42	30	45	1996	3.87	22	35.2	10	22	13	3	13	1.9	197	197	410	25	11
37	01AKFC13	28	55	60	90	1	48	4.3	30	28.6	95	1	10	0	3	0.2	176	176	463	13	14
38	01AKFC14	43	57	56	20	93	2522	7.27	5	42.5	0	8	14	7	19	0.9	193	193	508	16	0
39	01AKFC15	24	60	30	75	21	667	4.5	30	28.6	80	0	4	0	1	0.0	141	142	347	9	15
40	01AKFC16	36	68	49	70	52	4303	4.58	31	28.6	60	1	5	6	2	2.0	174	175	398	15	13
41	01AKFC17	47	74	35	40	56	2751	5.66	11	42.5	5	5	10	3	7	0.9	185	185	385	25	10
42	01AKFD01	29	59	45	70	30	1610	6.71	18	28.6	75	1	9	0	4	0.2	174	184	549	11	5
43	01AKFD02	29	57	45	25	61	1146	7.31	20	49.4	50	1	1	5	0	12.0	161	163	407	14	7
44	01AKFD03	31	48	55	0	59	0	7.16	0	44.4	0	4	3	2	3	2.0	187	186	574	11	0
45	01AKFD04	28	52	64	55	41	2091	5.2	36	37.2	95	0	1	2	3	1.0	185	190	547	10	18
46	01AKFD05	23	57	42	70	54	2074	6.92	31	27.4	85	2	1	2	0	8.0	169	179	480	9	13
47	01AKFD06	38	73	36	0	44	0	6.72	8	42.5	0	2	5	1	4	0.7	150	150	321	22	3
48	01AKFD07	62	83	23	0	66	0	6.2	3	49.4	0	1	3	16	12	2.3	178	179	325	36	0
49	01AKFD08	56	74	26	0	64	0	6.67	2	42.5	0	5	10	12	13	1.5	200	200	397	34	0
50	01AKFD09	33	66	51	50	37	2044	3.95	37	37.2	90	2	1	3	3	2.5	162	161	389	16	20
51	01AKFD10	37	55	56	40	41	1920	5.23	28	37.2	55	0	5	4	6	0.7	189	189	512	16	11
52	01AKFD11	35	59	64	55	23	1654	4.29	25	28.6	65	2	1	2	2	2.7	168	173	455	16	18
53	01AKFD12	30	49	79	55	43	2768	4.45	26	37.2	80	6	1	2	3	4.0	149	149	441	12	15
54	01AKFD13	33	49	78	50	22	1382	3.99	29	37.2	90	4	2	3	4	2.3	172	172	496	14	12
55	01AKFD14	22	59	49	55	31	1095	5.76	43	28.6	85	1	0	0	0	#DIV/0!	124	130	363	9	11
56	01AKFD15	25	58	55	65	34	1772	3.58	35	28.6	95	2	3	3	2	2.0	186	192	521	12	16
57	01AKFD16	25	49	79	50	27	1314	3.89	31	37.2	100	4	0	0	2	4.0	203	207	604	8	16
58	01AKFE01	17	54	68	60	48	1713	5.16	29	37.2	80	2	13	0	3	0.3	111	126	348	7	7
59	01AKFE02	37	57	56	50	33	1971	5.16	23	49.4	80	1	1	3	1	4.0	146	156	421	18	9
60	01AKFE03	33	53	66	60	27	1906	4.67	33	28.6	100	2	3	2	3	1.3	157	163	464	11	15
61	01AKFE04	42	56	50	50	34	1985	6.97	25	42.5	65	4	4	5	7	1.6	202	208	589	16	12
62	01AKFE05	34	53	59	50	29	1533	5.14	28	37.2	90	0	1	1	2	0.7	157	162	471	14	15
63	01AKFE06	25	53	58	55	29	1215	5.52	41	37.2	90	0	2	10	14	1.3	158	158	443	10	11
64	01AKFE07	31	55	67	80	29	2640	4.1	35	29.6	95	0	0	4	0	#DIV/0!	136	143	430	11	19
65	01AKFE08	32	55	53	45	24	994	6.1	26	28.6	70	0	0	2	0	#DIV/0!	179	182	521	14	9
66	01AKFE09	23	51	59	55	30	1127	4.87	32	37.2	95	3	4	2	1	2.0	174	184	591	9	10
67	01AKFE10	23	56	58	65	32	1499	5.91	50	42.5	0	3	1	2	4	2.0	110	119	367	9	6
68	01AKFE11	26	57	52	65	37	1871	4.93	37	28.6	95	7	5	4	4	2.4	144	146	391	11	15
69	01AKFE12	26	51	59	20	20	320	4.98	35	37.2	100	0	2	0	2	0.0	170	171	492	11	22
70	01AKFE13	38	58	57	65	18	1414	2.11	22	28.6	70	0	1	3	2	2.0	185	187	479	18	12
71	01AKFE14	23	53	68	65	32	1741	4.7	21	28.6	80	1	0	0	1	2.0	144	146	426	9	11
72	01AKFE15	23	58	43	75	50	2045	5.09	39	26.5	95	0	0	2	3	1.3	113	121	349	9	9
73	01AKFE16	23	46	69	65	18	867	4.53	33	37.2	100	0	0	0	0	#DIV/0!	115	122	407	5	7
74	01AKFE17	39	58	59	40	31	1620	3.93	23	37.2	80	10	14	7	14	1.2	172	178	458	16	8
75	01AKFF01	12	54	46	25	46	356	1.6	4	47.1	25	2	0	0	4	1.0	232	232	588	6	1
76	01AKFF02	19	45	55	100	45	2106	8.08	20	29.6	80	1	4	0	5	0.2	222	223	661	7	6
77	01AKFF03	32	54	39	0	88	0	5.85	2	42.5	0	1	4	0	1	0.4	130	131	328	12	3
78	01AKFF04	5	60	46	0	16	0	-0.25	0	47.1	0	0	0	0	0	#DIV/0!	185	187	482	2	0
79	01AKFF05	14	56	49	15	31	175	2.33	7	47.1	5	0	2	0	5	0.0	201	205	535	5	1
80	01AKFF06	28	69	31	95	70	4103	5.96	53	24.4	85	1	3	1	5	0.5	200	207	447	14	27
81	01AKFF07	9	41	87	0	20	0	0.67	0	44.4	0	0	0	0	0	#DIV/0!	211	213	643	2	0
82	01AKFF08	17	31	69	0	30	0	3.58	0	44.4	0	2	5	0	2	0.6	211	211	669	6	0
83	01AKFF09	37	63	39	95	31	2644	4.31	19	31.1	50	0	0	4	2	4.0	192	192	479	17	8
84	01AKFF11	32	59	37	0	82	0	7.94	12	35.2	0	1	1	2	3	1.5	108	108	269	13	2
85	01AKFF12	28	48	59	55	75	3252	5.84	12	31.1	0	3	7	3	3	1.2	199	199	544	11	0
86	01AKFF13	24	44	69	55	53	2130	6.13	4	35.2	15	8	17	2	0	1.2	158	159	459	10	1
87	01AKFF14	41	65	48	45	55	3207	6.67	10	42.5	5	7	7	1	5	1.3	232	232	549	19	7

Appendix A:
Main characteristics for Newham EDs, taken from 1991 Census, HES statistics, survey data and calculated indicators

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	ed	% hh w 1+ pensioner	% hh w 1 or 2 persons	% hh w 5+ rooms	% dwlgs w low SAP (<35)	% hh w CTB receipt	FPR_{all} (assuming col.F max value =100) $=(B*C*D*E*F)*10^{-5}$	Townsend Index	% dwlgs w no CH	SAP mode	% dwlgs pre-1945	93-4 winter resp. count >64yrs	93-4 non-winter resp. count >64yrs	95-6 winter resp. count >64yrs	95-6 non-winter resp. count >64yrs	EWMbR 93-96 = (L+N)*2/(M+O)	total dwlgs w residents (91 Census: S610015)	total households (91 Census: S270031)	total persons (91 Census: S270032)	% population >64 yrs	% hh w lone pens + no ch
88	01AKFF15	30	53	55	50	42	1888	4.94	21	29.6	50	7	5	9	1	5.3	225	226	604	10	7
89	01AKFF16	37	70	31	5	120	406	6.86	5	42.5	5	5	11	7	9	1.2	219	219	467	19	0
90	01AKFF17	37	59	49	20	64	1334	5.15	9	42.5	15	13	18	14	29	1.1	243	244	630	15	6
91	01AKFF19	2	78	31	0	18	0	-0.23	2	47.1	0	0	0	0	0	#DIV/0!	223	224	451	1	0
92	01AKFF20	32	56	61	0	42	0	5.59	5	42.5	0	2	2	2	10	0.7	146	146	380	13	1
93	01AKFF21	32	78	27	15	20	205	6.69	9	47.1	40	3	11	2	16	0.4	372	377	714	17	12
94	01AKFF23	24	53	45	25	51	743	4.64	14	44.4	40	3	15	2	2	0.6	258	259	683	9	5
95	01AKFF24	36	64	41	10	44	416	5.51	12	47.1	10	0	4	3	4	0.8	220	220	514	18	3
96	01AKFF25	12	75	14	15	24	46	5.06	4	49.4	10	0	0	0	0	#DIV/0!	211	214	414	6	0
97	01AKFF26	17	63	41	5	12	27	6.98	4	42.5	5	1	0	0	1	2.0	183	182	429	7	1
98	01AKFG01	22	61	64	90	21	1650	2.31	29	28.6	90	0	3	0	3	0.0	181	187	481	8	8
99	01AKFG02	25	58	43	90	47	2621	5.65	6	42.5	20	1	7	1	2	0.4	207	209	526	11	0
100	01AKFG03	25	55	40	20	53	580	5.68	8	42.5	15	2	5	2	4	0.9	209	209	516	10	2
101	01AKFG04	29	64	51	15	33	454	3.27	27	28.6	85	6	3	1	3	2.3	202	206	489	12	19
102	01AKFG05	21	59	54	80	24	1319	3.17	22	28.6	60	0	4	0	3	0.0	213	215	541	10	7
103	01AKFG06	24	60	46	85	40	2285	6.62	14	42.5	50	1	2	0	2	0.5	172	183	434	9	3
104	01AKFG07	34	60	56	40	27	1233	2.35	24	37.2	90	4	4	3	1	2.8	176	180	432	14	10
105	01AKFG08	20	57	63	25	34	584	3.17	24	47.1	35	1	2	0	2	0.5	225	231	593	8	13
106	01AKFG09	22	52	44	40	35	698	5.24	24	28.6	70	0	3	2	4	0.6	218	220	603	10	9
107	01AKFG10	27	55	68	70	35	2461	4.43	20	28.6	50	3	1	5	4	3.2	195	204	537	12	3
108	01AKFG11	25	58	47	50	40	1346	5.79	12	47.1	25	0	2	2	2	1.0	129	134	359	9	1
109	01AKFG12	19	56	49	25	23	294	2.84	33	28.6	100	0	1	0	0	0.0	140	149	370	6	6
110	01AKFG13	24	59	63	100	23	1993	2.98	27	37.2	95	2	0	1	1	6.0	169	172	462	9	11
111	01AKFG14	26	53	70	35	24	785	1.44	29	28.6	95	0	0	2	0	#DIV/0!	179	181	489	10	15
112	01AKFG15	21	57	70	100	56	4669	1.79	27	37.2	90	4	1	1	3	2.5	164	164	416	9	9
113	01AKFG16	23	60	75	55	20	1104	1.67	27	37.2	100	0	4	0	2	0.0	197	197	501	11	9
114	01AKFG17	24	64	47	25	29	519	3.31	33	28.6	95	6	3	0	1	3.0	196	202	477	10	13
115	01AKFG18	33	59	46	90	46	3602	6.16	14	42.5	55	3	2	0	2	1.5	165	167	429	12	4
116	01AKFG19	36	62	47	50	33	1727	5.11	20	28.6	60	1	0	4	4	2.5	181	181	467	16	8
117	01AKFG20	19	56	65	45	43	1373	3.71	39	37.2	100	0	3	0	1	0.0	103	112	314	7	4
118	01AKFH01	37	69	41	45	41	1958	4.57	25	42.5	80	2	4	2	2	1.3	205	206	470	18	15
119	01AKFH02	33	63	57	55	25	1680	1.53	32	37.2	100	1	2	3	0	4.0	174	177	424	17	13
120	01AKFH03	28	61	53	20	21	376	1.3	29	37.2	100	1	5	1	2	0.6	175	180	451	15	15
121	01AKFH04	26	48	78	10	22	218	0.56	22	37.2	95	1	3	2	4	0.9	174	174	493	11	10
122	01AKFH05	41	54	65	60	15	1275	0.48	38	29.6	95	4	9	0	0	0.9	166	167	416	20	18
123	01AKFH06	33	57	51	75	20	1426	6.28	23	28.6	80	1	6	2	6	0.5	152	164	450	15	8
124	01AKFH07	39	69	58	55	20	1714	2.63	25	29.6	75	2	3	2	9	0.7	184	184	422	22	13
125	01AKFH08	36	60	51	60	16	1019	0.2	37	37.2	100	3	3	0	2	1.2	160	161	388	18	20
126	01AKFH09	29	60	61	20	13	283	-0.79	27	37.2	100	0	1	2	1	2.0	191	191	480	13	17
127	01AKFH10	25	50	59	15	22	249	0.66	29	37.2	95	4	4	0	2	1.3	196	197	529	13	15
128	01AKFH11	33	55	78	15	7	148	-0.72	27	37.2	100	0	0	1	4	0.5	187	188	482	15	18
129	01AKFH12	40	65	57	50	23	1725	0.88	30	37.2	90	0	1	0	1	0.0	177	178	416	20	17
130	01AKFH13	21	49	61	30	17	319	-0.91	20	37.2	100	0	0	2	5	0.8	200	201	562	10	10
131	01AKFH14	30	58	58	5	20	100	-0.1	38	37.2	100	0	3	5	2	2.0	184	186	457	16	21
132	01AKFH15	24	56	61	20	22	347	2.22	34	37.2	90	0	4	0	4	0.0	181	185	485	9	15
133	01AKFH16	28	59	63	20	25	526	1.1	29	37.2	80	0	1	5	1	5.0	173	173	457	12	11
134	01AKFH17	35	58	58	20	16	381	0.14	30	37.2	90	1	3	2	4	0.9	165	164	408	16	18
135	01AKFH18	25	57	71	35	20	709	-0.31	24	29.6	90	5	2	0	0	5.0	164	167	421	11	12
136	01AKFH19	42	63	56	70	37	3758	2.22	22	37.2	60	6	8	0	4	1.0	206	208	496	22	15
137	01AKFH20	29	53	70	10	41	445	1.69	23	37.2	70	0	4	2	0	1.0	177	177	471	13	14
138	01AKFH21	37	67	31	40	51	1561	7.11	9	35.2	70	2	1	0	0	4.0	166	166	402	16	4
139	01AKFH22	42	67	44	50	38	2371	4.45	18	35.2	60	3	1	3	2	4.0	170	175	390	21	11
140	01AKFH23	36	53	87	35	33	1908	3.47	6	29.6	90	2	2	6	3	3.2	194	193	555	14	2
141	01AKFJ01	34	54	64	90	45	4812	5.07	21	28.6	80	3	2	0	2	1.5	175	176	497	13	9
142	01AKFJ02	30	58	63	70	34	2581	4.87	30	28.6	70	2	3	1	2	1.2	212	221	576	13	13
143	01AKFJ03	61	82	24	95	59	6845	6.43	16	35.2	10	4	12	12	9	1.5	178	179	326	38	6
144	01AKFJ04	42	58	55	15	45	886	5.37	22	37.2	90	7	13	8	7	1.5	211	213	556	17	8
145	01AKFJ05	26	54	58	25	23	481	4.41	21	31.1	70	2	6	3	3	1.1	181	206	537	12	13
146	01AKFJ06	39	57	59	65	48	4099	5.26	18	29.6	85	1	0	2	2	3.0	119	120	303	17	5
147	01AKFJ07	26	57	71	55	78	4464	0.53	20	29.6	95	4	1	4	5	2.7	136	137	359	11	8
148	01AKFJ08	30	54	78	80	59	5954	3.71	29	37.2	85	1	4	5	3	1.7	169	170	470	14	18
149	01AKFJ09	39	72	31	45	67	2593	5.42	15	35.2	50	3	18	4	7	0.6	184	184	393	20	7
150	01AKFJ10	30	60	54	35	44	1450	3.53	20	28.6	95	1	1	6	2	4.7	210	210	505	13	7
151	01AKFJ11	37	70	30	80	50	3140	6.22	5	49.4	10	5	9	1	5	0.9	198	202	413	20	2
152	01AKFJ12	38	61	66	15	38	877	3.83	30	29.6	65	3	4	2	7	0.9	184	185	460	17	12
153	01AKFJ13	41	60	69	60	62	6398	5.28	11	29.6	90	12	5	7	3	4.8	226	227	550	19	9
154	01AKFJ14	32	72	41	70	47	3082	3.56	51	26.5	90	4	1	2	5	2.0	155	155	336	18	23
155	01AKFJ15	29	67	50	50	41	2009	1.83	38	28.6	100	0	3	0	0	0.0	168	170	383	14	21
156	01AKFJ16	27	60	45	100	24	1780	2.59	37	29.6	90	0	1	6	1	6.0	174	176	397	12	27
157	01AKFJ17	33	54	47	95	42	3290	4.51	16	29.6	95	4	1	8	10	2.2	210	214	538	14	7
158	01AKFJ18	37	63	59	90	42	5325	4	16	42.5	50	5	9	4	6	1.2	171	170	418	16	6
159	01AKFJ19	41	78	24	25	45	865	4.2	82	26.5	95	4	6	5	6	1.5	164	164	302	23	41
160	01AKFJ20	28	81	20	100	40	1874	3.66	72	26.5	100	1	1	4	3	2.5	166	166	297	15	31
161	01AKFJ21	35	61	42	95	40	3403	4.53	55	25.7	65	3	5	3	2	1.7	221	221	537	18	29
162	01AKFK01	22	47	66	0	42	0	4.57	27	37.2	95	1	0	3	2	4.0	199	203	635	8	11
163	01AKFK02	28	45	74	30	56	1556	4.89	29	37.2	90	4	2	4	4	2.7	157	162	507	11	8
164	01AKFK03	17	39	70	30	38	544	5.79	22	37.2	100	3	5	0	0	1.2	161	167	591	6	11
165	01AKFK04	20	37	84	25	45	688	4.16	25	37.2	100	0	1	0	2	0.0	151	150	503	6	5
166	01AKFK05	31	61	56	20	42	887	6.55	8	35.2	60	2	1	0	2	1.3	166	168	467	11	2
167	01AKFK06	40	78	13	10	75	296	8.37	4	49.4	0	4	3	3	5	1.8	177	178	332	24	5
168	01AKFK07	30	41	67	0	35	0	6.87	30	37.2	100	1	5	3	1	1.3	128	129	502	8	9
169	01AKFK08	22	34	83	25	27	408	4.6	15	37.2	100	0	0	3	6	1.0	131	131	490	6	5
170	01AKFK09	26	47	73	20	52	920	5.95	23	37.2	100	1	1	3	5	1.3	140	147	487	8	12
171	01AKFK10	25	31	80	40	42	1032	4.63	23	37.2	100	0	3	0	0	0.0	115	119	422	8	7
172	01AKFK11	23	26	82	30	50	746	4.85	27	37.2	100	6	3	0	4	1.7	147	149	602	6	3
173	01AKFK12	21	33	74	10	45	238	5.7	19	37.2	100	0	0	3	0	#DIV/0!	117	122	468	6	6

Appendix A:
Main characteristics for Newham EDs, taken from 1991 Census, HES statistics, survey data and calculated indicators

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	ed	% hh w 1+ pensioner	% hh w 1 or 2 persons	% hh w 5+ rooms	% dwlgs w low SAP (<35)	% hh w CTB receipt	FPR_{all} (assuming col.F max value =100) =(B*C*D*E*F)*10^5	Townsend Index	% dwlgs w no CH	SAP mode	% dwlgs pre-1945	93-4 winter resp. count >64yrs	93-4 non-winter resp. count >64yrs	95-6 winter resp. count >64yrs	95-6 non-winter resp. count >64yrs	EWMbR 93-96 = (L+N)*2/(M+O)	total dwlgs w residents (91 Census: S610015)	total households (91 Census: S270031)	total persons (91 Census: S270032)	% population >64 yrs	% hh w lone pens + no ch
174	01AKFK13	27	37	76	35	59	1595	5.08	27	37.2	95	1	0	0	2	1.0	127	133	480	8	7
175	01AKFK14	22	40	78	25	28	494	4.52	20	37.2	90	0	2	2	0	2.0	151	163	505	8	8
176	01AKFK15	35	42	63	30	26	710	5.33	23	37.2	85	5	5	1	0	2.4	116	127	445	12	5
177	01AKFK16	28	41	78	30	54	1426	5.14	22	37.2	95	0	4	0	2	0.0	137	136	470	9	8
178	01AKFL01	36	64	36	15	59	739	6.77	28	42.5	55	2	1	0	2	1.3	186	187	459	20	7
179	01AKFL02	32	62	54	40	58	2468	5.64	38	28.6	90	2	2	5	7	1.6	166	173	429	15	19
180	01AKFL03	25	66	38	75	42	1968	4.48	40	28.6	100	0	1	0	2	0.0	153	165	395	13	14
181	01AKFL04	34	60	75	100	29	4469	5.31	42	28.6	100	0	1	0	2	0.0	148	150	417	14	19
182	01AKFL05	23	44	74	100	37	2774	5.26	29	28.6	95	2	2	0	0	2.0	157	177	577	7	10
183	01AKFL06	22	51	69	95	38	2821	5.28	25	28.6	95	0	0	0	3	0.0	167	175	565	7	7
184	01AKFL07	26	62	68	95	60	6133	2.41	32	28.6	100	0	0	0	0	#DIV/0!	125	129	336	11	11
185	01AKFL08	45	87	11	100	57	2433	7.65	8	49.4	0	2	1	0	1	2.0	219	219	364	30	2
186	01AKFL09	35	63	46	0	43	0	5.11	4	42.5	0	7	12	0	2	1.0	188	191	434	16	0
187	01AKFL10	28	51	57	0	43	0	3.45	35	29.6	100	7	4	5	5	2.7	160	164	471	11	17
188	01AKFL11	38	68	23	100	58	3461	6.96	2	49.4	0	1	8	8	2	1.8	171	171	373	21	1
189	01AKFL12	35	62	52	0	71	0	7.16	7	42.5	0	2	17	7	6	0.8	188	188	459	16	3
190	01AKFL13	27	53	66	0	53	0	6.54	18	42.5	20	0	3	1	0	0.7	171	171	451	11	5
191	01AKFL14	30	50	60	25	47	1058	4.74	21	28.6	60	2	2	0	1	1.3	153	157	479	8	8
192	01AKFL15	28	46	74	80	29	2197	5.6	18	28.6	80	2	0	0	1	4.0	157	160	512	8	4
193	01AKFL16	22	53	66	80	45	2802	4.01	25	28.6	90	0	3	1	2	0.4	159	162	458	9	7
194	01AKFL17	25	55	52	100	39	2809	4.16	23	29.6	100	0	0	0	1	0.0	132	132	354	10	10
195	01AKFL18	31	56	53	90	47	3892	5.41	16	41.4	20	0	0	0	2	0.0	173	172	428	14	0
196	01AKFL19	26	58	73	20	28	607	3.17	35	28.6	90	2	0	1	2	3.0	148	149	396	10	23
197	01AKFL20	23	67	38	95	33	1810	2.89	41	26.5	100	3	8	4	2	1.4	187	187	424	10	17
198	01AKFL21	28	60	61	100	37	3806	2.53	27	29.6	70	5	1	0	0	10.0	192	194	481	14	14
199	01AKFL22	25	51	61	80	42	2664	5.1	26	28.6	80	0	0	0	0	#DIV/0!	179	179	526	9	9
200	01AKFL23	32	58	49	75	44	2999	5.39	20	42.5	30	0	2	2	0	2.0	219	220	572	12	11
201	01AKFM01	52	83	21	30	59	1586	4.34	22	42.5	100	2	1	7	11	1.5	223	227	426	32	20
202	01AKFM04	46	75	34	10	29	331	4.27	19	47.1	40	12	12	2	1	2.2	232	235	485	24	14
203	01AKFM05	13	61	40	20	23	148	0.91	22	37.2	100	3	3	0	0	2.0	169	174	451	7	5
204	01AKFM06	34	62	71	25	41	1512	3.3	29	37.2	100	3	4	0	0	1.5	257	257	660	16	19
205	01AKFM07	45	70	39	25	49	1513	6.75	16	42.5	40	0	2	2	4	0.7	195	201	440	21	7
206	01AKFM08	25	50	59	10	49	358	5.32	36	37.2	85	2	2	0	4	0.7	182	187	533	11	17
207	01AKFM09	23	68	32	25	27	335	4.48	27	37.2	65	1	0	1	0	#DIV/0!	212	224	523	11	6
208	01AKFM10	32	62	46	45	57	2287	5.61	23	42.5	60	11	7	3	1	3.5	185	190	475	15	5
209	01AKFM11	36	63	55	20	66	1624	5.7	9	42.5	35	2	7	2	6	0.6	227	227	583	16	7
210	01AKFM12	22	36	81	25	33	519	4.38	25	37.2	100	2	3	1	0	2.0	126	127	470	10	7
211	01AKFM13	28	41	75	20	62	1056	4.94	32	37.2	100	1	1	0	8	0.2	130	134	478	10	9
212	01AKFM14	29	40	84	30	38	1100	4.8	22	37.2	90	0	1	0	1	0.0	121	124	419	9	7
213	01AKFM15	28	55	53	15	56	694	5.03	27	37.2	85	1	4	5	6	1.2	204	208	582	12	9
214	01AKFM16	33	59	50	25	55	1347	6.35	40	37.2	85	3	2	9	8	2.4	157	170	486	11	13
215	01AKFM17	29	48	55	35	28	737	5.32	31	37.2	95	1	2	0	0	1.0	180	180	550	11	18
216	01AKFM18	19	34	77	30	63	942	4.62	18	37.2	100	1	1	5	2	4.0	127	127	441	8	12
217	01AKFM19	19	56	51	25	70	965	5.13	34	37.2	100	6	2	1	3	2.8	121	128	371	7	5
218	01AKFM20	24	51	58	50	54	1928	4.89	17	37.2	100	1	3	1	2	0.8	173	176	527	7	6
219	01AKFM21	26	44	70	45	37	1342	4.16	29	37.2	90	2	2	5	2	3.5	146	153	512	10	5
220	01AKFM22	23	35	72	35	37	757	5	28	37.2	100	6	6	0	4	1.2	160	164	592	6	4
221	01AKFM23	22	51	62	15	39	396	5.53	36	37.2	95	3	0	2	3	3.3	135	137	406	10	12
222	01AKFN01	27	49	64	30	44	1120	5.51	39	37.2	100	1	3	2	2	1.2	151	154	441	9	18
223	01AKFN02	19	50	57	40	54	1200	6.24	36	28.6	100	0	2	0	0	0.0	150	154	457	7	15
224	01AKFN03	27	49	63	100	46	3810	6.23	26	28.6	95	1	1	2	1	3.0	133	135	433	8	10
225	01AKFN04	24	35	64	80	41	1737	4.75	24	28.6	100	0	2	2	2	1.0	193	192	683	6	9
226	01AKFN05	20	40	79	95	14	837	4.25	34	28.6	100	0	3	0	0	0.0	154	158	506	5	10
227	01AKFN06	32	46	78	95	45	4824	6.09	28	28.6	95	1	0	0	0	#DIV/0!	166	166	577	11	13
228	01AKFN07	25	38	75	80	24	1381	3.97	17	28.6	100	0	2	0	1	0.0	168	170	578	6	12
229	01AKFN08	22	36	80	95	39	2354	4.59	27	28.6	100	2	2	4	3	2.4	148	149	538	8	12
230	01AKFN09	25	65	49	100	53	4165	4.21	34	28.6	90	3	2	0	3	1.2	170	175	419	13	13
231	01AKFN10	30	45	78	85	33	2900	4.9	26	28.6	100	1	0	0	2	1.0	172	174	579	10	11
232	01AKFN11	27	44	67	85	34	2321	4.7	32	28.6	100	0	1	1	0	2.0	139	144	439	9	12
233	01AKFN12	17	38	67	100	34	1513	5.24	22	28.6	95	1	0	0	0	#DIV/0!	124	126	427	6	9
234	01AKFN13	17	51	54	95	31	1385	4.99	29	28.6	100	1	4	0	1	0.4	163	173	507	6	9
235	01AKFN14	19	49	64	100	41	2397	5.61	32	28.6	100	5	7	3	1	2.0	147	155	487	7	8
236	01AKFN15	19	54	70	90	32	2028	5.68	27	28.6	100	4	2	0	3	1.6	159	165	509	6	12
237	01AKFN16	30	45	72	100	28	2711	4.39	38	28.6	100	0	1	4	3	2.0	140	143	461	11	10
238	01AKFP01	2	100	0	95	2	0	6.36	0	42.5	0	1	0	0	0	#DIV/0!	87	162	93	1	0
239	01AKFP02	3	56	46	0	48	0	4.43	10	42.5	0	0	0	1	1	2.0	135	181	473	1	1
240	01AKFP03	26	61	30	0	66	0	5.86	6	42.5	10	2	1	2	2	2.7	266	267	666	12	2
241	01AKFP04	32	58	72	5	44	287	4.32	24	28.6	60	1	5	0	4	0.2	161	167	433	15	18
242	01AKFP05	43	62	42	70	89	6876	7.32	1	47.1	5	8	7	4	12	1.3	135	136	354	19	0
243	01AKFP06	26	62	62	10	29	294	2.08	26	28.6	90	1	2	0	0	1.0	142	143	358	10	7
244	01AKFP07	32	64	54	55	32	1980	3.89	20	37.2	70	3	1	1	3	2.0	169	171	410	16	6
245	01AKFP08	26	67	29	15	46	352	5.91	21	49.4	65	0	2	4	2	2.0	241	240	558	13	8
246	01AKFP09	54	79	22	45	59	2488	6.44	6	32.3	35	7	15	9	4	1.7	183	192	361	30	0
247	01AKFP10	36	55	61	65	23	1794	4.27	27	37.2	90	0	1	2	0	4.0	198	198	516	15	9
248	01AKFP11	5	50	47	30	59	217	4.72	8	47.1	40	0	2	1	1	0.7	156	157	442	2	0
249	01AKFP12	36	69	40	30	48	1428	5.21	21	35.2	30	0	5	0	1	0.0	147	148	315	18	7
250	01AKFP13	28	66	62	5	46	264	4.71	32	28.6	95	18	28	12	19	1.3	156	176	416	13	12
251	01AKFP14	33	49	65	95	44	4270	6.79	10	35.2	10	2	1	2	0	8.0	154	156	424	17	3
252	01AKFP15	59	78	40	20	48	1757	5.48	9	35.2	5	4	10	6	10	1.0	186	185	363	37	3
253	01AKFP16	34	68	38	5	35	152	5.61	32	42.5	30	1	2	0	1	0.7	154	155	345	18	11
254	01AKFQ01	30	47	68	15	1	12	6.59	9	47.1	0	1	6	2	8	0.4	250	250	718	9	10
255	01AKFQ02	41	65	38	0	1	0	7.12	1	35.2	0	2	5	3	6	0.9	218	220	513	17	0
256	01AKFQ03	33	62	63	0	14	0	7.79	16	35.2	5	1	7	4	1	1.3	245	262	633	15	10
257	01AKFQ04	40	70	42	25	41	1204	6.03	11	35.2	5	1	7	3	12	0.4	159	160	357	18	4
258	01AKFQ05	33	69	22	10	34	171	6.12	7	42.5	10	1	2	2	1	2.0	176	175	350	16	2
259	01AKFQ07	31	69	33	0	59	0	7.43	8	42.5	0	9	5	4	2	3.7	407	406	887	14	5

Appendix A:
Main characteristics for Newham EDs, taken from 1991 Census, HES statistics, survey data and calculated indicators

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	ed	% hh w 1+ pensioner	% hh w 1 or 2 persons	% hh w 5+ rooms	% dwlgs w low SAP (<35)	% hh w CTB receipt	FPR_{all} (assuming col.F max value =100) =(B*C*D*E*F)*10^{-5}	Townsend Index	% dwlgs w no CH	SAP mode	% dwlgs pre-1945	93-4 winter resp. count >64yrs	93-4 non-winter resp. count >64yrs	95-6 winter resp. count >64yrs	95-6 non-winter resp. count >64yrs	EWMbR 93-96 = (L+N)^2/(M+O)	total dwlgs w residents (91 Census: S610015)	total households (91 Census: S270031)	total persons (91 Census: S270032)	% population >64 yrs	% hh w lone pens + no ch
260	01AKFQ08	21	46	59	0	72	0	6.53	11	42.5	0	1	4	1	0	1.0	198	199	549	7	2
261	01AKFQ09	32	63	45	0	41	0	7.89	7	42.5	0	2	2	4	3	2.4	196	197	436	13	3
262	01AKFQ10	33	60	37	0	65	0	7.95	6	35.2	0	4	4	0	9	0.6	155	155	371	13	3
263	01AKFQ11	48	65	53	15	43	1082	5.7	11	31.1	0	6	5	7	7	2.2	180	182	405	23	4
264	01AKFR01	15	71	24	40	48	502	8.77	35	35.2	70	1	3	0	5	0.3	112	128	286	9	5
265	01AKFR02	28	60	63	80	60	5098	4.68	31	28.6	60	2	6	2	2	1.0	131	136	332	13	10
266	01AKFR03	13	68	29	95	40	979	6.46	33	27.4	85	0	0	2	3	1.3	149	169	429	5	4
267	01AKFR04	28	69	54	65	25	1705	4.79	26	49.4	75	1	0	0	2	1.0	133	135	297	17	7
268	01AKFR05	19	68	47	80	32	1522	3.98	24	28.6	80	4	4	0	0	2.0	219	230	501	9	6
269	01AKFR06	49	68	29	10	55	525	6.32	13	42.5	10	0	4	3	9	0.5	229	234	492	25	4
270	01AKFR07	18	57	37	70	30	803	7.32	31	27.4	95	0	0	0	3	0.0	113	134	346	6	5
271	01AKFR08	19	63	42	50	29	743	6.51	19	37.2	80	0	0	1	0	#DIV/0!	110	113	281	8	3
272	01AKFR09	21	62	46	45	14	373	5.06	21	37.2	90	0	0	0	0	#DIV/0!	94	100	267	8	3
273	01AKFR10	26	85	9	0	39	0	6.25	9	49.4	0	2	7	1	2	0.7	186	186	337	18	0
274	01AKFR11	10	86	6	55	24	71	5.62	32	27.4	85	0	0	1	2	1.0	159	198	317	6	7
275	01AKFR12	22	58	39	25	28	352	2.71	29	37.2	70	15	7	4	7	2.7	187	190	466	10	11
276	01AKFR13	27	61	54	50	76	3435	4.91	32	37.2	70	12	5	3	5	3.0	240	248	613	11	20
277	01AKFR14	23	58	62	55	13	570	4.95	32	37.2	100	0	3	0	1	0.0	152	166	418	10	14
278	01AKFR15	14	61	54	50	29	692	4.39	26	37.2	90	0	0	0	2	0.0	137	160	417	4	4
279	01AKFR16	24	63	52	50	39	1519	3.57	33	27.4	70	0	0	2	0	#DIV/0!	132	135	331	11	10
280	01AKFR17	26	67	34	55	41	1309	6.12	20	27.4	60	2	0	2	3	2.7	170	180	463	10	7
281	01AKFR18	19	54	45	35	29	464	4.89	36	37.2	85	0	0	1	0	#DIV/0!	113	120	344	8	3
282	01AKFR19	25	65	48	55	22	966	5.6	30	37.2	100	3	1	0	1	3.0	215	247	577	13	21
283	01AKFR20	21	60	54	45	37	1113	5.78	42	37.2	100	1	1	0	0	2.0	169	175	446	7	18
284	01AKFR21	20	53	57	45	33	859	5.2	33	37.2	85	1	0	1	1	4.0	119	126	366	8	9
285	01AKFR22	18	44	71	25	42	578	5.12	20	37.2	100	0	3	0	2	0.0	150	150	501	6	6
286	01AKFR23	25	42	77	40	49	1563	6.91	29	37.2	90	2	0	1	0	#DIV/0!	155	161	556	9	5
287	01AKFS01	27	63	45	25	35	679	6.09	25	49.4	45	0	0	3	3	2.0	106	114	283	11	11
288	01AKFS02	32	60	48	35	55	1800	5.77	9	42.5	30	4	2	0	4	1.3	234	234	591	13	1
289	01AKFS03	30	71	23	35	59	1036	7.36	12	42.5	20	2	4	3	3	1.4	163	162	353	15	1
290	01AKFS04	45	60	41	0	137	0	6.57	7	42.5	0	11	8	8	15	1.7	227	228	544	20	3
291	01AKFS05	27	65	30	35	52	941	6.12	10	49.4	25	6	3	4	2	4.0	233	234	562	12	0
292	01AKFS06	29	62	42	45	58	1964	5.17	23	35.2	65	1	2	0	0	1.0	172	177	449	13	12
293	01AKFS07	32	54	49	0	63	0	8.08	9	35.2	0	1	4	1	0	1.0	169	169	461	12	3
294	01AKFS08	31	57	50	60	35	1823	4.96	23	28.6	85	1	1	1	3	1.0	214	214	584	13	12
295	01AKFS10	28	57	74	0	48	0	3.86	36	37.2	100	0	1	0	3	0.0	130	132	387	11	13
296	01AKFS11	32	56	59	50	45	2318	5.86	36	28.6	100	1	2	1	0	2.0	130	134	383	13	7
297	01AKFS12	28	54	54	100	38	3040	5.37	27	37.2	85	0	0	3	2	3.0	151	157	443	9	11
298	01AKFS13	22	57	56	70	33	1575	3.73	23	44.4	50	9	4	0	3	2.6	202	202	539	9	6
299	01AKFS14	29	66	48	60	48	2645	4.66	10	35.2	30	1	2	0	2	0.5	218	219	489	13	7
300	01AKFS15	39	75	41	50	43	2524	3.68	26	28.6	80	4	11	6	3	1.4	231	235	459	23	21
301	01AKFS16	24	54	59	50	50	1941	4.54	31	28.6	90	0	0	1	0	#DIV/0!	148	149	396	10	8
302	01AKFS17	26	56	61	90	44	3592	4.92	28	28.6	75	0	0	1	1	2.0	96	97	248	12	4
303	01AKFS18	30	53	55	60	51	2671	5.68	33	28.6	75	4	4	5	5	2.0	138	140	375	13	3
304	01AKFS19	27	59	62	75	28	2109	2.84	31	37.2	80	0	0	0	0	#DIV/0!	174	181	430	13	13
305	01AKFS20	34	46	39	55	77	2566	9.03	2	47.1	40	11	14	6	10	1.4	160	162	522	11	0
306	01AKFT01	39	68	49	0	44	0	6.81	15	42.5	30	0	0	2	3	1.3	183	186	431	16	4
307	01AKFT02	24	58	64	15	42	549	4.22	35	37.2	100	2	4	1	2	1.0	155	165	438	8	12
308	01AKFT03	34	54	75	65	22	1903	4.64	41	37.2	85	1	0	0	0	#DIV/0!	155	158	436	15	15
309	01AKFT04	34	63	66	25	40	1381	3.19	27	28.6	70	11	14	0	5	1.2	162	171	419	15	9
310	01AKFT05	34	62	68	50	29	2077	3.47	19	37.2	85	5	3	2	4	2.0	194	197	481	16	7
311	01AKFT06	24	63	39	55	48	1564	6.53	35	27.4	100	2	1	0	4	0.8	170	175	456	11	11
312	01AKFT07	8	57	41	70	53	743	5.31	32	27.4	100	3	0	1	0	#DIV/0!	166	167	479	4	3
313	01AKFT08	22	52	58	75	39	1987	4.31	27	27.4	95	2	0	0	0	#DIV/0!	215	218	651	7	17
314	01AKFT09	30	57	61	80	31	2541	4.77	39	37.2	100	2	2	2	3	1.6	150	153	429	12	11
315	01AKFT10	28	49	60	70	53	2985	4.45	32	37.2	95	1	1	0	0	2.0	130	139	410	12	14
316	01AKFT11	20	37	71	60	52	1675	6.02	30	37.2	100	2	9	0	0	0.4	107	117	432	4	6
317	01AKFT12	24	48	62	60	44	1915	4.54	24	37.2	100	0	0	0	1	0.0	124	132	409	9	6
318	01AKFT13	22	35	71	35	59	1136	6.24	25	28.6	95	1	0	2	0	#DIV/0!	121	128	508	6	6
319	01AKFT14	30	46	64	70	44	2763	6.79	32	28.6	80	4	1	1	2	3.3	119	124	433	9	9
320	01AKFT15	40	64	45	65	55	4065	6.64	9	35.2	0	11	4	2	2	4.3	250	249	588	18	5
321	01AKFT16	37	64	62	10	42	613	5.81	25	32.7	20	7	10	4	8	1.2	190	189	452	18	14
322	01AKFT17	35	74	34	55	44	2120	7	17	35.2	60	2	4	2	12	0.5	190	212	434	18	4
323	01AKFT18	31	61	48	40	43	1541	5.38	17	42.5	10	3	5	3	1	2.0	185	185	448	14	3
324	01AKFT19	27	57	52	45	50	1818	5.31	17	37.2	75	4	4	6	1	4.0	184	185	508	11	3
325	01AKFT20	27	62	34	10	49	285	6.69	4	44.4	0	0	6	0	4	0.0	157	168	379	11	0
326	01AKFT21	17	60	13	0	53	0	8.9	4	49.4	0	1	1	2	2	2.0	172	175	390	7	0
327	01AKFT22	41	67	25	0	51	0	6.76	3	42.5	0	0	6	0	4	0.0	175	176	394	21	1
328	01AKFT23	28	51	54	0	42	0	6.2	34	37.2	100	1	4	1	2	0.7	132	137	439	7	16
329	01AKFT24	28	67	51	80	50	3762	3.59	27	27.4	90	0	0	0	1	0.0	116	124	321	11	6
330	01AKFU01	24	46	65	75	33	1795	4.59	30	37.2	95	1	1	1	0	4.0	153	153	499	8	7
331	01AKFU02	19	45	59	10	51	262	5.53	31	37.2	100	5	0	2	0	#DIV/0!	155	157	503	7	11
332	01AKFU03	24	43	57	40	49	1152	5.28	34	37.2	95	5	3	6	6	2.4	190	205	625	8	14
333	01AKFU04	27	43	63	30	23	531	5.05	23	37.2	95	0	0	2	1	4.0	165	166	558	8	12
334	01AKFU05	28	58	50	15	41	500	7.54	28	37.2	90	0	6	0	3	0.0	137	164	430	11	13
335	01AKFU06	23	35	74	35	41	874	4.61	32	37.2	100	2	1	0	0	4.0	132	135	486	9	8
336	01AKFU07	33	43	65	15	29	398	5.68	16	29.6	85	2	0	0	0	#DIV/0!	136	143	449	11	3
337	01AKFU08	25	46	65	75	24	1358	6.21	34	37.2	90	1	3	2	3	1.0	140	143	459	9	14
338	01AKFU09	31	56	52	40	28	1022	5.78	26	37.2	80	1	2	0	2	0.5	156	161	435	13	6
339	01AKFU10	34	42	67	20	54	1012	5.77	31	37.2	100	7	5	3	11	1.3	136	138	466	10	9
340	01AKFU11	22	37	67	35	48	936	5.87	31	37.2	100	1	1	0	0	2.0	124	131	457	8	7
341	01AKFU12	36	66	31	25	59	1078	7.27	19	42.5	30	3	4	1	3	1.1	207	214	496	19	9
342	01AKFU13	18	48	62	25	47	641	6.22	28	37.2	85	7	4	1	3	2.3	164	171	479	8	11
343	01AKFU14	21	45	62	40	31	737	5.79	34	37.2	95	0	0	0	1	0.0	147	162	533	8	16
344	01AKFU15	39	52	61	40	42	2057	6.02	31	37.2	75	3	3	2	1	2.5	140	142	459	14	7
345	01AKFW01	35	64	58	0	31	0	2.72	29	29.6	80	1	2	5	2	3.0	183	183	440	17	15

Appendix A:

Main characteristics for Newham EDs, taken from 1991 Census, HES statistics, survey data and calculated indicators

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	ed	% hh w 1+ pensioner	% hh w 1 or 2 persons	% hh w 5+ rooms	% dwlgs w low SAP (<35)	% hh w CTB receipt	FPR_{all} (assuming col.F max value =100) =(B*C*D*E*F)*10^-5	Townsend Index	% dwlgs w no CH	SAP mode	% dwlgs pre-1945	93-4 winter resp. count >64yrs	93-4 non-winter resp. count >64yrs	95-6 winter resp. count >64yrs	95-6 non-winter resp. count >64yrs	EWMbR 93-96 = (L+N)*2/(M+O)	total dwlgs w residents (91 Census: S610015)	total households (91 Census: S270031)	total persons (91 Census: S270032)	% population >64 yrs	% hh w lone pens + no ch
346	01AKFW02	48	67	46	65	43	4174	5.51	16	35.2	25	4	10	2	4	0.9	191	191	443	23	7
347	01AKFW03	59	79	28	30	62	2414	5.62	11	35.2	5	3	4	9	3	3.4	201	201	396	35	4
348	01AKFW04	52	76	28	20	47	1034	6.22	9	42.5	30	2	3	2	4	1.1	191	196	389	30	7
349	01AKFW05	31	50	62	40	41	1559	6.26	11	35.2	40	0	4	3	0	1.5	173	174	510	12	4
350	01AKFW06	44	77	36	45	34	1867	3.03	23	42.5	60	3	5	5	2	2.3	223	225	426	27	18
351	01AKFW07	30	60	57	45	28	1302	0.81	37	37.2	100	1	2	2	3	1.2	183	182	419	15	21
352	01AKFW08	35	62	63	40	29	1628	2.65	33	37.2	100	1	4	2	3	0.9	180	181	421	15	18
353	01AKFW09	35	58	46	45	42	1797	4.28	17	42.5	35	2	3	3	2	2.0	170	170	425	16	5
354	01AKFW10	28	63	60	15	46	720	3.61	35	29.6	100	1	8	0	2	0.2	132	131	318	14	9
355	01AKFW11	40	56	68	100	31	4585	2.9	11	29.6	100	0	1	1	3	0.5	205	206	520	20	7
356	01AKFW12	31	52	65	80	36	2971	5.02	28	37.2	70	0	0	1	2	1.0	179	179	480	14	18
357	01AKFW13	24	52	63	35	23	610	0.27	28	29.6	90	1	0	1	2	2.0	176	176	470	11	12
358	01AKFW14	27	49	60	100	15	1231	1.1	27	29.6	100	3	2	0	3	1.2	168	168	456	11	16
359	01AKFW15	34	60	59	80	28	2617	2.33	31	29.6	90	2	3	5	2	2.8	207	206	511	17	18
360	01AKFW16	20	47	63	85	39	1981	4.87	0	47.1	0	4	0	0	5	1.6	242	244	771	7	0
361	01AKFW17	4	39	64	0	39	0	3.74	0	47.1	0	0	0	0	0	#DIV/0!	189	189	632	1	0
362	01AKFW18	6	57	57	0	25	0	-1.1	1	47.1	0	1	0	0	0	#DIV/0!	152	152	394	3	0
363	01AKFW19	3	70	35	0	45	0	-0.42	0	47.1	0	2	1	1	1	3.0	203	205	454	1	0
364	01AKFW20	5	55	37	0	62	0	3.9	1	47.1	0	4	1	3	0	14.0	163	162	417	2	2
365	01AKFW22	26	49	63	30	96	2290	1.04	0	52.5	5	0	1	1	0	2.0	179	179	480	10	0
366	01AKFW23	1	47	38	5	21	2	1.41	10	47.1	0	0	0	0	0	#DIV/0!	115	115	317	0	1
367	01AKFW24	4	57	40	0	32	0	-0.6	24	47.1	0	0	0	0	0	#DIV/0!	183	183	464	3	0
368	01AKFW25	6	69	34	0	31	0	-2.56	24	47.1	0	0	0	0	0	#DIV/0!	143	144	322	2	0
369	01AKFW26	4	67	28	0	60	0	1.97	9	47.1	0	3	1	0	2	2.0	195	194	435	1	0
370	01AKFW27	41	77	63	0	319	0	1.53	44	47.1	10	2	6	0	2	0.5	57	57	122	21	12
371	01AKFW28	9	72	26	10	28	46	0.56	20	47.1	0	1	2	0	0	1.0	198	198	417	4	1
372	01AKFW29	6	67	22	0	16	0	1.83	13	47.1	0	1	0	0	0	#DIV/0!	238	240	536	2	0
373	01AKFW30	24	69	24	0	74	0	2.89	11	47.1	0	2	10	2	5	0.5	212	213	445	14	0
374	01AKFW31	44	61	40	0	57	0	6.11	0	42.5	0	3	5	0	0	1.2	181	182	448	19	0
375	01AKFW32	21	32	67	0	93	0	8.38	0	47.1	0	3	1	1	0	8.0	172	172	613	6	0
376	01AKFW33	34	57	46	0	77	0	6.65	1	47.1	0	0	0	1	3	0.7	140	141	413	15	0
377	01AKFW35	28	63	32	15	55	467	6.03	8	49.4	10	0	3	4	0	2.7	300	303	722	11	5
378	01AKFW36	31	63	32	0	27	0	7.81	3	49.4	0	4	4	0	0	2.0	153	152	355	15	0
379	01AKFX01	19	62	49	100	34	1963	4.92	31	28.6	100	0	0	2	2	2.0	148	155	361	9	6
380	01AKFX02	26	62	32	25	58	747	5.03	14	35.2	40	6	3	3	10	1.4	208	208	499	12	8
381	01AKFX03	17	64	45	35	31	531	3.52	33	47.1	55	4	3	1	12	0.7	115	127	296	7	4
382	01AKFX04	35	61	34	0	51	0	7.5	3	35.2	0	2	2	0	0	2.0	186	187	417	16	1
383	01AKFX05	28	64	42	0	68	0	6.73	2	42.5	0	0	3	5	2	2.0	249	250	576	13	0
384	01AKFX06	22	78	10	0	56	0	8.53	1	42.5	0	4	3	3	10	1.1	168	167	312	11	1
385	01AKFX07	23	59	33	0	60	0	7.26	1	49.4	0	0	5	0	2	0.0	152	153	380	9	0
386	01AKFX08	47	70	37	20	46	1124	4.41	24	35.2	30	6	8	5	6	1.6	205	205	459	23	15
387	01AKFX09	9	71	22	25	30	105	7.06	11	47.1	25	0	0	0	0	#DIV/0!	229	232	484	5	8
388	01AKFX10	23	77	22	60	20	445	3.73	36	37.2	95	3	1	0	1	3.0	187	188	386	13	19
389	01AKFX11	24	66	32	50	22	548	4.37	40	37.2	90	0	0	0	0	#DIV/0!	157	160	358	12	18
390	01AKFX12	29	77	16	50	40	717	3.96	29	37.2	90	2	6	0	1	0.6	195	196	394	16	22
391	01AKFX13	32	63	55	60	57	3736	4.1	19	29.6	85	1	3	4	1	2.5	201	200	474	16	6
392	01AKFX14	21	84	11	25	43	207	5.28	10	47.1	60	0	2	4	4	1.3	234	236	414	12	0
393	01AKFX15	20	55	41	30	56	747	6.96	4	47.1	25	0	0	0	2	0.0	158	158	395	9	0
394	01AKFY01	18	63	48	50	34	899	4.27	31	37.2	100	0	1	1	3	0.5	102	130	333	8	4
395	01AKFY02	23	33	73	25	23	316	2.24	14	37.2	100	2	1	0	0	4.0	105	110	394	7	3
396	01AKFY03	27	55	54	25	33	641	4.5	19	37.2	80	4	4	2	6	1.2	205	212	595	11	6
397	01AKFY04	41	70	31	15	45	601	6.26	17	35.2	30	3	4	3	11	0.8	186	193	451	19	4
398	01AKFY05	22	66	32	65	29	867	4.82	39	27.4	100	0	1	2	0	4.0	73	92	244	8	4
399	01AKFY06	30	63	56	45	26	1237	5.08	28	37.2	90	0	0	1	1	2.0	107	115	345	11	11
400	01AKFY07	18	50	57	40	46	936	5.62	28	37.2	85	0	0	5	2	5.0	151	160	509	7	10
401	01AKFY08	25	45	61	60	42	1720	5.06	29	37.2	100	0	1	0	2	0.0	128	130	458	9	6
402	01AKFY09	18	39	63	55	36	889	5.56	25	37.2	100	1	2	3	1	2.7	150	152	536	6	5
403	01AKFY10	31	47	70	60	35	2163	5.46	33	37.2	100	0	0	0	1	0.0	161	167	550	10	15
404	01AKFY11	31	46	74	100	50	5266	4.53	35	28.6	100	4	2	2	8	1.2	136	135	438	10	7
405	01AKFY12	14	36	60	70	33	685	4.95	19	28.6	100	0	0	0	0	#DIV/0!	132	138	495	6	5
406	01AKFY13	18	51	54	40	22	427	5.57	34	37.2	85	0	2	0	1	0.0	162	164	484	7	11
407	01AKFY14	23	54	60	85	38	2365	6.08	26	28.6	95	0	3	1	1	0.5	175	191	579	8	10
408	01AKFY15	29	51	45	75	225	4964	6.1	30	32.3	80	2	5	1	0	1.2	138	148	418	9	5
409	01AKFY16	24	41	62	45	8	214	4.27	29	37.2	95	0	0	0	1	0.0	113	118	383	10	6
410	01AKFY17	23	40	62	55	15	470	3.71	25	37.2	100	1	2	0	3	0.4	154	157	559	5	11
411	01AKFY18	16	48	60	35	22	354	5.38	21	37.2	85	2	1	0	5	0.7	141	166	508	5	7
412	01AKFY19	23	44	53	95	9	465	5.36	26	28.6	95	2	0	1	3	2.0	147	155	514	8	1
413	01AKFY20	15	46	57	55	5	111	5.83	28	37.2	85	3	5	6	3	2.3	168	170	569	5	10
414	01AKFY21	24	43	57	45	18	482	5.29	23	37.2	95	2	1	5	1	7.0	188	201	664	8	8
415	01AKFZ01	25	52	52	50	24	796	4.7	24	37.2	85	0	3	1	0	0.7	192	193	541	10	9
416	01AKFZ02	16	48	68	60	24	782	4.15	24	37.2	95	0	4	0	1	0.0	148	156	499	6	5
417	01AKFZ03	26	47	72	75	20	1346	3.95	29	29.6	100	1	2	1	1	1.3	177	189	582	9	19
418	01AKFZ04	31	54	73	70	34	2943	4.56	30	37.2	80	1	1	0	3	0.5	157	160	477	13	8
419	01AKFZ05	30	41	77	60	36	2074	4.21	32	37.2	95	0	0	1	0	#DIV/0!	159	163	538	9	14
420	01AKFZ06	18	36	73	55	31	819	4.64	13	28.6	80	0	0	3	2	3.0	124	129	440	6	3
421	01AKFZ07	26	44	72	95	33	2609	1.84	24	29.6	80	7	5	7	8	2.2	218	218	625	10	9
422	01AKFZ08	21	53	47	65	32	1084	2.94	33	27.4	80	3	1	0	1	3.0	182	187	520	8	13
423	01AKFZ09	32	50	74	95	23	2622	3.93	25	29.6	90	0	5	4	1	1.3	229	231	652	12	18
424	01AKFZ10	30	62	43	85	25	1667	4.62	34	27.4	95	0	0	2	4	1.0	210	215	550	14	20
425	01AKFZ11	29	52	74	65	28	2032	3.6	28	29.6	90	1	0	4	3	3.3	216	218	607	10	18
426	01AKFZ12	27	52	62	50	25	1119	4.64	37	37.2	95	0	0	2	2	2.0	153	161	449	10	12
427	01AKFZ13	22	43	73	55	19	703	2.73	25	37.2	100	0	2	4	3	1.6	178	177	544	8	12
428	01AKFZ14	25	53	71	85	25	2022	1.84	29	29.6	100	0	2	1	1	0.4	179	182	531	10	9
429	01AKFZ15	26	58	58	75	25	1622	3.04	28	29.6	100	3	2	2	2	2.5	221	223	591	12	18
430	01AKFZ16	39	67	38	10	55	546	4.61	16	42.5	40	2	12	5	12	0.6	180	181	401	20	9
431	01AKFZ17	41	62	38	15	38	557	5.77	8	42.5	25	5	12	1	6	0.7	214	219	538	17	4

Appendix A:
Main characteristics for Newham EDs, taken from 1991 Census, HES statistics, survey data and calculated indicators

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	ed	% hh w 1+ pensioner	% hh w 1 or 2 persons	% hh w 5+ rooms	% dwlgs w low SAP (<35)	% hh w CTB receipt	FPR_{all} (assuming col.F max value =100) $=(B*C*D*E*F)*10^{5}$	Townsend Index	% dwlgs w no CH	SAP mode	% dwlgs pre-1945	93-4 winter resp. count >64yrs	93-4 non-winter resp. count >64yrs	95-6 winter resp. count >64yrs	95-6 non-winter resp. count >64yrs	EWMbR 93-96 = (L+N)*2/(M+O)	total dwlgs w residents (91 Census: S610015)	total households (91 Census: S270031)	total persons (91 Census: S270032)	% population >64 yrs	% hh w lone pens + no ch
442	01AKGA07	27	39	51	45	39	970	7.17	12	31.1	0	0	1	0	3	0.0	191	190	545	10	4
443	01AKGA08	22	72	32	0	59	0	7.58	3	42.5	0	0	5	2	5	0.4	174	176	358	9	3
444	01AKGA09	16	50	81	30	14	270	2.28	21	44.4	50	0	0	1	4	0.5	170	177	490	7	7
445	01AKGA10	40	69	15	5	60	126	7.69	5	42.5	30	2	0	0	1	4.0	183	183	425	18	3
446	01AKGA11	28	57	46	65	50	2364	3.52	31	28.6	60	6	23	2	9	0.5	171	172	439	12	9
447	01AKGA12	21	60	29	80	47	1376	4.44	30	28.6	80	3	4	2	4	1.3	182	182	427	11	12
448	01AKGA13	26	56	43	25	63	983	6.35	2	42.5	25	2	1	4	5	2.0	216	215	575	10	1
449	01AKGA14	29	67	53	75	20	1559	3.29	26	28.6	90	0	1	0	1	0.0	169	175	385	14	19
450	01AKGA15	33	60	56	40	51	2281	3.68	22	44.4	40	5	6	4	7	1.4	191	193	494	14	13
451	01AKGA16	22	53	65	100	17	1284	2.85	31	28.6	100	0	2	2	3	0.8	158	160	426	10	14
452	***total***											*980*	*1464*	*932*	*1362*		*78413*	*80242*	*209901*		
453	***average***	*28*	*57*	*53*	*44*	*42*	*1423*	*5*	*22*	*36*	*62*	*2.2*	*3.3*	*2.1*	*3.0*		*174*	*178*	*466*	*12*	*9*
454	***SD***	*10*	*11*	*16*	*31*	*27*	*1314*	*2*	*12*	*7*	*38*	*2.8*	*3.8*	*2.6*	*3.5*		*39*	*38*	*95*	*6*	*6*
455	***max***	*62*	*100*	*87*	*100*	*319*	*6876*	*9*	*82*	*53*	*100*	*22*	*28*	*16*	*29*		*407*	*406*	*887*	*38*	*41*
456	***min***	*1*	*26*	*0*	*0*	*0*	*0*	*-3*	*0*	*24*	*0*	*0*	*0*	*0*	*0*		*57*	*57*	*93*	*0*	*0*
457																					
458																					
459																					

Appendix B:

Data processing: Table showing 1991 Census variables used

(One page)

Appendix B:

1991 Census variables[1] employed for all EDs, relating to the cell identifiers in the Small Area Statistics

Relevant indicator	***ED characteristic***	***Component***	***Description of census variable used***	***Table no.****	***Variable no(s).***
Low income (*see* 6.3)	% Households (hh) with CTB receipt/ total hhs	Total hh (also denominator for other measures)	Households (hhs) with persons usually present	S27	31
Building classification for typical SAP ratings (*see* 6.4.7)	% Dwellings by house type/ total dwellings	Total dwellings	Total hh spaces with residents	S56 ***	16
		House type	Detached		17
			Semi-detached		18
			Terraced		19
			Flat		20 + 21
			Converted flat		22+23+24 + 25+26+ 27+ 28+29
	% Dwellings by tenure type / total dwellings	Total dwellings	Dwellings with persons present or resident	S62 ***	1
		Dwelling tenure	Owner-occupied		2+3
			Private rented		4+5+6
			Housing association		7
			Local authority		8
Under-occupation among older households (*see* 6.5; 7.2.3)	1 or 2 person hhs in larger dwellings	Age of hhs	Hhs with 1 or more pensioner**	S47	1
		Small hhs	1 person hhs	S57	81
			2 person hhs		89
		Larger dwellings	Hhs with 5 or more rooms	S22	6+7+8
	Lone pensioner h'holds in larger dwellings	Lone pensioners at low density	Lone pensioner hh living at <0.5 persons/room	S47	16+30+44 + 58+72 +86
		Larger dwellings	1 person hhs with 5+ rooms	S22	15+16+17
No central heating (*see* 6.8.1; 7.2.4)	% Dwellings with no central heating (CH)	Total hhs	Hhs usually present	S27	31
		No CH	Hhs without CH	S26	3
		Pensioners with no CH	Hhs with 1+ pensioner with no CH	S47	4
Population age (*see* 6.8.1)	% Population >64 yrs old	Population	Total persons (1991)	S27	32
		Population >64 years old	Age of hh residents	S35	113+120+127+134+141+148

* *Tables with prefix 'S' used - for England and Wales*

** *Men are classed as pensioners at 65+, women at 60+*

*** *These two tables were used for pilot study, but an alternative would have been to use Table 63 for combined type and tenure.*

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[1] as identified from SASPAC User Manual, Part 2, (1st edition, April 1992) produced at the Manchester Computing Centre in accordance with an agreement between the Combined Higher Education Software Team (CHEST) and the London Research Centre.

Appendix C:

Data processing: Calculations of EWMbR for ranked percentile groups of EDs

(one page)

Appendix C:
Example sheets showing calculations for EWMbR for ranked percentile groups of EDs

Page showing EDs ranked by FPR_{all}, calculated EWMbR by ED (col M) and by groups of 18 EDs after sorting by FPR_{all}, then by CTB receipt (cols N-P)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	ed	%hhw1+pens	%1and2phh	%hhw5+rms	%<35SAP	pop>64	%ctb/hh (max 100)	FPR (all) 2ndsort by CTB receipt	93-4 wint resp count >64	93-4 nonwint resp count >64	95-6 wint resp count >64	95-6 nonwint resp count >64	ED resp ewmbr 3 (93-6)	percentile resp ewmbr 1 (93-4)	percentile resp ewmbr 2 (95-6)	percentile resp ewmbr 3 (93-6)	rank of percentile group
2	01AKFQ02	41	65	38	0	88	1	0	2	5	3	6	0.91	0.93	1.59	1.19	1
3	01AKFF04	5	60	46	0	8	14	0	0	0	0	0		0.93	1.59	1.19	1
4	01AKFF19	2	78	31	0	3	14	0	0	0	0	0		0.93	1.59	1.19	1
5	01AKFQ03	33	62	63	0	98	14	0	1	7	4	1	1.25	0.93	1.59	1.19	1
6	01AKFW29	6	67	22	0	13	14	0	1	0	0	0		0.93	1.59	1.19	1
7	01AKFF07	9	41	87	0	16	20	0	1	0	0	0		0.93	1.59	1.19	1
8	01AKFW18	6	57	57	0	13	25	0	0	0	0	0		0.93	1.59	1.19	1
9	01AKFW36	31	63	32	0	54	27	0	1	0	0	0		0.93	1.59	1.19	1
10	01AKFF08	17	31	69	0	40	30	0	4	4	0	0	2.00	0.93	1.59	1.19	1
11	01AKFW01	35	64	58	0	76	31	0	2	5	0	2	0.57	0.93	1.59	1.19	1
12	01AKFW25	6	69	34	0	7	31	0	1	2	5	2	3.00	0.93	1.59	1.19	1
13	01AKFW24	4	57	40	0	12	32	0	0	0	0	0		0.93	1.59	1.19	1
14	01AKFK07	30	41	67	0	41	35	0	0	0	0	0		0.93	1.59	1.19	1
15	01AKFW17	4	39	64	0	5	39	0	1	5	3	1	1.33	0.93	1.59	1.19	1
16	01AKFR10	26	85	9	0	60	39	0	0	0	0	0		0.93	1.59	1.19	1
17	01AKFQ09	32	63	45	0	58	41	0	2	7	1	2	0.67	0.93	1.59	1.19	1
18	01AKFF20	32	56	61	0	50	42	0	2	2	4	3	2.40	0.93	1.59	1.19	1
19	01AKFT23	28	51	54	0	32	42	0	2	2	2	10	0.67	0.93	1.59	1.19	1
20	01AKFK01	22	47	66	0	49	42	0	1	4	1	2	0.67	0.93	1.59	1.19	1
21	01AKFL09	35	63	46	0	70	43	0	1	0	3	2	4.00	1.33	1.38	1.35	2
22	01AKFL10	28	51	57	0	51	43	0	7	12	0	2	1.00	1.33	1.38	1.35	2
23	01AKFT01	39	68	49	0	71	44	0	7	4	5	5	2.67	1.33	1.38	1.35	2
24	01AKFD06	38	73	36	0	72	44	0	0	0	2	3	1.33	1.33	1.38	1.35	2
25	01AKFW19	3	70	35	0	5	45	0	2	5	1	4	0.67	1.33	1.38	1.35	2
26	01AKFA08	21	40	68	0	49	46	0	2	1	1	1	3.00	1.33	1.38	1.35	2
27	01AKFP02	3	56	46	0	5	48	0	0	0	5	1	10.00	1.33	1.38	1.35	2
28	01AKFS10	28	57	74	0	43	48	0	0	0	1	1	2.00	1.33	1.38	1.35	2
29	01AKFT22	41	67	25	0	81	51	0	0	1	0	3	0.00	1.33	1.38	1.35	2

Page showing formulae for calculating EWMbR for percentile groups, with reference to columns shown above

	T	U	V	W	X	Y	Z	AA	AB
30	rank of group	93-4 winter resp count >64	93-4 non-winter resp count >64	95-6 winter resp count >64	95-6 non-winter resp count >64	percentile resp ewmbr 1 (93-4)	percentile resp ewmbr 2 (95-6)	percentile resp ewmbr 3 (93-6)	
31	1	=SUM(I2:I19)	=SUM(J2:J19)	=SUM(K2:K19)	=SUM(L2:L19)	=U31*2/V31	=W31*2/X31	=(U31+W31)*2/(V31+X31)	
32	2	=SUM(I20:I37)	=SUM(J20:J37)	=SUM(K20:K37)	=SUM(L20:L37)	=U32*2/V32	=W32*2/X32	=(U32+W32)*2/(V32+X32)	
33	3	=SUM(I38:I55)	=SUM(J38:J55)	=SUM(K38:K55)	=SUM(L38:L55)	=U33*2/V33	=W33*2/X33	=(U33+W33)*2/(V33+X33)	
34	4	=SUM(I56:I73)	=SUM(J56:J73)	=SUM(K56:K73)	=SUM(L56:L73)	=U34*2/V34	=W34*2/X34	=(U34+W34)*2/(V34+X34)	
35	5	=SUM(I74:I91)	=SUM(J74:J91)	=SUM(K74:K91)	=SUM(L74:L91)	=U35*2/V35	=W35*2/X35	=(U35+W35)*2/(V35+X35)	
36	6	=SUM(I92:I109)	=SUM(J92:J109)	=SUM(K92:K109)	=SUM(L92:L109)	=U36*2/V36	=W36*2/X36	=(U36+W36)*2/(V36+X36)	
37	7	=SUM(I110:I127)	=SUM(J110:J127)	=SUM(K110:K127)	=SUM(L110:L127)	=U37*2/V37	=W37*2/X37	=(U37+W37)*2/(V37+X37)	
38	8	=SUM(I128:I145)	=SUM(J128:J145)	=SUM(K128:K145)	=SUM(L128:L145)	=U38*2/V38	=W38*2/X38	=(U38+W38)*2/(V38+X38)	
39	9	=SUM(I146:I163)	=SUM(J146:J163)	=SUM(K146:K163)	=SUM(L146:L163)	=U39*2/V39	=W39*2/X39	=(U39+W39)*2/(V39+X39)	
40	10	=SUM(I164:I181)	=SUM(J164:J181)	=SUM(K164:K181)	=SUM(L164:L181)	=U40*2/V40	=W40*2/X40	=(U40+W40)*2/(V40+X40)	
41	11	=SUM(I182:I199)	=SUM(J182:J199)	=SUM(K182:K199)	=SUM(L182:L199)	=U41*2/V41	=W41*2/X41	=(U41+W41)*2/(V41+X41)	
42	12	=SUM(I200:I217)	=SUM(J200:J217)	=SUM(K200:K217)	=SUM(L200:L217)	=U42*2/V42	=W42*2/X42	=(U42+W42)*2/(V42+X42)	
43	13	=SUM(I218:I235)	=SUM(J218:J235)	=SUM(K218:K235)	=SUM(L218:L235)	=U43*2/V43	=W43*2/X43	=(U43+W43)*2/(V43+X43)	
44	14	=SUM(I236:I253)	=SUM(J236:J253)	=SUM(K236:K253)	=SUM(L236:L253)	=U44*2/V44	=W44*2/X44	=(U44+W44)*2/(V44+X44)	
45	15	=SUM(I254:I271)	=SUM(J254:J271)	=SUM(K254:K271)	=SUM(L254:L271)	=U45*2/V45	=W45*2/X45	=(U45+W45)*2/(V45+X45)	
46	16	=SUM(I272:I289)	=SUM(J272:J289)	=SUM(K272:K289)	=SUM(L272:L289)	=U46*2/V46	=W46*2/X46	=(U46+W46)*2/(V46+X46)	
47	17	=SUM(I290:I307)	=SUM(J290:J307)	=SUM(K290:K307)	=SUM(L290:L307)	=U47*2/V47	=W47*2/X47	=(U47+W47)*2/(V47+X47)	
48	18	=SUM(I308:I325)	=SUM(J308:J325)	=SUM(K308:K325)	=SUM(L308:L325)	=U48*2/V48	=W48*2/X48	=(U48+W48)*2/(V48+X48)	
49	19	=SUM(I326:I343)	=SUM(J326:J343)	=SUM(K326:K343)	=SUM(L326:L343)	=U49*2/V49	=W49*2/X49	=(U49+W49)*2/(V49+X49)	
50	20	=SUM(I344:I361)	=SUM(J344:J361)	=SUM(K344:K361)	=SUM(L344:L361)	=U50*2/V50	=W50*2/X50	=(U50+W50)*2/(V50+X50)	
51	21	=SUM(I362:I379)	=SUM(J362:J379)	=SUM(K362:K379)	=SUM(L362:L379)	=U51*2/V51	=W51*2/X51	=(U51+W51)*2/(V51+X51)	
52	22	=SUM(I380:I397)	=SUM(J380:J397)	=SUM(K380:K397)	=SUM(L380:L397)	=U52*2/V52	=W52*2/X52	=(U52+W52)*2/(V52+X52)	
53	23	=SUM(I398:I415)	=SUM(J398:J415)	=SUM(K398:K415)	=SUM(L398:L415)	=U53*2/V53	=W53*2/X53	=(U53+W53)*2/(V53+X53)	
54	24	=SUM(I416:I433)	=SUM(J416:J433)	=SUM(K416:K433)	=SUM(L416:L433)	=U54*2/V54	=W54*2/X54	=(U54+W54)*2/(V54+X54)	
55	25	=SUM(I434:I451)	=SUM(J434:J451)	=SUM(K434:K451)	=SUM(L434:L451)	=U55*2/V55	=W55*2/X55	=(U55+W55)*2/(V55+X55)	

Appendix D:

Data processing: Sample sheet of SAP value estimation

(One page)

Appendix D:

Beckton ward: building age, tenure , type distribution by ED, for calculation of SAP ratings from EHCS case study types

	agebands (A-H)								% pre'45													energy ratings	
	A	B	C	D	E					F				G				H				from ehcs	
ed					**%**	type	own	SAP		**%**	type	own	SAP	**%**	type	own	SAP	**%**	type	own	SAP	**class**	**SAP**
FA01									0	30	d			**70**	**e+d**							E.a.1	29.6
FA02									0	**80**	**d**			20	e+a							F.a.1	31.1
FA03					15	a			15					**50**	**d**			35	a			B.a.4, C.a.4, D.a.4	28.6
FA04									0	**70**	**d**							30	d			F.b.1	32.7
FA05									0	**80**	**d+a**			15	e			5	d			G.b.1	44.4
FA06									0					**100**	**d+a**							B.b.3, C.b.3, D.b.3	25.7
FA07									0					**80**	**d**			20	d			B.b.4, C.b.4, D.b.4	37.2
FA08									0					**100**	**d**							D.c.2	24.4
FA09					**60**	**a**			60					30	d			10	a			A.c.3	34.8
FA10					20	a			20	**50**	**d**			30	d							D.c.3	26.5
																						F.d.1	35.2
																						G.d.1	42.5
																						H.d.2	47.1
																						G.e.1	49.4
																						F.f.1	23.7
																						F.f.4	30.5

type
- a = small terr = <70m2
- b = lge terr = >70m2
- c = converted flat
- d = lowrise flat/mais
- e = highrise flat = 6+ storeys
- f = bungalow

own
- 1 = local auth
- 2 = housing ass
- 3 = private rented
- 4 = own -occ

assumptions:
1-if less than 5% of house type in e.d. not noted.
2-size of terraced houses estimated from frontage and gable end where visible

NB generally assumed that E is a, C is a, and D is b, unless specifically noted otherwise

ED	% no ch	% pre 1945	% det	% semi	% tce	**% pb flat**	% conv flat	% oo (4)	% pr (3)	% ha (2)	**% la (1)**				SAP mode
FA01	11	0	0	0	16	**84**	0	12	0	1	**86**	G	d/e.1		42.5-49.4
FA06	11	0	0	1	31	**68**	0	12	0	8	**78**	G	d.1		42.5
FA07	8	0	0	1	19	**80**	0	21	0	2	**75**	G	d.1		42.5
FA05	11	0	0	3	32	**65**	0	13	2	12	**70**	F	d.1		35.2
FA04	9	0	1	0	21	**78**	0	17	0	4	**79**	F	d.1		35.2
FA02	17	0	0	0	26	**74**	0	18	0	1	**80**	F	d.1		35.2
FA08	17	0	0	0	**42**	**57**	0	20	1	1	**77**	G	d.1		42.5
FA10	6	20	0	5	**41**	**54**	0	15	0	3	**79**	F	d.1		35.2
FA03	9	15	3	4	**55**	38	0	**41**	5	5	**47**	G	d.1	H.a.4	42.5
FA09	10	**60**	0	2	**64**	33	0	**32**	3	7	**57**	E.	a.1		29.6

Appendix E:

Data processing: Sample page of spreadsheet showing SAP ranges by ED

(One page)

Appendix E:

% homes with different SAP ratings, according to building classification procedure, by ED

bldg class.	BCDa.3	Ff.1	Dc.2	BCDb.3	Dc.3	Fh.1	BCc.3	BCDa	Eh.1	Gf.4	Ea.1	Ff.4	Fa.1	BCc.2	Fb.1	Eh.4	Ac.3	Eg.4	Fd.1	BCDb.4	Fh.4	Gh.4	Gd.1	Gd.2	Gg.4	Gb.1	Gb.2	Hd.2	Ge.1	Hg.4	total	avSAP				min	max
SAP	17.1	23.7	24.4	25.7	26.5	27.1	27.4	28.6	29.2	29.6	29.6	30.5	31	32.3	32.7	32.8	34.8	35.2	35.2	37.2	38.1	41.4	42.5	43	43.4	44.4	44.6	47.1	49.4	52.5	%		mode	2nd m	3rd mode		
FA01													15						15										70		100	**44.5**	**49.4**			31.1	49.4
FA02													15						65							10			10		100	**36.9**	**35.2**			31.1	49.4
FA03									5		5							5					40			10		35			100	**42.6**	**42.5**			29.2	47.1
FA04													10						60									30			100	**38.4**	**35.2**			31.1	47.1
FA05						5							25						50									5	15		100	**36.5**	**35.2**			27.1	49.4
FA06																							70			30					100	**43.1**	**42.5**			42.5	44.4
FA07																							80					20			100	**43.4**	**42.5**			42.5	47.1
FA08																							60			40					100	**43.3**	**42.5**			42.5	44.4
FA09									5		55												30					10			100	**35.2**	**29.6**			29.2	47.1
FA10									5		15		20						30				20			10					100	**35.6**	**35.2**			29.2	44.4
FB01			5		10			5			25				25				30												100	**31.4**	**35.2**			24.4	35.2
FB02				15	5			75																						5	100	**29.3**	**28.6**			25.7	52.5
FB03				10				15	10		20		20										15			10					100	**32.7**	**31.1**	**29.6**		25.7	44.4
FB04			10		10			20					25				5			20			5			5					100	**32.1**	**31.1**			24.4	44.4
FB05				10				55					5																30		100	**34.7**	**28.6**			25.7	49.4
FB06					10			45			5												20						20		100	**35.4**	**28.6**			26.5	49.4
FB07			5	20				75																							100	**27.8**	**28.6**			24.4	28.6
FB08				10				90																							100	**28.3**	**28.6**			25.7	28.6
FB09				10				25					5										40			20					100	**37.2**	**42.5**			25.7	44.4
FB10				15															5	80											100	**35.4**	**37.2**			25.7	37.2
FB11			5	15				80																							100	**28.0**	**28.6**			24.4	28.6
FB12			5	10				85																							100	**28.1**	**28.6**			24.4	28.6
FB13				20				70															10								100	**29.4**	**28.6**			25.7	42.5
FB14																	HOSP														0	**0.0**					
FC01				10				20			50																	20			100	**32.5**	**29.6**			25.7	47.1
FC02					5				dR				5					40	10	40											100	**35.4**	**37.2**			26.5	37.2
FC03						10			dR				20					50	10							5		5			100	**34.6**	**35.2**			27.1	47.1
FC04									dR				5					45								50					100	**39.6**	**44.4**			31.1	44.4
FC05									30		40											15				15					100	**33.5**	**29.6**			29.2	44.4
FC06								20	10		20								45									5			100	**32.8**	**35.2**			28.6	47.1
FC07			5	5				40															50								100	**35.2**	**42.5**			24.4	42.5
FC08								30															70								100	**38.3**	**42.5**			28.6	42.5
FC09													30										70								100	**39.1**	**42.5**			31.1	42.5
FC10								25					10										10			20		35			100	**39.9**	**47.1**			28.6	47.1
FC11		5		5				5					5						10	20			20			20		10			100	**38.5**	**37.2**			23.7	47.1
FC12						5		10					15						60							10					100	**34.4**	**35.2**			27.1	44.4
FC13				30				60																	10						100	**29.2**	**28.6**			25.7	43.4
FC14													20										40						35	5	100	**43.1**	**42.5**			31.1	52.5
FC15				10				60						5					15							10					100	**31.1**	**28.6**			25.7	44.4
FC16							10	50					10						10							20					100	**32.6**	**28.6**			27.4	44.4
FC17				5									35										60								100	**37.7**	**42.5**			25.7	42.5
FD01							20	45						5															30		100	**34.8**	**28.6**			27.4	49.4
FD02							5	20												15									60		100	**42.3**	**49.4**			27.4	49.4
FD03																										65		5	30		100	**46.0**	**44.4**			44.4	49.4
FD04			5	15			5	30												30		5	10								100	**32.5**	**37.2**	**28.6**		24.4	42.5
FD05							25	20			15			10					15	15											100	**31.1**	**27.4**			27.4	37.2
FD06																			20				80								100	**41.0**	**42.5**			35.2	42.5
FD07																							40					20	40		100	**46.2**	**49.4**			42.5	49.4
FD08																							75					25			100	**43.7**	**42.5**			42.5	47.1

Appendix F:

Sample page of HES data, showing fields of data

(One page)

Appendix F: Sample database sheet showing fields of HES data obtained in July 1998

1 Admission method	2 Patient class	3 Age	5 Enumeration district	7 Epistart date	8 Epiend date	9 Sex	10 Admit date	11 Discharge date	13 Specialty	16 Diag 1	19 Diag 2	22 Diag 3	25 Diag 4	28 Op1	31 Op 2	34 Op 3	37 Op4	40 Provider	42 Discharge dest	44 ADM
28	1	74	AKFW09	01-Jan-98	26-Jan-98	1	30-Dec-97	26-Jan-98	300	I500	Z950	K808	I517					RNH	19	D
12	2	54	AKFH11	28-Jan-98	28-Jan-98	1	28-Jan-98	28-Jan-98	303	C900				X339				RNH	19	B
21	1	83	AKFF12	30-Dec-97	05-Jan-98	1	30-Dec-97	05-Jan-98	300	I200	Z951	I259	C61X					RNH	19	B
11	2	70	AKFG08	21-Jan-98	21-Jan-98	1	21-Jan-98	21-Jan-98	101	D414				M459				RNH	19	B
21	1	44	AKFN15	20-Jan-98	20-Jan-98	2	20-Jan-98	31-Jan-98	301	J459	I10X	G453						RNH	19	A
24	1	45	AKFG03	15-Jan-98	27-Jan-98	2	15-Jan-98	27-Jan-98	100	L022	Z867	J459	F112	S472	Z539	Z539	Z472	RNH	19	B
12	1	52	AKFF17	10-Jan-98	19-Jan-98	1	10-Jan-98	19-Jan-98	301	D128	K766	K709	K625	H221	Z291			RNH	19	B
21	1	74	AKFJ12	12-Jan-98	20-Jan-98	1	12-Jan-98	20-Jan-98	300	J440	I517	I501	I48X					RNH	19	B
21	1	77	AKFW02	12-Jan-98	26-Jan-98	1	12-Jan-98	26-Jan-98	430	J440	I500	I48X						RNH	19	B
21	1	84	AKFG18	08-Jan-98	21-Jan-98	2	06-Jan-98	21-Jan-98	430	J22X	R074	I259						RNH	19	D
12	2	83	AKFZ05	28-Jan-98	28-Jan-98	1	28-Jan-98	28-Jan-98	330	D233				E091				RNH	19	B
21	1	29	AKFD08	18-Jan-98	19-Jan-98	2	18-Jan-98	28-Jan-98	300	J180	F329							RNH	19	A
21	1	29	AKFD08	19-Jan-98	28-Jan-98	2	18-Jan-98	28-Jan-98	300	J180	F329			E491				RNH	19	D
11	1	52	AKFM01	19-Jan-98	20-Jan-98	2	19-Jan-98	20-Jan-98	101	Z090	N393							RNH	19	B
12	2	60	AKFL18	22-Jan-98	22-Jan-98	2	22-Jan-98	22-Jan-98	340	C342				E491	Y211			RNH	19	B
12	1	65	AKFJ09	06-Jan-98	27-Jan-98	2	06-Jan-98	27-Jan-98	100	K623	K529	A415		H334	X339			RNH	19	B
21	1	73	AKFT15	08-Jan-98	22-Jan-98	1	08-Jan-98	22-Jan-98	300	I500	Y522	N19X	J90X					RNH	19	B
28	1	73	AKFJ03	17-Jan-98	19-Jan-98	2	17-Jan-98	09-Feb-98	300	J440	I10X	G409	E119					RNH	19	B
21	1	75	AKFF20	02-Sep-97	22-Oct-97	2	13-Aug-97	13-Feb-98	410	I639	J22X	I259	I10X					RNH	19	N
21	1	75	AKFF20	13-Aug-97	02-Sep-97	2	13-Aug-97	13-Feb-98	300	I639	J22X	I259	I10X					RNH	19	A
21	1	75	AKFF20	22-Oct-97	30-Oct-97	2	13-Aug-97	13-Feb-98	110	S720	W082	J449	I739					RNH	19	N
21	1	75	AKFF20	30-Oct-97	13-Feb-98	2	13-Aug-97	13-Feb-98	410	Z508	J449	I739	I639					RNH	19	D
21	1	65	AKFH19	02-Dec-97	02-Dec-97	1	02-Dec-97	17-Dec-97	301	J440	Y427	E119						RNH	19	A
21	1	65	AKFH19	02-Dec-97	17-Dec-97	1	02-Dec-97	17-Dec-97	300	J440	Y427	E119						RNH	19	D
12	2	55	AKFZ01	21-Jan-98	21-Jan-98	2	21-Jan-98	21-Jan-98	100	M203				W033	Z943			RNH	19	B
28	1	75	AKFQ10	05-Jan-98	20-Jan-98	1	05-Jan-98	20-Jan-98	100	K590	Z850	I10X	G319					RNH	19	B
12	2	84	AKFC12	26-Jan-98	26-Jan-98	2	26-Jan-98	26-Jan-98	301	K210	K221			G451	Z271			RNH	19	B
21	1	79	AKFJ04	18-Jan-98	20-Jan-98	1	18-Jan-98	25-Jan-98	300	J22X								RNH	79	A
21	1	79	AKFJ04	20-Jan-98	21-Jan-98	1	18-Jan-98	25-Jan-98	430	I210	J22X	I451	I201					RNH	79	N
21	1	79	AKFJ04	21-Jan-98	25-Jan-98	1	18-Jan-98	25-Jan-98	430	I210	I501	I490	I469	L912				RNH	79	D
22	1	63	AKFW03	15-Jan-98	22-Jan-98	2	15-Jan-98	22-Jan-98	300	R17X	E109	C80X		J402	J439			RNH	79	B
11	1	22	AKFT08	13-Jan-98	19-Jan-98	1	13-Jan-98	19-Jan-98	110	M232				W772	Z942	Z846	T645	RNH	19	B
12	1	88	AKFM06	19-Jan-98	26-Jan-98	1	19-Jan-98	26-Jan-98	101	C61X	Z935	N40X		M653	Y037	M678		RNH	19	B
28	1	64	AKFW35	16-Jan-98	22-Jan-98	1	13-Jan-98	22-Jan-98	101	N459	Z951	I501	I252					RNH	19	D
28	1	55	AKFY15	20-Jan-98	26-Jan-98	2	20-Jan-98	26-Jan-98	303	A419	N907	N390	C859					RNH	19	B
21	1	28	AKGA12	21-Dec-97	24-Dec-97	2	21-Dec-97	24-Dec-97	300	J459								RNH	19	B
12	2	63	AKFH10	19-Jan-98	19-Jan-98	2	19-Jan-98	19-Jan-98	330	L720				E092				RNH	19	B
31	1	30	AKFZ13	20-Jan-98	20-Jan-98	2	20-Jan-98	20-Jan-98	501	O998	R05X	O996	K529					RNH	19	B

Description of fields of data

1 Admission method	2 Patient class	3 Age	5 Enumeration district	7 Epistart date	8 Epiend date	9 Sex	10 Admit date	11 Discharge date	13 Specialty	16 Diag 1	28 Op1	40 Provider	42 Discharge dest	44 ADM
Elective / emergency / other	Ordinary / day case / maternity	Age in years at date of admission		Start of FCE (Finished Consultant Episode)	End of FCE	1 = male, 2 = female	Date of admission	Date of discharge	Surgical / medical / obstetrics / etc	Primary diagnosis on admission	Operation codes	Organisation providing admitted patient care	Home / death / other	Signifies whether episode is at admission / middle / discharge stage of spell

Appendix G:

Copy letter from ELCHA re: ethical approval of data issue

(One page)

East London and The City **HEALTH AUTHORITY**

Janet Rudge
LEARN
School of Architecture and Interior Design
Spring House
40 Holloway Road
London N7 8JL

19/5/2000

Dear Ms Rudge

Re: HES data for Newham

Further to your recent query, I am writing to confirm the position regarding the NHS hospital admission data supplied to you by ELCHA in May 1998 for your research at the University of East London.

Following discussions with yourself with regard to the level of detail we could make available to you, this data was supplied as non-patient identifiable and was deliberately anonymised. As such, its issue would not have required approval by the Ethics Committee.

Yours sincerely

B. Garner

Bruce GARNER

HEAD OF INFORMATION SERVICES

Chairman: Professor Elaine Murphy
Aneurin Bevan House 81 Commercial Road · London E1 1RD
Tel: 0171 655 6600 · Fax: 0171 655 6666

NHS

Appendix H:

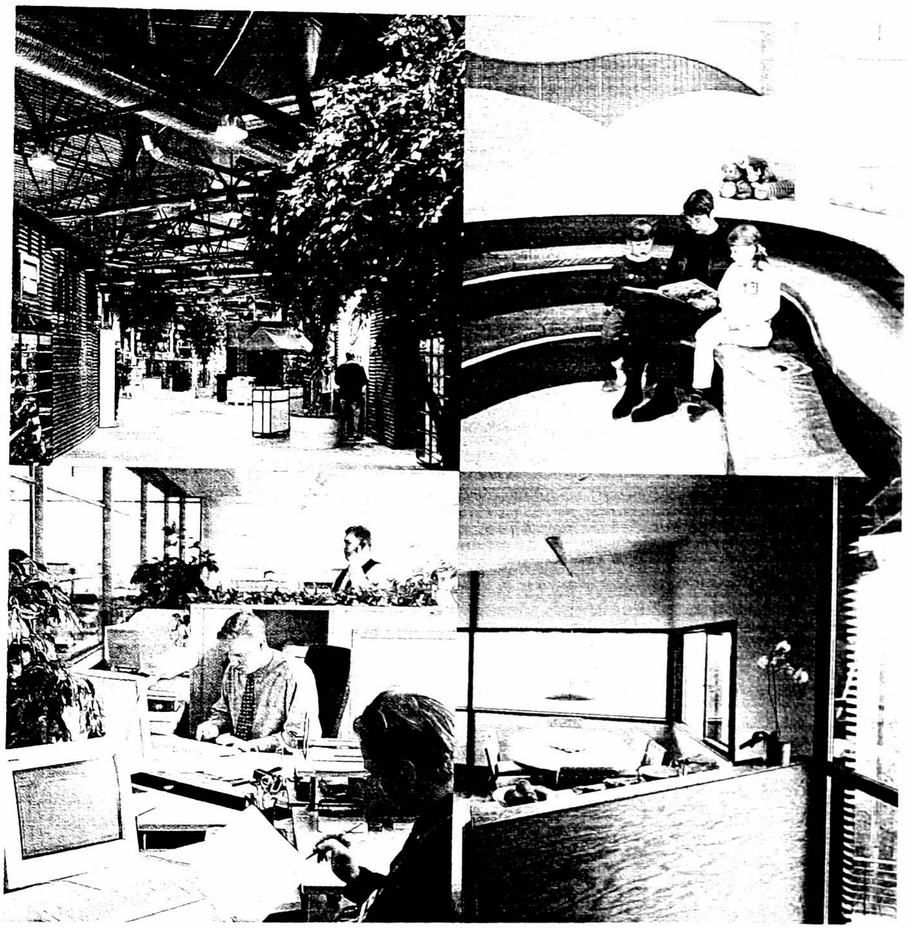
Conference paper ref: (Rudge, 2000b)

(3 pages):

Rudge J (2000) "Mapping: a tool for linking winter morbidity, low incomes and energy efficiency" *Proceedings of Healthy Buildings 2000:Exposure, Human Responses and Building Investigations,* **1:** 703-704 Helsinki: SIY Indoor Air Information Oy, Finland.

HEALTHY BUILDINGS 2000

AUGUST 6–10, 2000 ESPOO, FINLAND



EXPOSURE, HUMAN RESPONSES AND BUILDING INVESTIGATIONS

PROCEEDINGS, VOL. 1

Finnish Society of Indoor Air Quality and Climate, FiSIAQ

International Society of Indoor Air Quality and Climate, ISIAQ

MAPPING: A TOOL FOR LINKING WINTER MORBIDITY, LOW INCOMES AND ENERGY EFFICIENCY

Janet Rudge

University of North London, UK

ABSTRACT

This pilot study aims to develop a methodology for evaluating cost benefits, such as health improvements, resulting from investment in affordable warmth. Demonstrating causal links between housing and health is problematic because of the many confounding variables. However, low outdoor and low indoor temperatures have been linked with certain types of illness. For one London borough cold-related illness episodes in winter are analyzed geographically from hospital admission statistics. Correlations are sought with the location of low-income households in energy *inefficient* housing and, using GIS, mapping provides a visual presentation of the analysis. A larger area of study is needed and data sources and quality need further refinement for correlations to be established. The mapping tool could then serve to monitor, over time, various benefits following energy rating upgrading. It could also identify areas where certain health problems predominate and where housing needs upgrading most urgently.

KEYWORDS: energy, health effects, residential, seasonal, epidemiology

INTRODUCTION

Excess winter deaths rise as outdoor temperatures fall. Britain's high rate of excess winter mortality compares badly even with much colder countries. This may be due to the relatively low indoor winter temperatures common in British homes [1]. Low income families in hard-to-heat homes with poor insulation and inefficient heating systems are the "fuel poor". They are often elderly and the least able to invest in energy conservation for long-term savings.

Local authorities are required to reduce domestic energy use and CO emissions. Increased energy efficiency can lead to calculable energy savings or greater comfort. The cost-effective argument for investment overlooks the value of efficiency to fuel poor households because the benefits of providing affordable warmth, in terms of improved health and comfort, are difficult to quantify. If evidence showed that both health and environmental targets were met, wider sourcing of funding for energy efficiency measures may be justified. It would also assist the shift of emphasis from *saving* energy towards the *rational use* of energy.

Since low temperatures are associated with certain illnesses, predominantly respiratory and cardiovascular disease [2], it was thought possible that these types of illness could be shown as more prevalent in winter among the fuel poor. The intention was to use data already available within one London borough and, by taking an epidemiological approach, to find a relatively robust method of assessing health benefits of increased energy efficiency.

METHODS

The fuel poor are identified by the combined location of 1) households on low incomes and 2) poorly energy-rated housing. The indicator used for low income households is receipt of

Council Tax Benefit (CTB), a means-tested benefit available to all householders, whether tenants or owner-occupiers. The local authority provided this data, but the accuracy of the postcodes is variable. House energy ratings are estimated on the basis of building age, type and tenure, matched to typical dwellings and their average energy ratings given in the EHCS [3]. Building age was mapped from local authority records, size and type from external surveys and tenure from Census data. The third dataset concerns the location of population suffering cold-related illness in winter. The health authority provided hospital admission statistics for a 4 year period. An Excess Winter Morbidity Ratio (EWMBR) for each year was calculated on the basis of 4-month seasons between August and July:

$$\text{EWMBR} = \frac{\textit{no. of emergency winter respiratory episodes (December - March)}}{\textit{average no. of respiratory episodes for the other 2 seasons}}$$

All datasets were broken down by enumeration district (e.d.) and shown as percentages of baseline statistics for all e.d.s, which were gained from the 1991 Census data (numbers of households, dwellings, population, household tenure and agebands of population). Daily Met Office data for the 4 years allowed comparison of winter severity. Using different measures, '93 and '94 were consistently less severe than '95 and '96, so the EWMBR was calculated over the combined 2 year periods. These datasets for all e.d.s were analyzed for correlations.

RESULTS

The EWMBR for respiratory conditions across the borough is greater than 1, indicating that more respiratory episodes occur in winter for the population as a whole. Conclusions from the first analysis are concerned with the quality of the data, rather than with correlations of factors, since no correlations have yet been identified. This had been anticipated in part, due to the fact that the area of study is small, with a population which is consistently deprived throughout. The study needs widening to include districts with different income characteristics. An e.d. includes about 200 households, which is not enough to register significant annual variations in numbers of hospital admissions. Grouping e.d.s will help to eliminate this and other difficulties with the present data. Postcoded addresses had to be converted to e.d.s but this process approximates to e.d.s where postcodes are close to boundaries. Zoning should reduce the resulting anomalies if done by contiguity. Grouping will be tested by house type, low income and agebands of population to eliminate one point of variation at a time from comparisons.

DISCUSSION

The methodology has yet to be completed as discussed above. However, the practical application intended for this tool would be for local and health authorities to identify costs of energy inefficient housing to the health service. Plotting data at regular intervals could potentially reveal health improvement in the community following upgrading of buildings and could monitor additional benefits such as savings to other social services or to building maintenance budgets. The mapping tool could also identify areas where certain health problems predominate and where housing needs upgrading most urgently.

ACKNOWLEDGEMENTS

These are due to the Eaga Charitable Trust for one year's funding of the pilot study.

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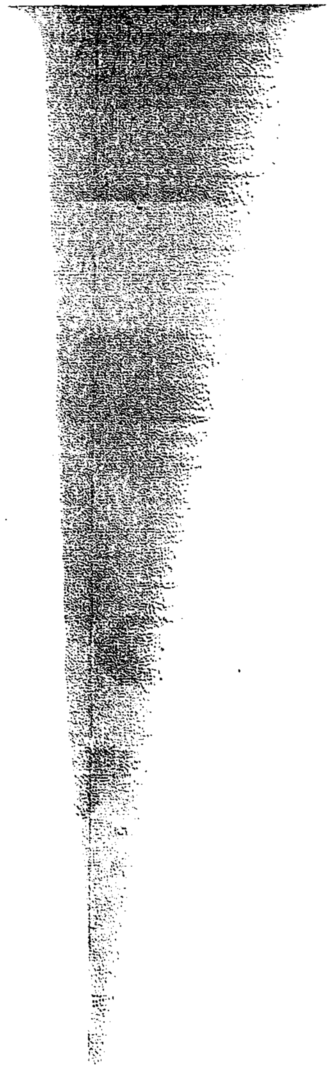
Appendix I:

Chapter in book co-edited by the author, ref: (Rudge, 2000a)

(6 pages)

Chapter 10: "Winter morbidity and fuel poverty: mapping the connection" in:
Rudge and Nicol eds (2000) *Cutting the Cost of Cold: Affordable Warmth for Healthier Homes.* London: E&FN Spon, pp134-142.



Cutting the Cost of Cold

Affordable warmth for healthier homes

Edited by

JANET RUDGE & FERGUS NICOL

E & FN SPON
Taylor & Francis Group
London and New York

10

Winter morbidity and fuel poverty: mapping the connection

Janet Rudge

This chapter describes a proposed tool for evaluating the outcome of investment in affordable warmth. The development of this tool could also be of use to both local and health authorities in monitoring the effects of such investment. Ideally, it would be used to provide evidence of significant benefits in terms of reductions in costs to the health service, other services, or to building maintenance budgets. The case could then be made for further investment with assistance from a variety of different Government Departments or funding bodies.

10.1 Changing priorities

Britain has long had a reputation for cold, draughty and poorly insulated dwellings although the general public places a high priority on keeping warm. Even so, the relatively mild climate has often been used to justify the low priority given to energy efficiency in construction [Rudge 1995, 1996]. The Government now recognises the need for improving energy efficiency in buildings in order to limit their contribution to global carbon dioxide emissions and climate change. Legislation is in place relating to new construction, but the current rate of building replacement means that most people will be living in the existing housing stock, largely built before energy efficiency requirements were introduced, for many years to come [Boardman, 1993].

If measures are introduced to increase energy prices in order to limit energy use, this will adversely affect those who live on low incomes in buildings which are poorly insulated, with inefficient or

expensive heating systems, and are therefore hard to heat. These are the 'fuel-poor' households, who are often the elderly. They are also the households least able to invest in energy efficiency so that savings could be made in the long term.

The Home Energy Conservation Act [HECA 1995] required that local authorities plan to reduce domestic energy use by 30% over a ten year period. The initial local authority bids had to include provision for the fuel poor but the Act does not make allowance for additional funding towards upgrading existing housing stock. HECA progress reports are submitted annually and they highlight targets with regard to the reduction in carbon dioxide emissions and energy use as well as the percentage improvement in energy efficiency. They do not relate specifically to progress with respect to fuel poverty so there is a danger that the specified targets will take priority. The main provision of the proposed Private Member's Bill on Fuel Poverty and Energy Conservation would have required local authorities to report on progress on dealing with fuel poverty. The New Labour Government has suggested that this data will be asked for on a voluntary basis, having negotiated withdrawal of the Bill in light of their proposed improvements to the Home Energy Efficiency Scheme [NEA, 1999; DETR, 1999]. The significance of action on fuel poverty will consequently remain unsupported by the force of legislation.

Justification for public investment normally requires demonstrable cost benefits. Potential energy savings resulting from increased energy efficiency can be calculated. The savings relating to carbon dioxide emissions are also measurable. In fact, the fuel poor have limited resources available for fuel expenditure, however energy-efficient their homes are made. In such cases, the benefit of energy-saving improvements is often 'taken back' as extra comfort [Milne & Boardman, 1997]. This means that there would be limited reduction of energy use or even none at all. This could militate against investment in hard-to-heat homes occupied by low-income households.

The indirect savings to the health service, or other social support services, are less easily demonstrated than energy savings. The cost-effective argument for investment will overlook the value of improvements to fuel-poor households because the benefits of providing affordable warmth, in terms of improved health and comfort, or reduced building maintenance costs, are difficult to quantify. If evidence were available to show that health targets were met as well as environmental targets, funding for energy efficiency measures may be justified from more than one Government Department. The emphasis would be shifted from that of purely saving energy towards the *rational use* of energy as recommended in the Watt Committee Report: *Domestic Energy and Affordable Warmth* [Markus, 1994].

The aim of the proposed mapping tool is to provide such evidence. A pilot study has been funded by the Eaga Charitable Trust to investigate the feasibility of this methodology, using the London Borough of Newham as its basis.

10.2 Housing and health

As described in Part One, Britain suffers a high rate of excess winter deaths and these are shown to increase as outdoor temperatures fall. This country's record is poor compared with many others with similar or even much colder climates. It has been argued that this is due to the relatively low indoor winter temperatures commonly found in British homes [Boardman, 1991].

Although the connections are widely recognised, demonstrating direct causal relationships between housing and health is problematic because of the many confounding variables which preclude an accurate comparative assessment of risk factors [Ambrose, 1996]. Dr Collins has described some of the complexities in Chapter 3 and they are further discussed in Chapter 18 by Dr Bardsley. One problem in researching the links is that self-reporting of illness attributed to cold and damp homes may be regarded as too strongly motivated by the desire for re-housing. There are also difficulties in funding longitudinal health surveys before and after interventions are made to improve housing conditions. Because they are expensive, these surveys usually involve relatively small sample populations. Some work has shown, however, that improvements in health have resulted from investment in energy efficiency in housing as described, for example, in Chapters 7 and 12.

10.3 Development of the methodology

For the purposes of developing an evaluation tool the intention was to use data which was already available to existing agencies and, by stepping back from the detail, to invent a relatively robust method of assessing health benefits of increased energy efficiency.

Since low temperatures are associated with certain illnesses - these have been identified as predominantly respiratory and

cardiovascular disease [Kunst *et al.*, 1993] - it was thought pos that these types of illness could be shown to be more prevale winter among the fuel poor. In order to do this, therefore, it woul necessary to locate:

a) households on low incomes;
b) housing with poor energy rating, (where the combinatio these two features would identify the fuel poor);
and c) those who suffer from cold-related illnesses in winter.

These data would then be overlaid to look for correlations. Plottin regular intervals could potentially reveal health improvement in community following upgrading of buildings.

Mapping provides a simple and accessible visualisation of data analysis and it has other advantages as a tool in this context. GIS (Geographical Information Systems) for spatial data analysis is becoming more commonly employed in a variety of fields. It is already used by some local authorities and so, for them, the mapping tool could easily be accessed and tied into existing databases. GIS also functions as an epidemiological tool and the overlaying of health information with building and socio-economic data is therefore well served by geographical analysis.

10.4 An indicator for ill health related to cold

Previous chapters have referred to excess winter deaths as an indicator of adverse health effects of low winter temperatures. Curwen [1997] describes the definition of excess winter deaths as the number of deaths in the 4 month period from December to March, less the average of numbers in the preceding 4 months (autumn) and the following 4 months (summer). For the purposes of monitoring effects of home improvements, however, it is more appropriate to use a measure of excess winter morbidity, or illness. (Once death has occurred there is no longer any potential cost to the health service!) This may be calculated similarly, so the same 4 month winter periods are compared with the rest of the year as taken from August to July. This methodology proposes the use of a ratio (similar to the Excess Winter Death Index), which does not therefore rely on absolute numbers for its value.

For the pilot study, it was decided that health data would be more easily obtained by using hospital admission statistics from a health authority as a single source. It would be more problematic attempting to gain information from a number of GPs across a borough, whose data collection methods probably vary and who may not all be prepared to make their records available. The East London and the City Health Authority provided records of hospital admissions over the four year period from August 1993 to July 1997 with 21 fields of data, including admission dates, type of admission, diagnosis and specialty codes, age and gender. (This range of data gives scope for analysis beyond the initial parameters of the pilot study, with a view to pursuing the work further.)

At first, it was envisaged that buildings and households could be identified at postcode level to show correlations between ill health and fuel poverty. However, due to the issue of confidentiality, the health authority was unwilling to give postcoded addresses as part of the data. Identification by enumeration districts, or 'e.d.'s, (these being census-related subdivisions of wards) was acceptable to the authority and it was thought would still give a reasonably detailed classification of data in relation to the area's population. (Newham constitutes 460 e.d.s for a population of approximately 220,000.)

On the other hand, it was recognised that when hospital admission statistics were broken down to enumeration district level (each constituting a population of approximately 500) the e.d. may not be a large enough unit to register significant variations. As this has proved to be the case, e.d.s will have to be clustered in the final analysis. This could mean analysis at ward level (there being 24 wards in Newham) or, possibly, grouping e.d.s according to building age and type, or energy rating. The method of zoning within the borough would be an area deserving further exploration.

10.5 Low income indicator

The question of which is the best indicator to use for low-income households is debatable. Some studies use a measure of deprivation based on points of information from census data. The aim of the proposed methodology is to use data that should be within the normal remit of collection by the local authority, as far as possible. The indicator should relate to ability to pay for heating rather than more wide-ranging deprivation factors (although some of these may be relevant to residents' state of health). The intention of this methodology is to be robust and is therefore concerned with statistics at a broad level. It avoids the level of detail required to look only at those individual households falling within the strict definition of fuel poverty as now used by the Government (a minimum of 10% of

income needed to be spent on fuel to achieve acceptable levels of comfort).

Newham Council's published *'Poverty Profile'* [Griffith 1994] suggests that the receipt of Housing Benefit is a good indicator of where people are living in poverty. However, as Housing Benefit is not available to offset mortgage payments, the many elderly owner-occupiers of older terraced houses, with poor energy efficiency characteristics, would not be identified from this information. It is likely that they constitute significant numbers of the fuel poor in Newham, so this data would not be sufficient on its own.

Council Tax Benefit is available to all householders, including owner-occupiers, and does overlap Housing Benefit receipt. Details of those claiming this benefit would therefore be necessary together with, or possibly instead of, Housing Benefit data. These data were considerably more difficult to obtain, but may not be in future as councils rationalize their data collection systems. Alternatively, the indicator used could be that of Income Support claims, which the Local Government Anti-Poverty Unit can supply by ward as at 1996 and plans to produce by e.d. Benefit data is usually supplied as at the date of extraction so a historical record over a particular time period is unlikely to be obtainable by present data collection methods.

Of course it is not possible to include the many who do not take up benefits to which they are entitled, nor those whose incomes are still low but are just above the qualification cut-off point. So all data will underestimate numbers actually living on low incomes in relation to fuel expenditure necessary for comfort and wellbeing.

10.6 Housing energy performance

To assess the energy ratings for all properties in the borough, even on the basis of external surveys, would be a lengthy exercise beyond the scope of the pilot study. The Energy Report of the 1991 English House Condition Survey [DETR 1996] gives average energy ratings for typical dwellings which were derived from case studies. It classifies buildings according to the combination of age, ownership and type (low-rise or high-rise flat, terraced house and so on). In order to use these average ratings, house types in Newham were identified to match the case study examples as closely as possible.

The energy rating used is the Government's Standard Assessment Procedure, or SAP. This rating measures the cost of heating per unit floor area, based on heat loss characteristics of the building and the efficiency of the heating system. In some boroughs this information may already be available for dwellings at a basic level. Because of HECA, Newham Council had set up a database of residential properties by address and tenure, and energy rating details are gradually being entered from a variety of sources. The information already included within the borough was so far incomplete, particularly with regard to the privately rented and owned sector. However, the validity of the House Condition Survey average ratings in the Newham context could be tested using examples for which data did exist.

Information on the age of buildings was collated from the Planning Department to a single map, which allowed classification of each e.d. according to the predominant building age. From this map, it is very clear that in most cases whole streets have similar characteristics (one e.d. usually comprises two or three streets).

Computerised aerial photographic surveys of the area could help to identify recently constructed housing and to determine the storey heights and types of buildings. However, only a physical survey of the area was found to produce reliable confirmation of these details. Historical information relating to building improvements presents further difficulties. Newham Housing Department provided details of large scale Estate Action schemes carried out over the period under study. However, the energy rating improvement resulting from various upgrading works could only be estimated and records of smaller scale refurbishment works could not be obtained.

A spreadsheet was developed showing each ward so that combination details of building age, type and, where known, tenure could be entered as percentages for each e.d. These were then matched against the EHCS combinations to select average SAP ratings for the e.d. and ward, or other grouping of e.d.s.

10.7 Winter severity

Finally, from Meteorological Office data showing daily records of temperatures, wind speed, rainfall, and sunshine hours, the relative severity of each winter in the 4 year period could be determined, and the winter conditions compared with those during the rest of the year. Different measures of winter severity could be investigated for links with annual variations in hospital admissions for cold-related diseases. These could include the number of days with a mean temperature below 5°C, the number of days when the minimum

temperature fell to 0°C or below, as well as the monthly mean monthly mean minimum temperatures. As Curwen [1997] points variability of temperature, or wind chill, for example, could be par the seasonal influences on health.

10.8 Conclusions

At the time of writing, the analysis of data for the anticipa potential correlations is incomplete. Preliminary work with figures emergency hospital admissions indicates a slight excess wi incidence for all causes, a greater excess for ischaemic heart dise and a still greater excess for respiratory conditions. Various causes will also be analysed for different age groups. The method for grouping e.d.s within the borough and relating building information to health statistics needs further investigation.

It is clear that acquiring all the relevant data for this project was not without some difficulties but, on the other hand, officers of Newham Council and the Health Authority were extremely helpful and supportive of the work. On the basis of the work done, there would seem to be a good case for using existing information databases to produce a potentially useful mapping tool. When using databases held by others, there is no control over their quality, but once relevant queries are set up and these are used on a regular basis, they might be expected to become more reliable. There will always be problems over the issue of confidentiality when dealing with health matters and benefit receipts. If the data can be classified by enumeration district, it removes the possibility of personal identification. Address details do not include the e.d. in all databases, although it is possible to convert postcodes to e.d.s in GIS, with the loss of a small measure of accuracy.

Deprivation or low income indicators vary in usefulness, but work continues under different agencies to expand these and test their effectiveness. The variety of sources of information relating to buildings should become less of a problem as local authorities progress towards completing their energy databases.

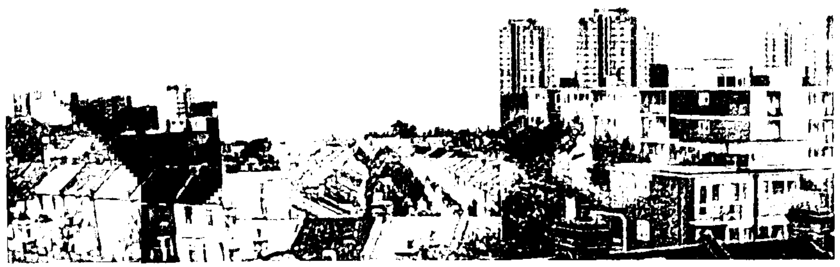
As discussed above, it is likely that the pilot area selected will prove too small to find demonstrable correlations, but the work could be extended to include other boroughs in order to test it further, and in more detail, over a wider area. A greater variety of residential circumstances than is usual within one East London borough would probably be necessary to identify significant differences in health profiles and use of services.

If anticipated correlations between fuel poverty and high rates of winter respiratory illness are found, then the tool could be developed to estimate the attached costs to the health service to be set against the cost of building upgrades. Furthermore, it could demonstrate the value of increased energy efficiency as a preventative health measure as well as its potential contribution towards improved quality of life for the socially excluded fuel poor.

It would be a means of regularising the collation of data which is routinely produced separately by a number of departments within a local authority, or by different agencies, such as local and health authorities. In this way the summary of all the data would be made more useful to each organisation.

It should be possible to use the tool to monitor, over time, a number of different benefits resulting from energy rating upgrading. These could include, along with health improvements, reduced building maintenance costs and increased lifetime of the housing stock. The proposed methodology intentionally takes a broad view of conditions. It is not appropriate for assessing the detail of how far energy ratings are increased by particular measures, or their specific health advantages. With regard to the problems of damp in addition to cold in dwellings, the assumption is made that improving energy efficiency should include proper consideration of ventilation and relative humidity control.

However, in addition to the monitoring role, the mapping should highlight areas where problems combine to make fuel poverty likely, identify where certain health problems predominate and require servicing and indicate the types of housing that need upgrading most urgently.



Typical Newham housing mix

Appendix J:

Conference abstract / poster, ref: (Rudge, 2001b)

(4 pages)

a) Abstract published as:
Rudge J (2001) "Mapping fuel poverty risk and excess winter morbidity: a tool to promote interagency partnership around domestic energy efficiency and health inequalities" *Geographic Information Sciences in Public Health - 2001 Conference, 19-20 Sept.* Sheffield University.

b) Copy of poster shown at conference

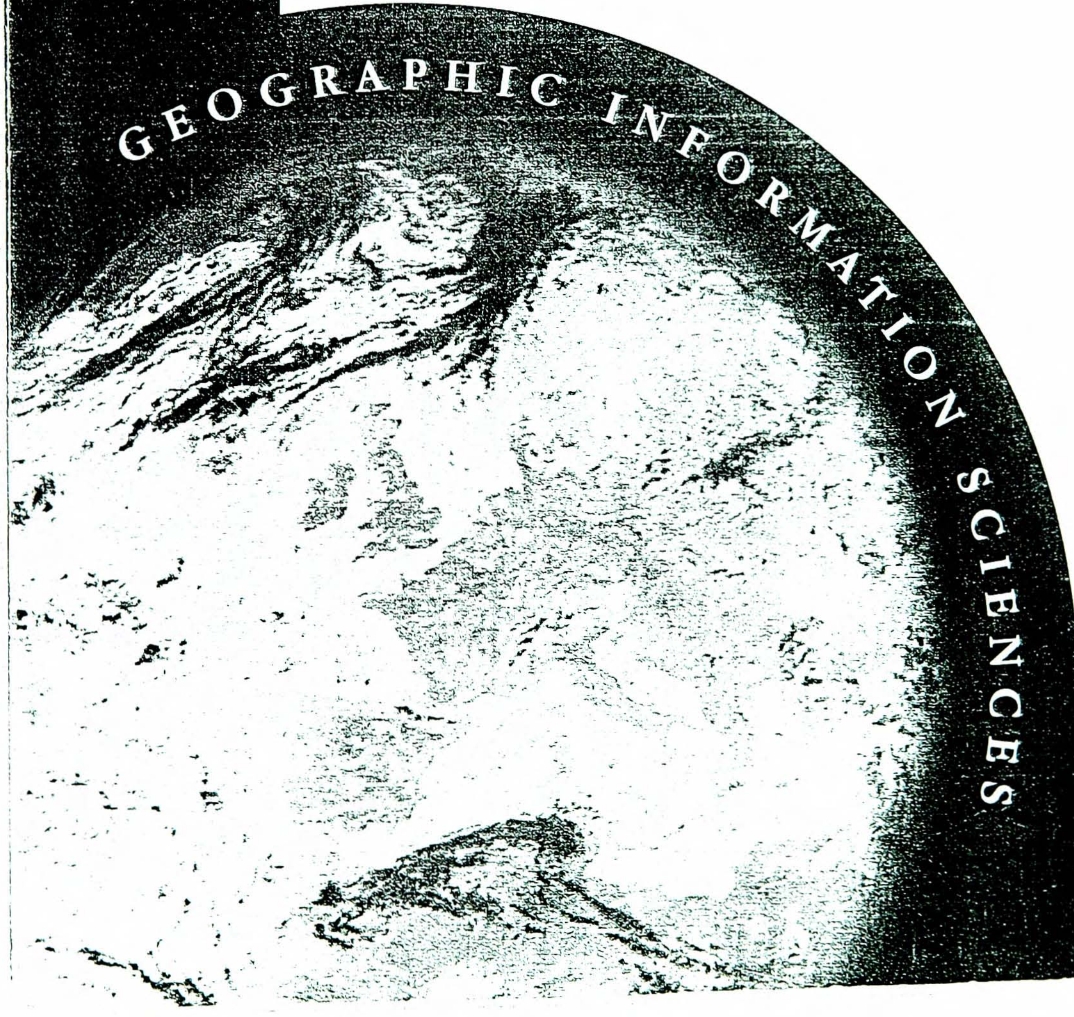
Conference Abstracts

Geographic Information Sciences

in PUBLIC HEALTH 2001

First European Conference

19-20 September 2001
Sheffield, UK



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Samhällsmedicin
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Mapping fuel poverty risk and excess winter morbidity: a tool to promote interagency partnership around domestic energy efficiency and health inequalities

Janet Rudge
University of North London, UK

This pilot study aimed to develop a methodology for evaluating health benefits of investment in domestic affordable warmth. The objective is a monitoring tool usable by housing and health agencies.

An epidemiological approach was used to link cold-related ill-health and lack of affordable warmth at ED level in a London borough. A Fuel Poverty Risk Index (FPR) was devised, combining factors of population age and income, under-occupation and housing with poor energy efficiency. An Excess Winter *Morbidity* Ratio (EWMbR) was calculated for the population aged over 64, using emergency hospital admissions for respiratory disease over a four-year period. Winter severity was prepared from Met. Office data. The EWMbR was calculated for percentiles of EDs ranked by FPR and by individual component factors of FPR. Results were presented using GIS.

Regression analysis showed a significant positive correlation (R^2=0.326, p=0.003) between increased EWMbR for this age group and fuel poverty risk. Correlations were not apparent when component factors of FPR were removed. Maps produced show quintiles of EDs similarly ranked for FPR and for EWMbR across the borough.

Results indicate a relationship between the energy performance of buildings, as a factor in fuel poverty risk, and residents' health. The methodology therefore has potential for monitoring and costing the effectiveness of energy efficiency improvements in terms of health benefits, thus helping promote partnership approaches to combating fuel poverty and aspects of health inequalities. Future development will include consideration of zone design methods and sensitivity analysis to further evaluate the robustness of results.

Acknowledgement is due to the EAGA Charitable Trust for funding towards this study.

MAPPING FUEL POVERTY RISK and EXCESS WINTER MORBIDITY:

a tool to promote interagency partnership around domestic energy efficiency and health inequalities

Janet Rudge
LEARN
University of North London

SUMMARY

This pilot study aimed to develop a methodology for evaluating health benefits of investment in domestic affordable warmth. Correlations were sought between mapped data relating to low incomes, building characteristics and hospital admissions. The objective is a monitoring tool usable by housing and health authorities in tackling fuel poverty and health inequalities.

INTRODUCTION

Low indoor winter temperatures common in British homes have been linked with high numbers of excess winter deaths. Low-income families in hard-to-heat homes are the *fuel poor*. Many are older people. Wider government investment in energy efficiency requires evidence of cost benefits to health services.

METHOD

An epidemiological approach was used to link cold-related ill-health and lack of affordable warmth at ED level in a London borough.

A **Fuel Poverty Risk Index** (FPR) was devised, combining factors of population age and income, under-occupation and housing with poor energy efficiency.

FPR criteria

Percentage / ED of:

- *households with 1+ pensioners*
- *one or two person households*
- *houses with 5+ rooms*
- *receipt of Council Tax Benefit*
- *housing with low energy rating (SAP <35)*

An **Excess Winter *Morbidity* Ratio** (EWMBR) was calculated for the population aged over 64, using emergency hospital admissions over a 4-year period for respiratory disease (ICD9: 460-519; ICD10: J00-J99).

$$\text{EWMBR} = \frac{\text{no. emergency winter episodes (Dec-Mar)}}{\text{average no. for other 2 seasons}}$$

Winter severity was compared from Met Office data. The EWMBR was calculated for percentiles of EDs ranked by FPR and by individual component factors of FPR. Results were presented using GIS.

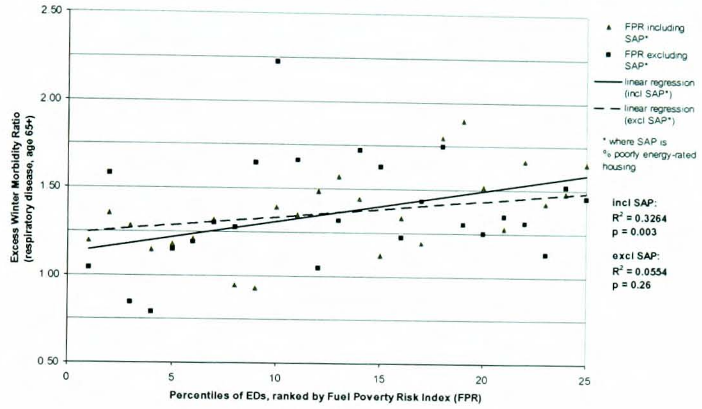
Contact: J.Rudge@unl.ac.uk or LEARN website: www.unl.ac.uk/LEARN

This study was funded by the Eaga Charitable Trust.

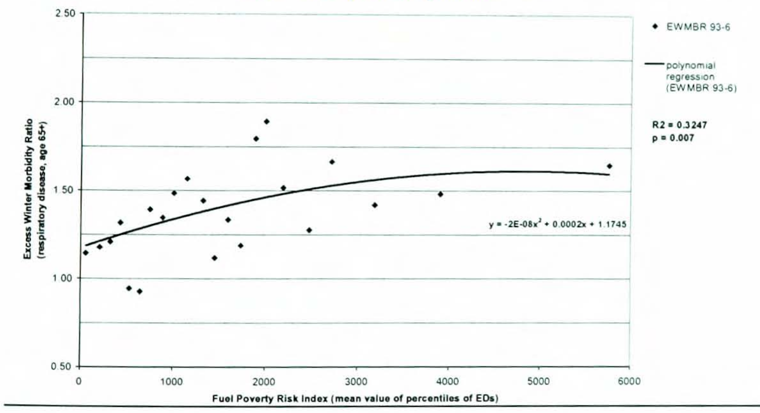
RESULTS

EWMBR for all age groups was 1.12. Regression analysis showed a significant positive correlation (R^2=0.326, p=0.003) between increased EWMBR for the older age group and fuel poverty risk.

Relationship between excess winter morbidity and housing with poor energy efficiency

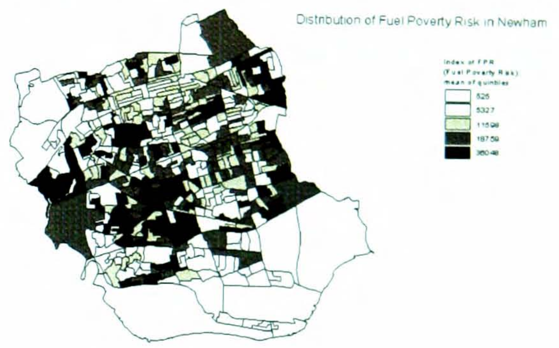


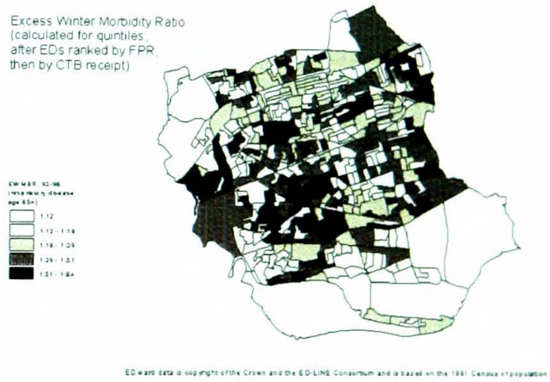
Relationship between excess winter morbidity and fuel poverty risk



Correlations were not apparent when component factors of FPR were removed, *e.g.* low energy ratings.
Maps produced show quintiles of EDs similarly ranked for FPR and for EWMBR across the borough.

Newham enumeration districts: showing correlation between fuel poverty risk and excess winter morbidity for over 64 year olds





DISCUSSION

Results indicate a relationship between the energy performance of buildings, as a factor in fuel poverty risk, and residents' health. The methodology therefore has potential for monitoring and costing the effectiveness of energy efficiency improvements in terms of health benefits, thus helping to promote partnership approaches in combating fuel poverty and aspects of health inequalities.

Further research will expand the area of study and consider zone design methods, as EDs may not be the most appropriate level of aggregation for studying this phenomenon. Sensitivity analysis will be undertaken to further evaluate the robustness of results.

Epidemiological advice was provided by Dr Paul Aylin, Imperial College London.

Appendix K:

Report to the Eaga Charitable Trust, 2001,:ref: (Rudge, 2001a)

(Title and contents pages, / Executive summary only)

(5 pages)

Rudge J. (2001) *Developing a methodology to evaluate the outcome of investment in affordable warmth.* Penrith: Eaga Charitable Trust.

Eaga Charitable Trust
Report Number 6

Developing a methodology to evaluate the outcome of investment in affordable warmth

April 2001

Research conducted by Janet Rudge, Low Energy Architecture Research Unit (LEARN), School of Architecture and Interior Design, University of North London.

A report to the Eaga Charitable Trust

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Contents

Executive summary

This pilot study aims to develop a methodology for evaluating cost benefits, particularly health improvements, resulting from investment in domestic affordable warmth. This has involved seeking correlations between mapped data relating to low incomes, building characteristics and hospital admissions. The objective is a monitoring tool for use by local authorities and health authorities.

Low indoor winter temperatures common in British homes have been linked with Britain's relatively high numbers of excess winter deaths. Low-income families in hard-to-heat homes with poor insulation and inefficient heating systems are the *fuel poor*. They are often older people who are least able to invest in energy conservation for long-term savings. The cost-effective argument for investment in energy efficiency overlooks the value to fuel poor households of improved health and comfort because these benefits are more difficult to quantify than energy savings.

Demonstrating causal links between housing and health is problematic because of the many confounding variables. However, low outdoor and low indoor temperatures have been linked with certain types of illness. This study, based on one East London borough, Newham, uses an epidemiological approach to link cold-related ill-health and lack of affordable warmth.

The fuel poor are identified by the combined location of

- *households on low incomes* and
- *housing with poor energy efficiency ratings.*

These are then compared with the location of

- *population suffering cold-related illness in winter.*

The low-income households are defined as those in receipt of Council Tax Benefit. Energy efficiency ratings are estimated by comparison of buildings with case study house types from the 1991 English House Condition Survey, using building age, type and tenure for classification. The population with cold-related winter illness are identified using hospital admission statistics for respiratory disease over a four year period from 1993 to 1997. Further population data are drawn from the census and winter severity is compared using Met Office data. All data are calculated as rates at enumeration district[1] (ED) level.

The health indicator used is the Excess Winter Morbidity Ratio (EWMBR):

$$\frac{\textit{no. of emergency winter respiratory episodes}}{\textit{average no. for rest of year}}$$

The EWMBR for respiratory conditions across the borough is greater than one, indicating that more respiratory episodes occur in winter than the rest of the year for the population as a whole. EWMBR is calculated for the population over 64 years old, who are those most affected by cold-related illness, for groups of EDs ranked according to an index of Fuel Poverty Risk (FPR). Analysis shows a significant positive correlation between the FPR and increased EWMBR for this age group. The index is derived from a combination of factors, including poorly energy rated housing and low incomes. The risk is amplified

[1] Census-related sub-division of a ward (see 3.3.3)

where pensioners are likely to live alone or as couples in larger houses. GIS[2] mapping is used to provide visual presentation of parts of the analysis.

The pilot study was designed to test the feasibility of the methodology, using available data. The correlations found indicate useful potential for further development and research. The suggested directions to explore would include testing another area of study which has a more diverse population than Newham, where greater variation of risk factors might produce stronger correlations. In addition, further refinement of sources and quality of data is needed to confirm the correlations demonstrated in the pilot.

The practical application intended for this tool would be for local and health authorities to identify costs of energy inefficient housing to the health service. Plotting data at regular intervals could potentially reveal health improvement in the community following upgrading of buildings and could monitor additional benefits such as savings to other social services or to building maintenance budgets. The mapping tool could also identify areas where certain health problems predominate and where housing needs upgrading most urgently. It could therefore serve as one diagnostic tool among others, as well as an evaluation tool for measuring the effectiveness of affordable warmth strategies.

[2] Geographical Information Systems (software)

Appendix L:

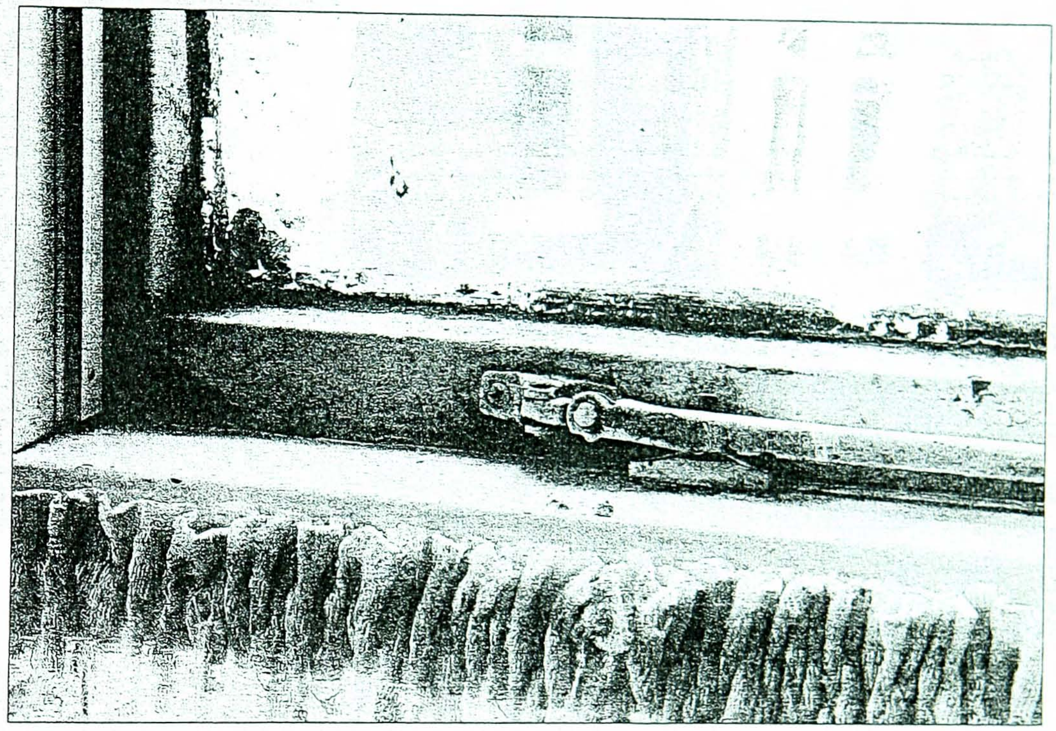
Article from Energy Action, 2001

(2 pages)

Rudge J. (2001c) "Sick of the cold." *Energy Action* **84**: 18-19 (August).

sick of the cold

Janet Rudge explains how compound equations can help to evaluate the health benefits of affordable warmth programmes.



The consequence of under-heated, poorly insulated and inadequately ventilated housing is living conditions that can be seriously harmful to health.

The increasing government recognition of fuel poverty is most welcome, together with the fact that it now acknowledges the link between cold homes and poor health. At the same time, a key factor of current health policy is the reduction of inequalities in health. The Acheson Report, commissioned by the Department of Health in 1998, included a recommendation for insulation and heating improvements to reduce the prevalence of fuel poverty, in recognition of its contribution to health inequalities.

MAKING THE CASE

The compound nature of fuel poverty factors and their relationship with health means that 'joined up' action, as widely promoted, is essential to tackle the problem from all sides. However, in a climate of targeting resources, inter-agency investment in housing improvements requires justification, through evaluation. As Professor John Chesshire pointed out in Energy Action 83, the national fuel poverty strategy should be more firmly evidence-based in relation to health and welfare cost-benefits. In addition, a recent British Medical Journal editorial on making public policy argued for improved evidence on interventions to reduce health inequalities.

COUNTING THE COST

Various estimates have been made of the annual cost to the health services of poor housing (£2.4 billion)[1] cold housing (£220 million)[2] and damp housing (£1billion)[3]. In the absence of national statistics that can be used to establish associations between housing and health information, these figures were necessarily derived from fairly crude calculations and assumptions. Despite the amount of research indicating links between poor housing and ill-health, there are difficulties in demonstrating or quantifying direct cause and effect because of numerous confounding variables, including income, smoking, diet or simply the stress associated with poverty itself. However, links have been shown between low outdoor and indoor temperatures and certain types of illness. Some studies have also found health improvements following investment in domestic energy efficiency.

A NEW APPROACH

The Eaga Charitable Trust recently funded a piece of research designed to investigate whether an epidemiological, or population, approach could be found to confirm the connections between fuel poverty and health[4]. Whereas most epidemiological studies of the effects of winter cold have previously concentrated on the incidence of excess winter mortality, the aim here was to look at excess winter morbidity – in terms of cold-related illness. Death is, after all, the most extreme outcome of exposure to cold indoor temperatures. Mortality figures do not reflect the large numbers of people suffering from respiratory and cardiovascular diseases, for which risk is increased by cold or damp conditions. (Ironically, once death has occurred, there is no further cost to the health service to be balanced against investment in warm and comfortable homes.)

DATA MONITORING

East London and the City Health Authority and the London Borough of Newham co-operated to provide data for a four year period so that hospital admissions for cold-related diseases could be compared with the likely incidence of fuel poverty across Newham. Using additional census-derived data, a Fuel Poverty Risk (FPR) Index was calculated for all enumeration districts (EDs), based on percentages of households with risk factors such as age, under-occupation and low income and houses with below average energy efficiency.

Older people are most at risk from cold-related illnesses, of which respiratory disease showed the greatest winter excess in the data. So an Excess Winter Morbidity Ratio was calculated for respiratory disease in the population over 64 years old, by comparing the number of emergency winter hospital admissions with the average number for the rest of the year. (Using a seasonal comparison excludes the influence of non-seasonal factors, such as smoking and diet.) The results were mapped using GIS software and a moderately significant correlation was shown between Fuel Poverty Risk and this Excess Winter Morbidity Ratio. The correlation was found to be weakened or non-existent when various factors were excluded from the FPR calculation, eg. none was found for the low energy efficiency factor alone. This indicated that the compounded factors of fuel poverty risk were influential on the relationship found, linking inability to afford warmth with excess winter respiratory illness in older people.

THE NEXT STEPS

From the evidence of this pilot study, further development of the methodology appears to be justified. Its advantages would be its use to monitor and evaluate the health outcomes of investment in affordable warmth – and to provide a means of attaching health service savings to the outcomes. As a tool requiring co-ordination of data collected routinely by different agencies, it could encourage more partnership between local and health authorities in ameliorating the effects of inequalities in both health and housing.

As Colin White described in Energy Action 83, Chester-le-Street provides one encouraging example of a pioneering scheme to 'prescribe' energy efficiency measures on the grounds of health. The research outlined here could potentially be used towards health impact assessment of schemes like this. This would bolster the argument for the health sector to invest resources in providing affordable warmth as part of a preventive health strategy.

The report describing this research is available, price £10.00, from:

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1 National Housing Federation (1997) Housing for health. National Housing Federation, London.

2 Lawson R (199[illegible]) Bills of health. Radcliffe Medical Press, Oxford.

3 Boardman, quoted in Bown H, Baines R, Curtis A (2000) Fuel Poverty Fact File. National Right to Fuel Campaign, London.

4 Rudge J (2001) Developing a methodology to evaluate the outcome of investment in affordable warmth. Report no 6. Eaga Charitable Trust, Penrith.