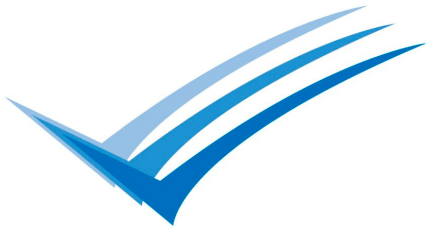

Greater Manchester
Public Health Practice Unit

# Understanding the costs and benefits of fuel poverty interventions: A pragmatic economic evaluation from Greater Manchester

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***Commissioned by: Angela Mawle, Chief Executive, UK Public Health Association***

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# Executive summary

This report is about fuel poverty interventions undertaken as part of the Affordable Warmth Access Referral Mechanism (AWARM) programme. The report uses real world data collected from the AWARM team in Greater Manchester about the costs of interventions and uses available literature to describe the benefits of interventions and to inform the development of economic models. Economic models are then created which have transparent assumptions and these are used to explore the benefits needed to justify the cost of the interventions. The report discusses model findings, limitations, the cost effectiveness and value for money of warm housing interventions and draws a conclusion about whether the interventions are a good use of resource.

Recipients of interventions that make a house more thermally efficient can take the benefit either as reduced fuel use or increased household temperature. The literature showed that in the UK recipients on average take the benefit as a warmer house. This is crucial for economic models as the assumed benefits from lower fuel use (lower carbon emissions and fuel bills) disappear and are replaced with the benefits of living in a warmer house. The literature shows that living in a warmer house improves quality of life which is thought to come about via two main mechanisms – greater comfort in the home, and less worry and stress about fuel bills.

The cost benefit analysis considered AWARM interventions in 52 households. The AWARM process ensures that recipients of interventions are those in need. The residents were 82 adults and 12 children. The interventions were mainly insulation (wall and loft) and heating improvements (boiler repair or new central heating). The cost of providing interventions was estimated to be £88,800.

The model analysed benefits of warmer housing in terms of an increase in quality of life and a smaller increase in length of life. The model considered benefits in adults. The gain in quality adjusted life years (QALYs) due to an improvement in quality of life in 82 adults was estimated to range from a minimum 1.67 to a maximum of 31.16 depending on the scenario modelled. The life years gained from living longer was estimated to be 2.55 years, this was assumed to equal 1.53 QALY, a reduction of 40% because the years gained are towards the end of life.

Using the NHS threshold of £20,000 for a QALY, an intervention costing £88,800 must generate at least 4.44 QALYs. In the scenarios modelled the value of the QALYs gained ranged from £64,000 to £653,800. It is only in one scenario, in which benefits are limited to a small group (those with measurable depression and anxiety), and are short term, that the intervention was not cost effective. When modest benefits are assumed to accrue to half of the recipients or large benefits accrue to those with measurable depression and anxiety the interventions are very cost effective.

In a second analysis the value of benefits needed to reach the total cost of the intervention was considered. It was found that if the whole benefit to a recipient of a warm housing intervention is valued at 50p for each cold day then the benefits would exceed costs after about ten years. If a higher value of £1 is thought to be more reasonable then benefits exceed costs within five years. The value that should be placed on helping to keep a vulnerable member of the population or a child warm in their home are not known but an amount of £1 for each cold day does not seem excessive or unreasonable when placed into the context of expenditure on fuel to keep warm or alternative health interventions. Indeed in terms of opportunity cost it is hard to think of alternative interventions that might have a substantial impact on mental wellbeing at a lower cost.

This report concludes that warm housing interventions in targeted populations are almost certainly cost effective and that they can be considered a good use of public resources. The benefits gained in the UK are likely to be mainly from comfort taking and a consequent improvement in mental wellbeing.

# Introduction

Not being warm enough in the home is a threat to health. The threat has been recognised for many years and has brought about policies to improve housing conditions especially in the elderly and vulnerable groups such as the Warm Front scheme.[1] Ideally everyone would live in spaces that can be heated efficiently to comfortable temperatures at a cost that was not prohibitive. With concerns about the impact of $CO_2$ on climate change the sensible solution is to help people keep warm whilst using fuel efficiently. Unfortunately many in the population live in fuel poverty. Fuel poverty has been defined as spending more than 10% of income on heating the house.[2] However, fuel poverty is not about income alone. It is often caused by interplay between low overall income and the size and ease of heating a property. This causation allows for interventions to alleviate fuel poverty to focus on improving the efficiency of heating the home such as better insulation and boilers.

Describing the segment of the population that could benefit from more efficient heating is straightforward, but engaging with those individuals and families is more challenging. Warm Front was the government's flagship scheme to alleviate fuel poverty and was originally introduced in 2000. The scheme recognised that ascertaining income levels and fuel expenditure was problematic and used receipt of certain benefits as a proxy measure for fuel poverty. The UK Public Health Association (UKPHA) successfully piloted the Affordable Warmth Access Referral Mechanism (AWARM) initiative in Greater Manchester. The programme works by using multiple sources including GP referrals to identify those most at need. The UKPHA want to assess the impact of such initiatives as AWARM on recipient's quality of life to add to the evidence base and inform UK debate.

The Chief Executive of the UKPHA, Angela Mawle met with Dr Soraya Meah and Dr Anthony Threlfall from the GM Public Health Practice Unit to discuss and develop ways to evaluate the AWARM programme. An evaluation using the validated EuroQol measure of quality of life was discussed and investigated. A pragmatic evaluation was designed using a before and after study approach whereby quality of life would have been measured before recipients receive the intervention and then again approximately 12 months after. However, to be conclusive this study required a large sample size and a funding commitment that was beyond scope. It was therefore decided that an alternative approach to help decision makers reach a judgement about the value of AWARM type initiatives be explored.

The GM Public Health Practice Unit has used pragmatic economic modelling and threshold analysis to help commissioners make decisions about public health interventions.[3] The approach relies on having robust estimates for the

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[1] http://www.direct.gov.uk/en/MoneyTaxAndBenefits/BenefitsTaxCreditsAndOtherSupport/On_a_low_income/DG_10018661?CID=MTB&PLA=warmfront&CRE=lowincome

[2] B. Boardman, *Fuel poverty: from cold homes to affordable warmth*, Belhaven Press, London 1991

[3] http://www.gmpublichealthpracticeunit.nhs.uk/wp-content/uploads/2009/12/Quit-bus-Final-April-222.pdf

cost side of the cost benefit equation and then estimating the benefits that need to accrue to justify the expenditure. This approach can be used to transparently explore funding decisions. In this report it is applied to the fuel poverty initiatives undertaken as part of the AWARM initiative. The report uses real world data collected from the AWARM team in Greater Manchester about the costs of interventions and uses available literature to describe the benefits. Basic economic models are then created which have transparent assumptions and these are used to explore the benefits needed to justify the cost of the interventions. The report finishes by discussing the models findings, its limitations and drawing conclusions based on the literature and the model.

This report aims to:

- Use literature, theory and knowledge to describe the main health and wellbeing benefits that are likely to accrue from warm housing interventions
- Use economic modelling approaches to investigate the likelihood that the benefits accruing to recipients of warm housing interventions are of a magnitude to demonstrate that these interventions are good value for money
- Discuss and highlight implications for decision makers of the findings of the economic modelling

The report is presented in three sections: literature, economic model and discussion.

# Literature

The literature used in this report comes from a focussed review of the literature on fuel poverty interventions. The intention was to uncover the best, most relevant literature to inform the development of an economic model. The scope and depth of the literature review was constrained by the time and resource available and it is not a systematic review. Nevertheless, the methods employed will have ensured that all of the main intervention studies published in the main journals since 2000 have been included and considered.

The literature was searched to answer two general questions about fuel poverty interventions and health. The first general question was: What is current knowledge and understanding about the benefits of warm housing initiatives? To answer this literature was generated from an initial search that focussed on finding key documents, such as the documentation supporting government programmes and reports by the World Health Organisation (WHO). The intention was to uncover the thinking behind these initiatives and uncover the expected mechanisms by which warm housing initiatives benefit those receiving them. These documents were reviewed, and references included in these documents were also used.

The second general question was: What does current evidence from intervention studies tell us about the impact of fuel poverty initiatives on health and wellbeing? To answer this question, published evaluation studies that have compared outcomes from interventions were used. The studies were found using a formal search of Medline, NHS Evidence and CINAHL. The search was undertaken in November 2010 and considered published studies since January 2000. The search strategy was devised by a trained librarian and aimed to identify any intervention study that was about health and warm home improvements.

The abstracts of the papers identified by the search were reviewed and those papers that were thought at this stage to be publications of evaluations of interventions were considered further. The search strategies employed will have detected the overwhelming majority, but not all, meta-analyses, systematic reviews, randomised trials and intervention studies about housing warmth and health published in peer review journals since 2000. The papers that were considered are listed in Appendix 1.

### Understanding the benefits of warm housing initiatives

The WHO in Europe has looked at the impact of housing conditions on health for a number of years and has had a series of conferences and published numerous reports on the link between warm housing and health.[4]

[4] http://www.euro.who.int/en/what-we-publish

There are a number of mechanisms for how housing warmth can impact upon health. The main routes are via ambient temperature, dampness, mould growth and air quality. These are often associated; for example, a cold house might be heated badly which can cause poor air quality, lead to damp patches and mould growth. In addition to direct health impacts from low ambient temperatures, dampness and mould growth warm housing interventions can have indirect health benefits to householders from potential reductions in fuel use. Through reducing expenditure on fuel, household bills are reduced allowing the households to have more income so decreasing poverty which is linked to health. The following sections look at these benefits in more detail.

Ambient temperature

The UK fuel poverty strategy published in 2001[5] reports that physiological effects of cold are well documented. It states that resistance to respiratory disease falls when temperatures fall below 16ºC and temperatures below 12ºC result in raised blood pressure caused by the narrowing of blood vessels, which also lead to an increase in thickness of the blood as fluid is lost from the circulation. This, with raised fibrinogen levels due to respiratory infections in winter, is associated with increased deaths from coronary thrombosis in cold weather. The strategy reports that about half of excess winter deaths are circulatory in cause, due to the above factors.

The physiological link between cold temperature and an increased risk of respiratory and circulatory disease is noted in a number WHO Europe reports, these include, for example, the *Review of evidence on housing and health: background document for the Fourth Ministerial Conference on Environment and Health*.[6] This report describes a study by Wilkinson *et al*[7] as important. This study found that cardiovascular mortality was lowest at a daily mean temperature of about 20ºC and increased as the temperature drops from this point. Wilkinson *et al*. reported that there were five major determinants of cold indoor temperatures for United Kingdom properties, these were:

- Age of dwelling – older houses tend to be colder than newer houses
- Not having or being dissatisfied with the heating system – houses with inadequate or heating judged by residents to be poor tend to be colder
- The cost of heating the dwelling – houses that cost a lot to heat tend to be colder
- Low household income – houses that have the lowest household incomes tend to be colder

[5] http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file16495.pdf
[6] Bonnefoy XR, Annesi-Maesano I, Aznar LM, *et al*. *Review of evidence on housing and health: background document for the Fourth Ministerial Conference on Environment and Health*, Budapest 2004. Apr. Report No.: Eur/04/5046267/BD/1. Geneva: World Health Organisation, 2004.
[7] Wilkinson P, Armstrong B, Landon M., 2001, *Cold comfort: The social and environmental determinants of excess winter deaths in England, 1986-1996*, Foundation by The Policy Press (ISBN 1 86134 355 8). (Summary available here http://www.jrf.org.uk/knowledge/findings/housing/n11.asp)

- Household size – houses with small households tend to be colder

WHO Europe have attempted to quantify the risk to health from bad housing and have used evidence reviews to describe the factors and health outcomes for which the evidence of a housing-health link is strong.[8] It was concluded that for: heat and related cardiovascular effects and/or excess mortality; cold indoor temperatures and winter excess mortality, and energy efficiency of housing and health there is sufficient evidence of a link to allow effects to be quantified.

In the United Kingdom alone the number of excess winter deaths is, on average, in the range of 40 to 50 000 a year. According to the WHO review[9] the number that can be attributed to cold homes remains unclear although some attempts to quantify have shown figures in the range of 6%. If this is the case, the above numbers suggest that between 2400 and 3000 winter deaths in the UK are caused by cold homes.

In addition to excess deaths, the 2001 UK fuel poverty strategy notes the impact of cold on morbidity. Cold causes discomfort for older people, for example worsening arthritic pains or contributing to a general feeling of illness. WHO Europe also report a relationship between cold indoor temperature and morbidity and note Irish research which indicated that households enduring cold (or 'fuel-poor' households) were over three times as likely to report respiratory conditions and almost three times as likely to self-perceive ill health caused by cold housing.

Whilst it is clear that cold temperatures increase risk of death from cardiovascular and respiratory events, the temperature that housing should be to avoid deaths is less clear. The Warm Front better health report[10] which describes the work around evaluating the government's Warm Front programme notes that there is little agreement about the temperature needed to avoid risk to health. They note that the government's strategy recommends 18ºC but others have defined unhealthy living room temperatures as below 16ºC.

The issue of the correct indoor temperature to avoid ill health is further complicated when consideration is given to the subjective nature of thermal comfort. The WHO review of the impact of housing conditions on health notes the Fanger (1970)[11] definition of thermal comfort as being that condition of mind that expresses satisfaction with the thermal environment. As such thermal comfort is subjective. However, Fanger found that thermal comfort is

[8] http://www.euro.who.int/__data/assets/pdf_file/0007/98674/EBD_Bonn_Report.pdf
[9] Bonnefoy XR, Annesi-Maesano I, Aznar LM, *et al. Review of evidence on housing and health: background document for the Fourth Ministerial Conference on Environment and Health*, Budapest 2004. Apr. Report No.: Eur/04/5046267/BD/1. Geneva: World Health Organisation, 2004.
[10] *Warm Front better health. Health impact evaluation of the Warm front scheme*. Geoff Green and Jan Gilbertson. Centre for Regional, Economic and Social Research, Sheffield Hallam University 2008.
[11] Fanger, P. O. *Thermal comfort. Analysis and applications in environmental engineering*. Copenhagen, Danish Technical Press, 1970.

dependent on six main variables: air temperature, relative humidity, radiant temperature, air speed, clothing level and metabolic rate (activity level).

The fact that experience of cold is subjective is important when considering its impact on mental health, stress and wellbeing. Not feeling comfortable because you are cold is obviously stressful and not good for wellbeing. The Warm Front better health report notes that low indoor temperature is linked to stress but not as strongly as an occupant's own assessment of thermal comfort. They report that in their study they found that those reporting that their bedroom was 'much too cool' were over 75% more likely to report high or moderate stress. The report also presents compelling evidence of a link between stress and fuel poverty with those reporting it fairly difficult or hard to pay bills more than twice as likely to have high levels of stress.

Finally, the differential impact of cold housing on different population groups is important. The UK fuel poverty strategy notes the impact on the long term sick, the elderly and children. It notes that children are particularly vulnerable to respiratory conditions such as asthma, which have been linked to cold and damp homes. It states that cold homes also increase the time taken to recover from other illnesses so that children may be off school more, affecting their education and development. Homework can also suffer if the family is squeezed into a small part of their home, and there is nowhere for the children to study in quiet. Fuel poverty therefore impairs the opportunities available for children.[12]

The impact of fuel poverty on children is addressed in a policy briefing for Save the Children written by Professor Christine Liddell.[13] It draws on recent research evidence, and documents the effects that fuel poverty has on infants, children, and young people. It notes that for children, studies are even fewer than for adults but the effects of living in a warmer home free from damp seem to be found in both mental and physical health. The author notes the importance of the timing of these benefits and their potential for gains over a lifetime.

To summarise, it is very clear that cold temperatures increase health risk via known physiological routes. It is also apparent that cold housing has at least some role in the excess deaths from circulatory causes seen each winter. Being cold is stressful as is finding it difficult to keep warm in your house. Stress and discomfort from being unable to heat your home adequately is then exacerbated if fuel bills are a worry. However, although increasing temperature in houses will reduce health risk, defining the minimum threshold is problematic because thermal comfort is subjective.

<u>Dampness and mould growth</u>

Mould spores are found in all housing but require an adequate supply of moisture to grow. Mould is common in older houses that have suffered water

[12] http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file16495.pdf
[13] http://www.savethechildren.org.uk/en/docs/The_Impact_of_Fuel_Poverty_on_Children_Dec_08.pdf

damage. Butler *et al* 2003[14] report that poor social conditions (large household size, state rental housing and financial difficulty with housing costs) are significant predictors of damp, mouldy homes.

The evidence is strong that the presence of dampness and mould is linked to cough, wheeze and asthma. The WHO Europe report about quantifying the impact of housing on health looked at mould and dampness.[15] It found that the strongest evidence exists on the association of dampness with cough, wheeze and on asthma. The report found evidence on both onset of new asthma cases and increased asthma symptoms on previously sensitized individuals. It reported that the Odds Ratios vary between 1.4-2.2. For other health outcomes, the Odds Ratios vary remarkably from study to study and from symptom to symptom; approximately between 1.1-4.6. The report notes that the literature has been carefully reviewed by several working groups during the recent years and that their conclusions are very similar: the evidence of the findings on cough, wheeze and asthma is strong. The report notes that for other conditions more evidence is needed to be able to quantify risk.

As children are particularly vulnerable to respiratory conditions, such as asthma, the above indicates that mould and dampness should be considered a particular health hazard for children. An observational study reported in policy briefing for Save the Children[13] of 14,000 English children followed over a period of 5 years found that respiratory problems were more than twice as prevalent in children who lived for 3 years or more in cold homes (15%), compared with similar children living in energy efficient homes (7%). This study found that children living in homes that had damp and mildew, 16% had respiratory problems compared with 6% of similar children living in energy efficient homes.[16]

Reduced spend due to fuel efficiency and lower $CO_2$ emissions

In addition to direct health benefits from warmer housing there is the potential for indirect benefit to recipients of interventions via a reduction in fuel bills. The UK fuel poverty strategy[12] describes how measures to improve fuel efficiency will help householders by reducing their fuel bills and also contribute to government targets to reduce $CO_2$ emissions. The expectation was that improvements in insulation and heating systems would lead to reduced use of fuel. This reduced use of fuel has been modelled by the government and suggests that many interventions pay for themselves over a period of time.

[14] Butler, S., Williams, M., Tukuitonga, C. and Paterson, J. (2003) Problems with damp and cold housing among Pacific families in New Zealand, *New Zealand Medical Journal*, Vol. 116, No. 1177, URL: http://www.nzma.org.nz/journal/116-1178/527/

[15] Bonnefoy XR, Annesi-Maesano I, Aznar LM, *et al*. *Review of evidence on housing and health: background document for the Fourth Ministerial Conference on Environment and Health*, Budapest 2004. Apr. Report No.: Eur/04/5046267/BD/1. Geneva: World Health Organisation, 2004.

[16] Barnes, M. *et al*., (2008). *The dynamics of bad housing: The impacts of bad housing on the living standards of children*. London: National Centre for Social Research.

Below are assumptions made by the Energy Saving Trust about savings gained from different interventions.[17]

*Table: Costs and savings from increasing loft insulation*

| | **Increase in loft insulation thickness (0 - 270mm)** | **Increase in loft insulation thickness (50 - 270mm)** |
|---|---|---|
| Professionally Installed cost | Around £250 | Around £250 |
| DIY installed cost | £50 - £350 | £50 - £350 |
| Annual saving per year (£) | Around £145 | Around £40 |
| Installed payback | Around 2 years | Around 6 years |
| DIY payback | Up to 3 years | 1 to 9 years |
| $CO_2$ saving per year | Around 730kg | Around 210kg |

*Table: Costs and savings from installing draft proofing and filling gaps*

| | **Draught proofing** | **Filling gaps between floor and skirting board** |
|---|---|---|
| DIY installed cost | Around £100 | Around £20 |
| Annual saving per year | Around £25 | Around £20 |
| DIY payback | Around 4 years | Around 1 year |
| Annual $CO_2$ savings | Around 120 kg | Around 100 kg |

*Table: Savings for changing from an old G rated boiler to an A rated condensing boiler and a full set of heating controls*

| | Condensing boiler upgrade and heating controls upgrade |
|---|---|
| **Annual saving (£/yr)** | Up to £225 |
| **$CO_2$ saving a year** | Up to 1,100 kg |

[17] http://www.energysavingtrust.org.uk/Energy-saving-assumptions

**Warm Housing Intervention Studies**

This section looks at the studies found using a formal search of Medline, NHS Evidence and CINAHL. The most important paper found was a systematic review of intervention studies by Thomson H, Thomas S, Sellstrom E, and Petticrew M, published in 2009. This paper used comprehensive searches of the literature and includes some studies in the grey literature, for example local reports from councils which were not found by our searches. By including the Thomson *et al* 2009 systematic review in this review there is confidence that all important relevant papers published before 2008 have been considered. Our search strategy will have found all the main intervention studies published in the mainstream journals after 2008 but will not have found studies published only as recent reports. After the Thomson *et al* 2009 systematic review the next most valuable resource found was from the evaluation of the UK government's Warm Front programme, *Warm Front Better Health, health impact evaluation of the Warm Front Scheme*, Green G and Gibbertson J for the Warm Front Study Group.

The following section describes the findings of the Thomson *et al* 2009 systematic review in detail, the key findings from the Warm Front Study Group and the main findings from journal studies that were published after 2007.

Thomson H, Thomas S, Sellstrom E, and Petticrew M . The Health Impacts of Housing Improvement: A Systematic Review of Intervention Studies from 1887 to 2007

The review searched forty-two bibliographic databases for housing intervention studies from 1887 to 2007. Twenty scientific bibliographic databases were searched and additional gray and non-scientific literature was searched for in 22 specialized health and social science databases. Housing experts were contacted and relevant websites were searched. The studies were appraised independently by the authors for sources of bias and the data were tabulated and synthesized narratively, taking into account study quality.

Studies of housing improvement that involved enhancement of the physical attributes of housing infrastructure, including interventions to increase warmth, were included. Excluded were improvements to mobile homes, psychosocial or educational interventions, and interventions to remove or reduce exposure to lead, radon or allergens.

Following extensive searching, 45 studies met the inclusion criteria. These studies were grouped by intervention type as follows: improvements in warmth and energy efficiency (after 1985); re-housing or retrofitting with or without wider neighbourhood renewal (after 1995); provision of basic housing needs in developing countries (after 1990); and re-housing from slum conditions (before 1975). Of interest here are the 19 studies of improvements to warmth and energy efficiency.

The type of intervention in the 19 studies included at least one of the following: insulation (roof or cavity wall or both), installation or upgrade of

central heating system, or replacement of an un-flued with an improved flued heat source. Some programmes in individual studies included additional measures such as light bulbs, domestic repairs, and advice on receipt of appropriate state welfare benefits. Improvements in housing conditions were reported in 16 studies. Within most of the studies, there was considerable variation in the intervention delivered to different participants. This was because interventions were usually tailored to need. For example, energy efficiency interventions ranged from minor heating repairs to the installation of central heating and insulation measures. Most of the interventions were set in deprived areas. Four studies included only children, and two studies included both adults and children. Six studies targeted households where at least one member had a diagnosed cardiac or respiratory condition and in three studies the majority of the population were elderly.

The review reports that nine of the nineteen studies assessed general health impacts. It reports that in four well-conducted studies, after the housing improvement, measures of general health were better in the intervention group than in the control group; and these differences were statistically significant. For example, in two New Zealand randomized controlled trials, general health was better after the intervention; the odds ratio for poor self-reported health was 0.480, 95% confidence interval was 0.310 to 0.74021. In one UK study, 25 Short Form-36 scores (100-point scale) for general health were better by 2.570 points (95% CI=0.870, 7.592) compared with the control group. Impacts in the less rigorous studies were unclear.

Eleven studies reported respiratory impacts. Compared with the control group, there was improved respiratory health in the intervention group in the two New Zealand studies. Improvement was reported for all the respiratory measures, mainly asthma symptoms, assessed for both adults and children. These differences were statistically significant for most measures. Among the remaining European studies, a mix of positive, unclear or conflicting respiratory impacts were reported regardless of study.

Seven studies reported mental health impacts. All but one of these studies reported a positive impact; one of these studies was a well-conducted randomized controlled trial (for Short Form-36 score for low happiness, OR=0.560; 95% CI=0.409, 0.767).

Ten studies reported illness or symptom impacts. The range of outcomes reported within this category was diverse, and there was no consistent effect reported for similar outcomes between studies.

One of the authors of this systematic review (Hilary Thomson) had previously reported findings from a systematic review of world literature in 1900-2000, focusing on intervention studies which assessed health after housing improvement at a WHO conference in Bonn.[18] She concluded that:

[18] http://www.euro.who.int/__data/assets/pdf_file/0007/98674/EBD_Bonn_Report.pdf

> There is a wealth of epidemiological evidence on both biological factors and social factors linking housing and health. However, the evidence of positive health impacts after housing improvements was limited in general. Small improvements in health, particularly in mental health, were identified, but long term health impacts were unknown.

The findings from the updated 2007 report allowed a much stronger conclusion:

> There is now stronger support for the hypothesis that housing improvement can improve health in the short term than there was at the time of our 2001 review. Improvements in warmth, in particular, can lead to tangible improvements in health, but the potential for health benefits may depend on baseline housing conditions and careful targeting of the intervention.

This issue of baseline condition is important. The strongest findings of benefit come from New Zealand and the authors note that housing construction methods (insulation and central heating are rare in New Zealand and many houses are constructed from poorly insulated weatherboard) make their housing particularly vulnerable to cold.

Green G and J Gilbertson for the Warm Front study Group. *Health impact evaluation of the warm front scheme*. Sheffield Hallam University 2008[19].

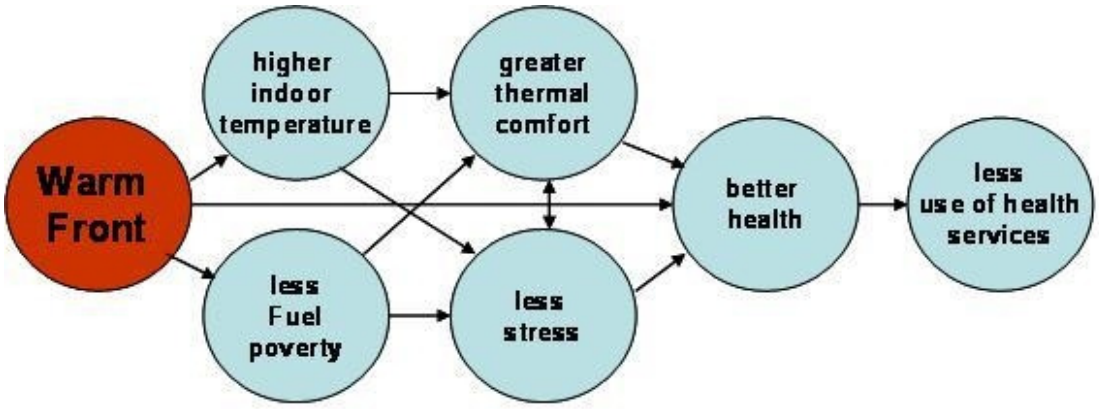
Warm Front was the Governments main tool for tackling fuel poverty in England. It was launched in 2000 and provided households with grants to improve home fuel efficiency. The Warm Front evaluation group includes academics from three universities and their evaluation explored the possible pathways to health from the initiative. The group produced a very helpful model which is shown below over the page. Central to the model is the link between thermal comfort, fuel poverty and stress. The direct impacts on better health are via increased thermal comfort and reduced stress.

*Overview of Warm Front Scheme*

The scheme offered grants to those in fuel poverty – it provided £1500 for insulation and heating improvements, and Warm Front Plus for the over 60s provides grants of up to £2500. The grants were provided to those receiving certain benefits. The grants could be used for new central heating, repairs, heating in individual rooms, replacement of boilers, cavity wall and loft insulation, insulation to boilers and draft proofing. Other measures included advice about heating, energy efficient light bulbs and timer controls. The scheme was large scale and between 2001 and 2004 assisted 900,000 homes at a cost of £600 million.

[19] *Warm Front better health. Health impact evaluation of the Warm front scheme*. Geoff Green and Jan Gilbertson. Centre for Regional, Economic and Social Research, Sheffield Hallam University 2008.

*Warm Front's Model*




**Source**: *Warm Front, Better Health. Health impact evaluation of the Warm Front Scheme*. Centre for Regional, Economic and Social Research. Sheffield Hallam University, 2008. p1.

*Research design*

The team used a range of methods to measure benefit from interventions. These included property survey, electronic data loggers, resident interviews, diaries, in-depth interviews and before and after surveys.

*Findings*

In terms of household temperature the study found significant increases in average temperatures after the interventions. The increases were from 17.9˚C to 19.6˚C for living rooms and from 15.9 ˚C to 18.3˚C for bedrooms. The authors note that these increases are modest but lifted many households over the threshold of 18 ˚C which avoids risk to health.

Fuel consumption was found to **rise** slightly after the interventions but peoples' views about ease of paying fuel bills was positively impacted. This mismatch is not yet understood but might be because of confusion in people's minds between being able to keep the house warm at a reasonable cost and the ability to pay the bill received.

Residents reported greater thermal comfort after the interventions. They reported this thermal comfort at a lower than predicted value with people reporting feeling comfortable at a temperature of 19˚C compared to the predicted estimate for comfort of 21 ˚C. The authors report a wide variation in comfort levels at different temperatures with some people reporting comfort at levels lower than recommended for health. Individual metabolism and layers of clothing account for some of the differences, but the authors also draw attention to low aspirations of warmth that could be linked to longstanding difficulties in paying for heating.

The authors note three main health benefits: a) improving mental health, b) alleviating respiratory problems in children, and c) reducing deaths in older

people. Of these it is only an improvement in mental health that was directly shown in their evaluation. Mental health showed significant improvement on the General Health Questionnaire. Compared with residents' responses before the Warm Front initiative those in receipt of heating and insulation measures were approximately 40% less likely to report psychological distress. The evaluation also found an important link between fuel poverty and mental health. Compared with households who paid fuel bills easily those reporting difficulty were four times more likely to suffer anxiety or depression.

The authors note that the evaluation, even though very large, was not able to demonstrate a reduction in deaths. They used a modelling technique and concluded that an average increase in indoor temperatures of 2.2ºC from insulation and heating improvements will reduce annual winter deaths by 0.4 per 1,000 occupants.

For children they also used a modelling approach and available literature. They estimated that for children under 14 the underlying rate of respiratory symptoms leading to health service use was about 11% giving a baseline rate of approximately 110 per 1,000 child occupants. They estimated that a fall in exposure to mould from 12% to 8% following Warm Front will reduce prevalence of symptoms by three cases per 1,000.

Finally, in terms of general health the authors found a link between stress and physical health with clear evidence of a link between fuel poverty and stress and dimensions of physical health covered by the Short Form 36 (SF36) measure. The authors suggest that, though the government's policy highlights the damage to physical health from cold homes, perhaps more damage is caused via the stress of fuel poverty.

The Warm Front evaluation also included a study using semi-structured interviews in a purposive sample of 49 households which received home energy improvements from five urban areas (Birmingham, Liverpool, Manchester, Newcastle, Southampton).[20] The study found that most householders reported improved and more controllable warmth and hot water. Many also reported perceptions of improved physical health and comfort, especially of mental health and emotional wellbeing and, in several cases, the easing of symptoms of chronic illness. There were reports of improved family relations, an expansion of the domestic space used during cold months, greater use of kitchens and improved nutrition, increased privacy, improved social interaction, and an increase in comfort and atmosphere within the home. Greater warmth and comfort also enhanced emotional security, and recipients were more content and at ease in their homes. However, there was little evidence of substantially lower heating bills. These authors state that the results provide evidence that Warm Front home energy improvements are accompanied by appreciable benefits in terms of use of living space, comfort and quality of life, and physical and mental well-being.

[20]Gilbertson J; Stevens M; Stiell B; Thorogood N; Home is where the hearth is: grant recipients' views of England's home energy efficiency scheme (Warm Front). *Social Science & Medicine*, August 2006, vol./is. 63/4(946-56)

*Economic analysis of Warm Front*

As part of the Warm Front evaluation a cost-benefit analysis was undertaken, which assumed an intervention in a couple aged 65. The evaluation found that interventions increased life expectancy by a very modest amount (see table below) but the authors note that, grossed up over many beneficiaries, the impact is thousands of life years saved.

*Costs and years of life saved (Warm Front Evaluation Group)*

| Intervention | Cost | Months of life saved per person | Average cost per life year saved |
|---|---|---|---|
| Insulation only | £280 | 0.26 | £12,905 |
| Heating only | £1130 | 0.51 | £26,629 |
| Insulation and heating | £1410 | 0.56 | £30,449 |

Recent publications of intervention studies (2008 - Sept 2010)

In this section papers published after 2007 which would not have been considered in Thomson H *et al Systematic Review of Intervention Studies from 1887 to 2007* are described. A total of four additional papers reporting the findings of intervention studies were found (references in Appendix 1).

A randomised trial of 178 patients in Aberdeen, UK with a previous hospital admission for chronic obstructive pulmonary disease (COPD) was carried out to determine if energy efficiency improves health-related quality of life (Osman LM *et al.* 2010). 118 patients were randomised and 60 agreed to monitoring only. On entry to the study the 178 homes had indoor air quality and temperature monitoring over a one week period and for one week at 12 month follow up. Respiratory and general health status was measured at baseline and follow up, and clinical data (lung function and hospital admissions) collected. Over the next 12 months, in spite of agreement to randomisation, more than half of the Intervention homes did not have the recommended energy efficiency action. The main reasons for this were concerns over the cost or disruption of energy efficiency action. Conversely, nine of the 59 Control homes had energy efficiency action carried out independent of the study. This weakened the power of the study to test for differences between the randomised arms. In the follow up evaluation, 12 months after intervention, no difference was found between the Control and Intervention groups in health or energy efficiency outcomes. Energy efficiency upgrading was carried out in 42% of homes randomised to intervention. Independent energy efficiency action was taken by 15% of control participants and 18% in the monitoring group. The main outcome measures were respiratory and general health status, home energy efficiency and hospital admissions. Intention-to-treat analysis found no difference in outcomes between the two groups.

However, in 45 patients, who had energy efficiency action independent of original randomisation, there were significant improvements in respiratory symptom scores. A secondary pragmatic analysis found that, in those who do take action, the clinically significant improvement in respiratory health was not associated with an increase in indoor warmth. The lack of significant impact in this study is not surprising given the small numbers included in the study and as only 42% of the homes randomised to the intervention group received an intervention and 15% in the control group also got an intervention. The authors note that many people with COPD are reluctant to have interventions.

Walker J *et al.* undertook a prospective controlled study of 1281 households in Scotland receiving new central heating under a publicly funded initiative, and compared them to 1084 households not receiving new heating. The main outcome measures were self-reported diagnosis of asthma, bronchitis, eczema, nasal allergy, heart disease, circulatory problems or high blood pressure; number of primary care encounters and hospital contacts in the past year; and SF-36 Health Survey scores. Usable data were obtained from 61.4% of 3849 respondents originally recruited. Heating recipients reported higher scores on the SF-36 Physical Functioning scale (difference 2.51; 95% CI 0.67 to 4.37) and General Health scale (difference 2.57; 95% CI 0.90 to 4.34). They were less likely to report having received a first diagnosis of heart disease or high blood pressure, but the groups did not differ significantly in use of primary care or hospital during the one year follow up period. The authors concluded that provision of central heating was associated with significant positive effects on general health and physical functioning; however, effect sizes were small. They suggest that the evidence of a reduced risk of first diagnosis with heart disease or high blood pressure must be interpreted with caution, due to the self-reporting and note a failure to detect any difference in health service use.

A study by El Ansari and El-Silimy in London looked at whether fuel poverty reduction schemes decrease excess winter mortality in elderly people. It compared excess winter mortality in the London Borough of Newham, which had piloted the Warm Zone government-led fuel poverty reduction scheme. They compared mortality excess winter mortality for people aged 65 or over in Newham to all London, employing data from before and throughout the duration of the Warm Zone project. They found no definitive evidence to support the effect of the Warm Zone on excess winter deaths.

A study by Barton *et al*. to assess the short term health effects of improving housing was undertaken in 119 council owned houses in south Devon. Housing was upgraded, including central heating, ventilation, rewiring, insulation and re-roofing in two phases a year apart. All residents completed an annual health questionnaire: SF36 and GHQ12 (adults). Residents reporting respiratory illness or arthritis were interviewed using condition-specific questionnaires, the former also completing peak flow and symptom diaries (children) or spirometry (adults). For those living in intervention houses, non-asthma-related chest problems (Mann-Whitney test, $p = 0.005$) and the combined asthma symptom score for adults (Mann-Whitney test, $z =$

2.7, p = 0.007) diminished significantly compared with control houses. No difference between intervention and control houses was seen for SF36 or GHQ12. The authors concluded that quantitatively measured health benefits are small, but as health benefits were measured over a period of one year, there may have been insufficient time for measurable improvements in general and disease-specific health to become apparent.

**Discussion of how the literature will inform the economic model**

The benefits that accrue to recipients of warm housing interventions come from improvement in the thermal efficiency of their house. This benefit can be taken in two different ways, or a combination of both. The first is a reduction in fuel use which benefits recipients as less of their income is spent on fuel. It also leads to a social benefit in terms of reduced $CO_2$ emissions. Government models have shown that when these benefits are taken the interventions pay for themselves over the medium term. The second is as an increase in the ambient temperature of the house. Here the benefit is taken as comfort and this leads to increased wellbeing.

The finding from the Warm Front evaluation that fuel consumption did not fall on average in recipients of interventions is of great importance. It indicates that, on average, recipients in the UK take the benefit from interventions mainly as improved comfort. Comfort taking is described as being when a householder experiences a lower saving than could actually be achieved because they opt for a more comfortable living environment.[21] For a UK economic model the above is crucial as the assumed benefits from reductions in fuel use and $CO_2$ emissions cannot reasonably be included. This means that the interventions must accrue sufficient benefits in terms of health and wellbeing to recipients for them to be considered value for money.

The reasons why recipients of Warm Front interventions did not reduce their fuel bills are not fully understood, but comfort taking in the form of an increase in overall temperature and increased usage of more space is likely to be the main explanation. Probably also of importance is the finding in the Warm Front evaluation report that when a Standard Assessment Procedure (SAP) was used, which rates properties from -10 to +120, intervention properties averaged 62 **after** the intervention and the Government benchmark is 65 for a decent home. This indicates that even post intervention many homes were not of a very high standard. This doubtless reflects the quality of the housing stock in the UK and the difficulty in raising many of these homes to levels of thermal efficiency which would make reductions in fuel consumption inevitable. The Warm Front evaluation also noted that in some cases the improvement work undertaken whilst improving thermally efficiency also created some problems by increasing drafts because of retrofitting pipes. It was also noted that sometimes the works undertaken were not done to the highest standards.

[21] http://www.energysavingtrust.org.uk/Energy-saving-assumptions

The importance of improvements to poor housing should not be underestimated even if they are insufficient to bring them up to the highest standards. For example, the systematic review by Thomson *et al*. attributed some of the larger gain in benefit found in New Zealand studies, when compared with the UK, to the use in New Zealand of poor timber based housing. This indicates that greatest gain comes from improving the very poorest housing, which is not surprising because incremental improvements to a house's thermal efficiency have a diminishing return. Consider for example the gains in thermal efficiency from loft insulation. The gain is much greater going from zero to 270mm than it is from going from 50 to 270mm with the biggest benefit coming from the first 50mm of insulation.

In relation to physical health, the available literature presents a conundrum. Although the impacts of damp cold housing conditions on physical health are known and widely described it has not been easy for researchers to demonstrate physical health benefits in intervention studies. This poses a question: why?

The answer is likely to be due to the low signal to noise ratio of the intervention. Firstly, consider the signal generated from a housing improvement in the context of all the known determinants of physical health. Whilst the warmth of a house is a determinant of health, the magnitude of benefit from heating improvements could be relatively small when compared to other factors. This means the signal could be swamped by other factors such as, for example, outbreaks of flu, very cold weather spells, neighbourhood crime, closure of local facilities, and bereavement.

Next, consider possible outcome measures for a study of a warm housing intervention. Death from cold is, for example, the most fundamental outcome. The literature suggests that approximately 3,000 deaths per year can be attributed to cold housing in the UK. The Warm Front evaluation estimated that a warm housing initiative could reduce death by 0.4 per 1,000. It also estimated that in vulnerable and elderly groups the underlying rate of cardiovascular deaths was 27 per 1,000 per year. This low event rate 0.4 per 1,000 and background noise of 27 deaths per 1,000 makes detection using a randomised trial highly problematic. First the trial has to be very large and second the results can be easily confounded.

A similar problem occurs when the outcome is a health event such as occurrence of respiratory disease or going to the family doctor. Whilst it is clear that there is a plausible mechanism of harm i.e. living in a cold house lowers resilience, the effect size will be relatively small when compared to a host of other events such as a flu outbreak which can occur non-randomly. Again a well run trial has to be very large to detect the small effect size and could easily find its results confounded by uncontrollable events.

In terms of mental health the evidence is clear cut. There is strong evidence from studies, including the large Warm Front evaluation, that having a warm home improves mental health and wellbeing. The mechanism is also highly plausible in that it can be expected that stress from worry over fuel bills could

be lowered if the house is more thermally efficient, thermal comfort is increased making people happier and more able to use more of their home in comfort. The qualitative research from the Warm Front evaluation[22] found multiple benefits that would improve mental wellbeing including improved family relations, an expansion of the domestic space used during cold months, greater use of kitchens and improved nutrition, increased privacy, improved social interaction, and an increase in comfort and atmosphere within the home.

The literature strongly supports a model of benefit that has improved mental wellbeing as the central largest gain. Physical health would be expected to increase by a small amount via two mechanisms. The first is direct from increased temperature and a lowering of mould and dampness. The second is by the mechanism of improved mental wellbeing leading to improved physical health over the long term.

[22] Gilbertson J; Stevens M; Stiell B; Thorogood N; Home is where the hearth is: grant recipients' views of England's home energy efficiency scheme (Warm Front). *Social Science & Medicine*, August 2006, vol./is. 63/4(946-56)

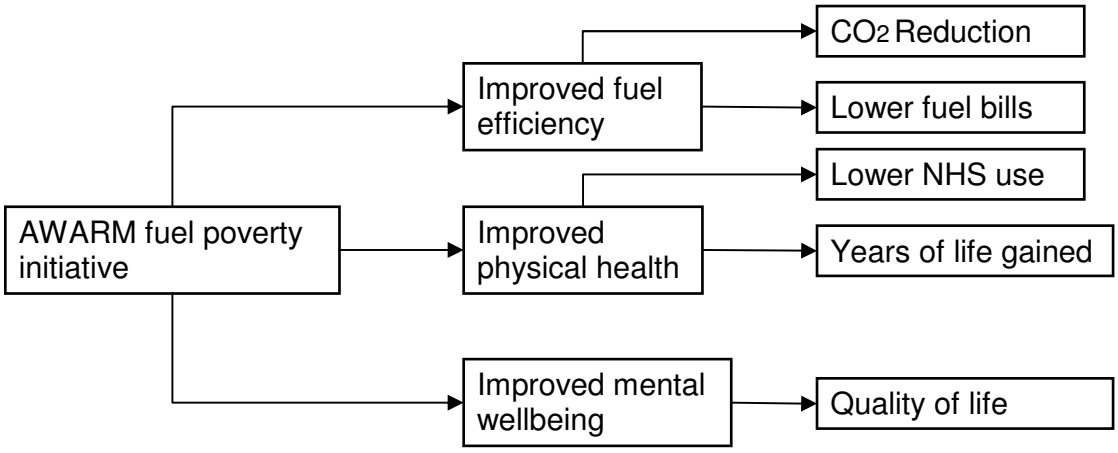
# Economic model

This section uses the understanding gained from the literature to produce a model of the benefits likely to flow from the interventions received by participants in the AWARM initiative in Greater Manchester. The data set used in the model is from 54 households and includes actual costs of the interventions. The benefits derived from the model are compared to the costs of the interventions.

## Benefits

The initial model for benefits developed for this project was as follows:

Model 1



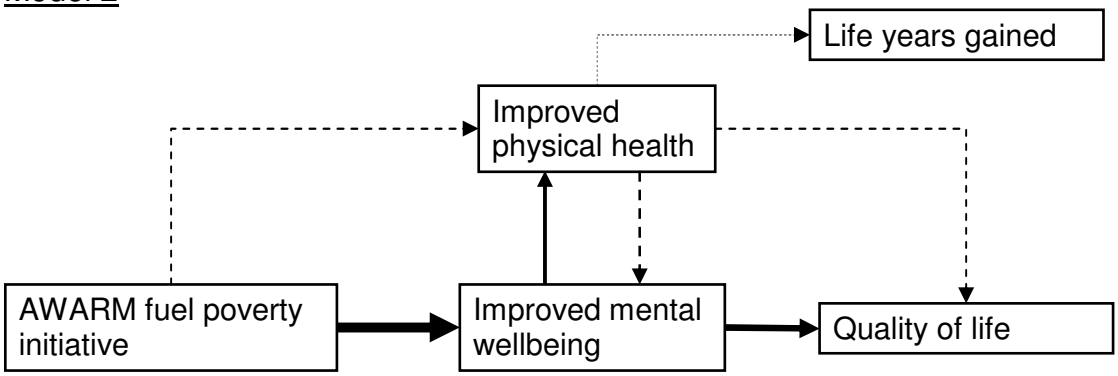

In this model the house improvements yield improved fuel efficiency which in turn reduce $CO_2$ and lower fuel bills. The expectation was that the lower fuel bills would over time be a substantial component of the benefit as they would help people directly by leaving them with more money. Improved physical health was also seen as a direct benefit via known cardiovascular and respiratory mechanism and this would lead directly to a small reduction in service use and a small increase in years of life. Finally in the model the house improvements would directly improve mental wellbeing as people would be happier in their improved house.

Whilst the above model appears to be attractive and fits with assumptions about gains from fuel efficiency it does not stand up well to the UK evidence. The literature section shows that many of the plausible benefits in the model above either do not materialise in a UK setting or are very small. The evidence indicates that the gain from improved fuel efficiency in houses that receive grant based improvements is taken in improved comfort and not in lower use of fuel. There is little evidence of direct improvements in people's circulation and respiration caused by increased household temperature and the evidence that is emerging indicates improvements are small or impact on few. The strongest evidence is that fuel poverty initiatives have a large and important impact on mental wellbeing. This evidence also indicates that the main physical health benefits from fuel poverty initiatives come from an

indirect route via the complex interrelationship between mental wellbeing and physical health.

The model developed after consideration and reflection on the literature is model 2 which is the preferred model and is described below.

Model 2




In this model the benefits from fuel efficiency are taken as comfort and the model ignores any potential savings from lower use of fuel. The fuel poverty initiatives yield a small direct impact on physical health and a larger indirect impact which together bring about a very modest gain in life years. However, the initiatives yield a large direct improvement on mental wellbeing which increases quality of life.

The model ignores some known benefits such as the potential improvements in respiratory illnesses in children because the magnitude of this benefit is uncertain. It also does not consider differences in benefit that might accrue to people with different health conditions.

## Costs

To estimate the cost of providing AWARM interventions real world data was used. Amanda Tudor, Marketing Manager Energy Saving Trust Advice Centre Greater Manchester, was contacted and asked to provide a representative sample of data. Amanda was asked to provide data from a random sample of at least 50 houses which were selected from all households eligible for AWARM interventions between November 2009 and October 2010.

The dataset provided included demographic data and details of the interventions received. Personal data such as names were removed. The dataset included number of people in household, their ages, their area of residence and if they had received any of the following interventions: cavity wall insulation; loft insulation; draft proofing; boiler repaired; boiler replaced or full central heating system. The dataset included 54 households.

A second data set provided the average costs of each type of intervention. An estimate of total cost was calculated by applying the average cost of each type of intervention to the number of interventions received. The cost data

used for each intervention was based upon the value of the grant that a household received to provide the intervention. The grant value received by a household will differ from the exact cost of providing the intervention but such differences would be expected to be small.

**Cost of AWARM interventions**

The following costs of interventions derived from Energy Saving Trust Advice Centre Greater Manchester are used.

*Table: Costs of AWARM interventions*

| **Intervention** | **Cost (£)** |
|---|---|
| *Cavity wall insulation* | |
| 2 bed terraced | 370 |
| 3 bed semi | 400 |
| 4 bed detached | 600 |
| *Loft insulation* | |
| 2 bed terraced | 220 |
| 3 bed semi | 280 |
| 4 bed detached | 350 |
| *Heating improvements* | |
| Central heating installation | 3500 |
| Boiler repair | 2000 |
| Boiler replacement | 2500 |
| Installing additional heating controls (e.g. thermostat, radiator valves) | 200 |
| *Other* | |
| Draught-proofing | 200 |
| Hot water tank jacket | 15 |

*Table: Description of interventions received by households*

| **Type of intervention** | **Number of households** |
|---|---|
| Cavity wall insulation | 24 |
| Loft insulation | 20 |
| Draught-proofing | 3 |
| Boiler repair | 1 |
| Boiler replacement | 11 |
| Full central heating | 11 |

Twelve households got more than one intervention. Eight got both loft and cavity wall insulation. One got loft and cavity wall insulation, draught proofing and a central heating system, one loft and cavity wall insulation and a central heating system, one boiler repair and loft and cavity wall insulation, and one got a full central heating system and loft insulation.

## Description of households

The majority, 44 (81%), of households were one or two person households. Nearly all one person households were over 60 years in age. In total, in the 54 households there were 98 people, 12 children under 16 years, 35 adults between 16 and 60, and 51 adults aged above 60.

*Table: Size of households included in analysis*

| | Number of households | Number with a child under 16 | Number with a person over 60 |
|---|---|---|---|
| 1 person household | 24 | 0 | 23 |
| 2 person household | 20 | 3 | 14 |
| 3 person household | 8 | 3 | 1 |
| 4 person household | 1 | 1 | 0 |
| 5 person household | 0 | 0 | 0 |
| 6 person household | 1 | 1 | 0 |
| Totals | 54 | 8 | 37 |

To allow a calculation of benefits based on the intensity of the intervention the people receiving interventions are grouped together as follows: those receiving insulation based interventions; those receiving heating alone; those receiving insulation and heating. Heating interventions included boiler repair, boiler replacement and full central heating. Two families received draught-proofing alone and these are removed from further analysis because the cost and benefit expected are low.

*Table: Number and composition of households by intervention type*

| Type of intervention | households | Number of adults | Number of children |
|---|---|---|---|
| Insulation alone | 29 | 46 | 8 |
| Heating improvements alone | 19 | 29 | 4 |
| Insulation and heating improvements | 4 | 7 | 0 |

## The total cost of interventions to 52 households

Here an estimate is made of the total cost of all the interventions received. An assumption is made with regards to loft and cavity wall insulation that every household was a three-bed semi. The AWARM team provided a figure for processing and administration of a case of £18.21. However the value of the engagement work and 'handholding' used in the AWARM process across Greater Manchester should not be underestimated or undervalued and is not included in the administration cost. It is very important to ensure that vulnerable groups have access to interventions. Indeed, according to AWARM the hardest part is reaching and engaging with the vulnerable groups and

individuals and persuading/coaxing and sometimes convincing them to accept help. This mirrors research in COPD patients in which over half of the people that actually agreed to take part in a trial subsequently refused the full intervention.[23] AWARM also note that the signposting and referral mechanisms behind the scheme help to reduce the level of stress on customers as does the holistic service which means that organising and ensuring the completion of the home improvement tasks required is taken care of for them. Further they note the importance of training and utilisation of frontline staff in identifying those that may need help. The entirety of this service has a cost and a fixed cost of £100 per household is added to cover the cost of the AWARM scheme.

*Table: total cost of AWARM interventions received by 52 households*

| **Type of intervention provided** | **Total cost (£)** |
|---|---|
| Cavity wall insulation | 9600 |
| Loft insulation | 5600 |
| Draught-proofing | 200 |
| Boiler repair | 2000 |
| Boiler replacement | 27500 |
| Full central heating | 38500 |
| AWARM support cost | 5400 |
| Total | 88800 |

The costs of providing the AWARM interventions to 52 households in Greater Manchester are estimated to be £88,800.

## Cost benefit analysis

In the following sections the costs of the interventions are compared with the benefits. The main analysis uses the NHS threshold value of a QALY to calculate the amount of benefit needed for the intervention to be considered cost effective.

### Cost benefit analysis using the NHS threshold for a QALY

The NHS values a QALY at between £20,000 and £30,000 as this is the threshold for cost effectiveness that NICE uses. Using the lower threshold an intervention that costs £100,000 can be considered cost effective if it generates 5 QALYs. An intervention that cost £88,800 must generate 4.44 QALYs to be considered cost effective.

[23] http://www.theclaymoreproject.com/uploads/associate/365/file/Health%20Documents/energy_efficiency_improvement_report.pdf

Using our preferred model, benefits accruing to children are ignored. Of interest is whether the benefits accruing to the 82 adults are likely to be greater than the threshold of 4.44 QALYs.

Estimating additional life years gained

From the economic analysis of Warm Front we can derive an estimate for the life years gained by the interventions. The Warm Front evaluation produced estimates of life gain which were 0.26 months for insulation only, 0.51 months for heating only and 0.56 months for heating and insulation.[24]

In our population, 46 adults had insulation only, 29 adults had heating improvements alone, and 7 adults had both heating and insulation. We estimate their benefit in terms of life years gained as:

46 x 0.26 months = 11.96 months
29 x 0.51 months = 14.79 months
7 x 0.56 months = 3.92 months

Total = 30.67 months or 2.55 years

So in terms of **extending life alone** the intervention has not reached the threshold of 4.44 QALYs.

Estimating improvements in quality of life

However, in our preferred model of benefit from warm housing initiatives most benefit accrues because mental health states are improved, not because years of life are extended. The model indicates that the important benefit is from improving quality of life through making people less stressed and anxious rather than length of life.

The most robust evidence from the UK about improvement in mental wellbeing comes from the Warm Front evaluation. In this evaluation depression and anxiety is estimated to fall by 48% and the baseline prevalence is assumed to be 300 per 1,000 people eligible for fuel poverty initiatives. Therefore, in 82 people living in cold housing (pre-intervention) the expected number suffering depression and anxiety is 24.6 and, using the warm front estimate, the expected number suffering depression and anxiety in warmer housing (post-intervention) is approximately 13, a fall of approximately 11.

Now this assumed benefit, a reduction of 11 people with anxiety or depression needs to be converted into a QALY gain over the lifetime of the intervention. The EuroQol descriptive system allows the comparison of different health states. (The standard form used can be found in Appendix 2.) It is based on a standard health questionnaire which has five dimensions. Each dimension is

[24] *Warm Front better health. Health impact evaluation of the Warm front scheme*. Geoff Green and Jan Gilbertson. Centre for Regional, Economic and Social Research, Sheffield Hallam University 2008.

scored from one to three; a score of one indicates little or no problem and a score of three indicates a major problem. The dimensions are: mobility; self-care; usual activity; pain and discomfort; and anxiety and depression. Values have been calculated for the UK population where 1.00 is no health problems, which is a score of 11111 across the five dimensions. A person scoring 11112 has some anxiety and depression and scores 0.848; a person scoring 11113 has a more severe problem and scores 0.414.

If we assume that the 11 people that would be more anxious and depressed without a housing intervention have a change of state equivalent to going from 2 to 1 as measured by the anxiety and depression dimension of the EuroQol measure, then we can produce an estimate for the QALY gain.

The gain per year is 11 – (11 x 0.848) = 1.67

Assuming the housing intervention has an impact for 15 years. The total gain from a reduction in anxiety and depression in these 11 people would be 25.08. However whilst the interventions work in improving thermal efficiency of the house over a long period, their impact on quality of life may not persist over the lifetime of the intervention.

The table below models different scenarios for possible well being benefits in the 82 people. Three scenarios are considered over two different time periods, one and five years. The first and second scenario assumes 11 people have an improvement in anxiety and depression but the magnitude of improvement differs. In the first scenario it improves from state 3 to state 2 and in the second from state 2 to state 1. The third scenario assumes that half of all adult participants get a wellbeing benefit. Their wellbeing is improved so that when measured with the standard EuroQol descriptive system their scores for anxiety and depression go from state 2 to state 1.

*Table: The QALY gain from changes in wellbeing as measured by EuroQol*

| Scenario | Number of people gaining benefit | Change EuroQol anxiety and depression state | Length time in years intervention has an impact | QALY gain |
|---|---|---|---|---|
| One | 11 | 3 to 2 | 1 | 4.77 |
| Two | 11 | 2 to 1 | 1 | 1.67 |
| Three | 41 | 2 to 1 | 1 | 6.23 |
| Four | 11 | 3 to 2 | 5 | 23.85 |
| Five | 11 | 2 to 1 | 5 | 8.35 |
| Six | 41 | 2 to 1 | 5 | 31.16 |

Only one scenario (scenario two) in the table yields a total number of QALYs that is below the threshold of 4.44 QALY. In all other scenarios the intervention is cost effective.

Adding the life years gained and improvement in quality

The preferred model for benefit assumes that there are two main gains: improvement in quality in life and a smaller improvement in length of life. The extra life years gained in the 82 adults is estimated to be 2.55 years. It is not possible to directly convert the 2.55 years of extra life into QALYs as we have no way of estimating the quality of those additional life years. The gain in QALYs due to an improvement in mental wellbeing is estimated to range from a minimum 1.67 to a maximum of 31.16 in the scenarios modelled.

To be considered cost effective the threshold to reach is 4.44 QALY. It is only in one scenario where this threshold is not reached. That is when the improvement in quality of life is confined only to those that were likely to already have measurable anxiety and depression, their improvement as measured by EuroQol is assumed to be small and this improvement persists for one year only. In this situation the gain in QALY is 1.67 and the gain in additional life years is 2.55.

To add the additional life years gained to the QALY estimates an assumption is needed to convert the 2.55 additional years into their QALY equivalent. Here it is assumed that the 2.55 years are equal to 1.53 QALY, a reduction of 40% because the years gained are towards the end of life.

In the table below the assumed total QALY gained in each scenario is converted into a monetary value using the NHS threshold of £20,000.

*Table: Converting QALYs gained into a monetary amount*

| Scenario | QALYs due to wellbeing improvement | QALYs from increase in length of life | Total QALYs | Value of total QALYs (£) |
|---|---|---|---|---|
| One | 4.77 | 1.53 | 6.3 | 126,000 |
| Two | 1.67 | 1.53 | 3.2 | 64,000 |
| Three | 6.23 | 1.53 | 7.76 | 155,200 |
| Four | 23.85 | 1.53 | 25.38 | 507,600 |
| Five | 8.35 | 1.53 | 9.88 | 197,600 |
| Six | 31.16 | 1.53 | 32.69 | 653,800 |

The intervention cost £88,800 and, in the scenarios modelled, the value of the benefits gained ranged from a minimum of £64,000 to £653,800.

Estimating the value of benefit needed to be considered a good value buy

This second analysis attempts to quantify the threshold value that must be placed on the benefit accrued by a participant of a warm housing intervention for the intervention to be good value for money. It looks at the total cost of the intervention and then uses the cost to derive a value for the benefit that must be exceeded for the intervention to be considered good value for money.

The cost of the interventions considered is again £88,800. This cost has to be paid at the start to install the interventions but the benefits gained will persist over the years to come. The intervention can be considered good value for money if the benefits gained from the intervention exceed the total cost of £88,800 in a reasonable time frame.

The population receiving interventions is 82 adults and 12 children. Each of these 94 occupants will gain some benefit from the intervention. If it is assumed that this benefit accrues only in the 200 coldest days of the year because heating is not needed in the remaining days an estimate can be derived for the daily benefit needed to accrue to pay back the cost of the intervention over different time periods.

Over a one year period
Person days of benefit = 200 x 94= 18800
Cost = £88,800

Cost per day =£4.72

Over a 5-year period
Person days of benefit =1000 x 94= 94,000
Cost = £88,800

Cost per day =£0.94

Over a 10-year period
Person days of benefit =2000 x 94=188,000
Cost = £88,800

Cost per day =£0.47

As previously shown, the bulk of the benefit from warm housing interventions accrues to adults because of an improvement in wellbeing brought about by reductions in stress. For children the benefit is mainly from being able to use more of a house, a small reduction in respiratory illness and doubtless a small increase in general wellbeing brought about by a higher ambient temperature. How much value should be placed on these benefits is unknown, as is the payback time over which benefit should accrue. If, to be considered value for money, the total benefits need to exceed the costs of the intervention over five years then the benefit of living in a more comfortable warmer home needs to be valued at 94 pence a day. If a ten year time frame is applied then the benefit of living in a more comfortable warmer home needs to be valued at 47 pence a day.

# Discussion and implications for decision makers

An important benefit from warm housing interventions in the UK is improvement in mental wellbeing. This benefit can manifest itself in a reduction in anxiety and depression, and in a reduction in stress levels. These benefits improve the quality of life of the recipients of interventions and this improvement in quality of life is by itself likely to be sufficient to make the interventions cost effective at the NHS valuation for a QALY.

This report used cost data from actual interventions provided to 54 households in Greater Manchester as part of the AWARM initiative. It found that, when assumptions based upon the Warm Front evaluation were used to estimate the wellbeing benefit of warm housing interventions, in all scenarios except one the interventions were cost effective. It is only if benefit is assumed to be small as measured by the EuroQol tool, short term and confined to approximately half of the group of people assumed to already have measurable anxiety and depression that the benefit is insufficient to reach the threshold. If benefit is assumed to be larger in this subset of people, which would fit with the findings of the Warm Front evaluation which found a large reduction in anxiety and depression, [25] then the interventions provided by the AWARM scheme are cost effective.

The evidence in the literature section indicates that most recipients of warm housing interventions gain benefit in terms of their own perception of wellbeing and comfort. In the scenario in which half of the population gain a benefit in terms of a measurable reduction in anxiety and depression on the EuroQol tool the benefits far outweigh the costs, especially if the benefit persists after one year.

This report considers interventions provided by AWARM which purposefully attempts to identify people most in need of interventions. This identification and support of the most needy is important as recipients of targeted schemes may get more benefit from the interventions than those observed in the earlier Warm Front intervention. This potential for amplified benefit due to effective targeting increases the likelihood further that the warm housing interventions delivered to AWARM recipients are cost effective. In addition the model only includes benefits in adults and ignores benefits gained by children. This means for any families with children the benefits considered are being underestimated.

In contrast to our model in which benefit from warm housing interventions are taken as comfort, models developed by, for example, the Energy Saving Trust, focus on the benefits gained from using less energy. These models show that warm housing interventions such as insulation and heating efficiency improvements are a good buy in the long term as the fuel saving eventually pays for the intervention. The energy saving models use

[25] *Warm Front better health. Health impact evaluation of the Warm front scheme*. Geoff Green and Jan Gilbertson. Centre for Regional, Economic and Social Research, Sheffield Hallam University 2008

assumptions about fuel use which do not fit the findings of the Warm Front evaluation. In the real world it seems that, on average, recipients of warm housing interventions take the benefit as an increase in household temperature rather than a reduction in total fuel used. When this happens the benefits from reduced fuel use disappear and are replaced with wellbeing benefits. This suggests that these warm housing interventions are less of a 'win-win' situation and more of a 'cannot lose' situation. In that you either get sufficient benefit for the cost of the intervention via fuel use reduction or if the household takes the benefit as comfort you get sufficient benefit from the gains in health.

There are known biological mechanisms as to why fuel poverty interventions should improve physical health, and no doubt that living in cold housing is bad for health and makes the lives of people more miserable. However, those living in colder housing conditions adopt coping strategies[26] and trying to measure changes in physical health and attributing them to a single housing intervention is bedevilled with difficulty. For example, if the outcome is mortality the event rate is low and is influenced by outside factors such as influenza outbreak, and falls in outside temperature. Similar measurement difficulties occur in demonstrating falls in NHS service use. Some studies have had expectations about the magnitude of benefit on physical health from warm housing interventions that appear somewhat naïve, for example expecting to be able to measure, in a small population, the impact on winter deaths.[27] Whilst there have been considerable difficulties in demonstrating physical health benefits, the conclusion from the most recent systematic review is that the evidence is much stronger now than in the past.

The economic modelling and threshold analysis used in this report is not meant to be a substitute for a full cost effectiveness analysis. It is meant to be a pragmatic investigation of the most likely benefits to accrue from warm housing interventions. It aims to assist decision making by identifying the types and magnitude of benefit needed for the interventions to be considered cost effective and a good buy for the money. The models are uncomplicated and transparent so that a general reader can understand the assumptions and limitations. The lack of sophistication means they are unsuited to use in specific populations, for example those with cancer who might gain more benefit from being able to keep warm. There are also technical limitations because the models do not use discounting. This lack of discounting would be important if it was expected that the cost of the interventions would be significantly lower in the future or if the benefits mainly occurred in the distant future. The cost of installing heating and insulation is not expected to dramatically fall in the future and there is much uncertainty about the timing of health and wellbeing benefits that follow from the warm housing interventions. It has, for example, been argued that the wellbeing benefits accrue first, and

[26] Harrington BE; Heyman B; Merleau-Ponty N; Stockton H; Ritchie N; Heyman A Keeping warm and staying well: findings from the qualitative arm of the Warm Homes Project. *Health & Social Care in the Community*, May 2005, vol./is. 13/3(259-67)

[27] El Ansari W; El-Silimy S Are fuel poverty reduction schemes associated with decreased excess winter mortality in elders? A case study from London, U.K. *Chronic Illness*, December 2008, vol./is. 4/4(289-94).

physical health benefits then follow.[28] Given this uncertainty the simplification that benefits accrue during cold periods and evenly over the first few years of the intervention is readily justified. However the reader should recognise that if discounting of future benefits was used the value of a benefit accruing in five years time would be considered to be less than the value of a benefit occurring in one year.

In the analysis it was found that if the whole benefit to recipients (from improvements in their physical and mental wellbeing) is valued at about 50p for each cold day then the benefits would exceed costs of the interventions after about ten years. If a higher value of £1 is thought to be more reasonable then benefits exceed costs within five years. The value that should be placed on helping to keep a vulnerable member of the population or a child warm in their home are not known, but an amount of £1 for each cold day does not seem excessive or unreasonable when placed into the context of expenditure on fuel to keep warm, or health interventions. Indeed in terms of opportunity cost it is hard to think of alternative interventions that might have a substantial impact on mental wellbeing at a lower cost.

The provision of free insulation and heating improvements to help people keep warm in their houses falls into the group of public health interventions for which there is certainty about the direction of benefit. It is known that the intervention will produce a positive benefit rather than harm. The benefit is from fuel saving for recipients or increased comfort or a combination of both. As discussed, the magnitude and exact timing of these benefits is uncertain. In these types of situation when the likelihood of harm can be ignored and direction of benefit is known, further evaluation need only look at the magnitude and timing of benefits to more precisely find out if the intervention is worth the cost.[29] Future evaluations should therefore investigate how benefits accrue and how they might be maximised to improve the cost effectiveness of the intervention. Of importance to the current climate concerns investigating how interventions can decrease fuel use and maintain sufficient warmth for wellbeing.

The priority to place on warm housing interventions depends not only on the size and type of benefits accruing but also on their recipient. The interventions considered here are targeted towards people living in fuel poverty. As such the benefits gained contribute to the agenda of reducing inequality which is supported by the coalition government.[30] Given that the interventions help to maintain employment, the benefits can be shown to repay the investment and the benefits if targeted accrue in the needy these interventions remain a sensible investment.

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[28] *Warm Front better health. Health impact evaluation of the Warm front scheme*. Geoff Green and Jan Gilbertson. Centre for Regional, Economic and Social Research, Sheffield Hallam University 2008.

[29] A Fischer, AG Threlfall, S Meah, MP Kelly. The economics of public health appraisal. (in preparation)

[30] *Healthy lives, healthy people White Paper: Our strategy for public health in England*. 30 November 2010

This report concludes that warm housing interventions in targeted populations are almost certainly cost effective and that they can be considered a good use of public resources. The benefits gained in the UK are likely to be mainly from comfort taking and a consequent improvement in mental wellbeing.

## Appendix 1

References from search for intervention studies


Armstrong D; Winder R; Wallis R. Impediments to policy implementation: the offer of free installation of central heating to an elderly community has limited uptake. *Public Health*, February 2006, vol./is. 120/2(161-6)

Barton A; Basham M; Foy C; Buckingham K; Somerville M. The Watcombe Housing Study: the short term effect of improving housing conditions on the health of residents. *Journal of Epidemiology & Community Health*, September 2007, vol./is. 61/9(771-7)

El Ansari W; El-Silimy S. Are fuel poverty reduction schemes associated with decreased excess winter mortality in elders? A case study from London, U.K. *Chronic Illness*, December 2008, vol./is. 4/4(289-94)

Gilbertson J; Stevens M; Stiell B; Thorogood N. Home is where the hearth is: grant recipients' views of England's home energy efficiency scheme (Warm Front). *Social Science & Medicine*, August 2006, vol./is. 63/4(946-56)

Harrington BE; Heyman B; Merleau-Ponty N; Stockton H; Ritchie N; Heyman A. Keeping warm and staying well: findings from the qualitative arm of the Warm Homes Project. *Health & Social Care in the Community*, May 2005, vol./is. 13/3(259-67)

Howden-Chapman P, Matheson A, Crane J, Viggers H, Cunningham M, Blakely T, s Cunningham C et al. Effect of insulating existing houses on health inequality: cluster randomised study in the community. *BMJ* 2007; 334 : 460

Howden-Chapman P, Pierse N, Nicholls S, et al. Effects of improved home heating on asthma in community dwelling children: randomised controlled trial. *BMJ*.2008;337:a1411.

Osman LM; Ayres JG; Garden C; Reglitz K; Lyon J; Douglas JG. A randomised trial of home energy efficiency improvement in the homes of elderly COPD patients. *European Respiratory Journal*, February 2010, vol./is. 35/2(303-9),

Osman LM; Ayres JG; Garden C; Reglitz K; Lyon J; Douglas JG. Home warmth and health status of COPD patients. *European Journal of Public Health*, August 2008, vol./is. 18/4(399-405)

Richardson G; Barton A; Basham M; Foy C; Eick SA; Somerville M. The Watcombe housing study: the short-term effect of improving housing conditions on the indoor environment. *Science of the Total Environment*, May 2006, vol./is. 361/1-3(73-80)

Rugsa J; Shortt NK; Boydell L. The right tool for the task: 'boundary spanners' in a partnership approach to tackle fuel poverty in rural Northern Ireland. *Health & Social Care in the Community*, May 2007, vol./is. 15/3(221-30)

Shortt N; Rugsa J. 'The walls were so damp and cold' fuel poverty and ill health in Northern Ireland: results from a housing intervention. *Health & Place*, March 2007, vol./is. 13/1(99-110)

Somerville M; Mackenzie I; Owen P; Miles D. Housing and health: does installing heating in their homes improve the health of children with asthma? *Public Health*, November 2000, vol./is. 114/6(434-9)

Stewart J; Habgood V. Benefits of a health impact assessment in relation to fuel poverty: assessing Luton's Affordable Warmth Strategy and the need for a national mandatory strategy. *Journal of the Royal Society for the Promotion of Health*, May 2008, vol./is. 128/3(123-9)

Thomson H, Petticrew M,Morrison D. Health effects of housing improvement: systematic review of intervention studies. *BMJ*. 2001;323(7306):187–190.

Thomson H; Thomas S; Sellstrom E; Petticrew M. The health impacts of housing improvement: a systematic review of intervention studies from 1887 to 2007. *American Journal of Public Health*, November 2009, vol./is. 99 Supp3

Thomson H; Morrison D; Petticrew M. The health impacts of housing-led regeneration: a prospective controlled study. *Journal of Epidemiology & Community Health*, March 2007, vol./is. 61/3(211-4)

Walker J; Mitchell R; Petticrew M; Platt S. The effects on health of a publicly funded domestic heating programme: a prospective controlled study. *Journal of Epidemiology & Community Health*, January 2009, vol./is. 63/1(12-7)

Walker JJ; Mitchell R; Platt SD; Petticrew MP; Hopton J. Does usage of domestic heating influence internal environmental conditions and health? *European Journal of Public Health*, October 2006, vol./is. 16/5(463-9)

*Warm Front Study Group. Health impact evaluation of England's home energy efficiency scheme (Warm Front). Headline results*. Report to Energy Saving Trust/Defra. March 2006.

**Appendix 2**

By placing a tick in one box in each group below, please indicate which statements best describe your own health state today.

**Mobility**

I have no problems in walking about ❑

I have some problems in walking about ❑

I am confined to bed ❑

**Self-Care**

I have no problems with self-care ❑

I have some problems washing or dressing myself ❑

I am unable to wash or dress myself ❑

**Usual Activities** (*e.g. work, study, housework, family or leisure activities)*

I have no problems with performing my usual activities ❑

I have some problems with performing my usual activities ❑

I am unable to perform my usual activities ❑

**Pain/Discomfort**

I have no pain or discomfort ❑

I have moderate pain or discomfort ❑

I have extreme pain or discomfort ❑

**Anxiety/Depression**

I am not anxious or depressed ❑

I am moderately anxious or depressed ❑

I am extremely anxious or depressed ❑