Warm Front
Better Health

Health Impact Evaluation of the Warm Front Scheme

Geoff Green and Jan Gilbertson for the Warm Front Study Group

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Foreword

Far too many people are affected by the scourge of fuel poverty. It derives from the combination of the poor thermal efficiency of buildings, low household incomes and high energy prices. Over the past decade in particular, UK governments have committed themselves to tackling this problem. Significant public expenditure has been targeted to address fuel poverty, particularly via the Warm Front scheme, complemented by the activities of energy suppliers through the Energy Efficiency Commitment. But recent increases in energy prices have slowed progress and even reversed earlier reductions amongst those occupying expensive-to-heat homes.

It is perhaps judged self-evident that a cold, damp home is most likely to have a deleterious impact on the health of its occupants. Indeed, there is a growing body of research on specific health dimensions, such as cold-related excess deaths in winter, asthma, cardiovascular disease, or the psycho-social benefits of a warm and comfortable home. But little of this earlier work has adopted a systematic approach, or sought to identify and analyse all direct and indirect health impacts.

Funded by the Government Department for Environment, Food and Rural Affairs (Defra) and the Welsh Assembly Government, a major study of the health impacts of the Government's flagship Warm Front programme was undertaken between 2001 and 2006. Led by Professor Geoff Green of Sheffield Hallam University, this research involved an experienced and multi-disciplinary team based at the London School of Hygiene and Tropical Medicine, the National Centre for Social Research, Sheffield Hallam University and University College London. Project finance and management was undertaken by the Energy Saving Trust; and the study was overseen by a Steering Group comprising representatives of several central and devolved government departments, leading medical academics and charities, and the Warm Front scheme manager – Eaga.

Much of the detailed research arising from this project has been published recently in peer-reviewed academic journals. But this final Overview Report summarises the key findings of a large and very ambitious research programme. It is, we all believe, essential reading for those engaged in tackling fuel poverty and in reducing its health impacts.

Finally, I express sincere thanks to all of the researchers engaged in this vital project for their dedicated enthusiasm and sheer hard work; to those who assisted the research through their active engagement in the study; to the Energy Saving Trust for their project management; and to the members of the Steering Group for their invaluable research and policy insights.

Professor John Chesshire OBE
Chair of the Evaluation Steering Group
Chairman of the Energy Efficiency Partnership for Homes
Deputy Chairman of the Fuel Poverty Advisory Group

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Acknowledgements

I should like to add my thanks to all members of the Steering Group chaired so creatively by John Chesshire. His support and encouragement steered us through this 'large and very ambitious research programme.' Special thanks to Dr. Noel Olsen who was one of the prime instigators of the project, to Pam Wynne, Head of Fuel Poverty Team and Sustainable Energy Policy for Defra, for her steadfast support throughout, and to Zoltan Zavody, Elaine Waterson and Brooke Flanagan from the Energy Saving Trust who successively managed and monitored the contract so positively.

The study, the scientific papers and this summary are a collective effort. The research team listed below harnessed the building science of University College London led by Tadj Oreszczyn, the environmental epidemiology of the London School of Hygiene and Tropical Medicine led by Paul Wilkinson and our own social science at Sheffield Hallam University. There were great synergies in this multi-disciplinary team and working together was I think a rewarding experience for us all.

The logistics of the project were demanding, with tight timelines and a very small window for surveys of people and property before they received *Warm Front* measures. Many thanks to Tony Burton and Martin France from Eaga, the managing agents for *Warm Front* who supplied addresses and works schedules; to Richard Boreham from the National Centre for Social Research who managed the surveys of *Warm Front* recipients; to Roger Critchley from First Report who organised the property schedules and Glyn Johnson from Managed Services and Consultancy who undertook the property surveys and to Bill Wilkinson from EAC Integrated Services who produced energy efficiency ratings. Thanks above all to my friend and colleague Jan Gilbertson who contributed greatly to the scientific papers and to managing the whole process.

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May 2008

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Executive summary

1 Introduction
Joined-up thinking encouraged the UK Government to commission this Health Impact Evaluation of the Warm Front Scheme.

2 Scientific context
By providing robust scientific evidence, universities can assist the policy community in making cost-effective investment decisions.

3 Conundrums
Though politicians like cross-cutting programmes which deliver 'win-wins' across different policy domains, the science is nuanced. Our study illuminates a number of conundrums.

4 *Warm Front Scheme*
The Warm Front Scheme *is the main instrument of the UK Government's Fuel Poverty Strategy and has the potential to deliver significant health gains.*

5 Research design
Scientists from three universities and many disciplines developed an innovative and ethical method of evaluating the health impact of Warm Front.

6 Targeting
Though a government objective is to target Warm Front *to householders in fuel poverty, in practice such selectivity is difficult to achieve without intrusive checks on status.*

7 Application process
Warm Front *recipients are generally positive about the application process, probably because they exercised choice by signing up.*

8 The works
Generally recipients are also positive about the work of installing Warm Front *measures, quickly recovering from the disruption.*

9 Temperature
Installation of Warm Front *measures – insulation and better heating systems – had exactly the intended effect. Energy efficiency improved and indoor temperatures increased. The coldest properties benefited most. However a significant minority of properties are still below the 18˚C threshold, posing a health risk.*

10 Humidity
Though insulation can reduce ventilation and increase humidity, there is no evidence of Warm Front *having this effect. On the contrary, higher indoor temperatures produced lower humidity and less dampness.*

11 Fuel
Our evidence on fuel consumption is contradictory. Though fewer residents reported difficulty paying fuel bills after Warm Front, *their overall fuel consumption increased. This unresolved conundrum bears on the climate change and fuel poverty agendas.*

12 Comfort
Residents reported greater thermal comfort after Warm Front, *feeling most comfortable at only 19.1˚C. Nearly 2˚C below the Government's recommended threshold, this average comfort vote has a positive bearing on fuel consumption and climate change targets.*

13 Stress
By focusing on physical health outcomes, the Fuel Poverty Strategy neglects the major psychosocial benefits of Warm Front, *including the alleviation of stress.*

14 Mental health
Relief from financial pressures is associated with a reduction in anxiety and depression. Reducing fuel poverty is a major route to improving mental health.

15 Body and soul
Resident satisfaction with living conditions is linked to better general health. Better mental health may over time lead to better physical health.

16 Physical health
Though we have no direct evidence of Warm Front *having an impact on physiological health, there is evidence of an indirect pathway via the alleviation of fuel poverty and stress.*

17 Death
Cold indoor temperatures are significantly linked to excess winter deaths in England and Wales, primarily because of heart failure.

18 Health impacts
Overall we assess the Warm Front Scheme *as having a positive impact on (a) improving mental health (b) alleviating respiratory problems in children and (c) reducing deaths of older people. The investment is cost-effective in extending years of life.*

19 Conclusion
Our study broadly confirms 'wins' in the two policy domains of health and fuel poverty, plus a possible 'win' slowing climate change.

Independent Health Impact Evaluation of *Warm Front*

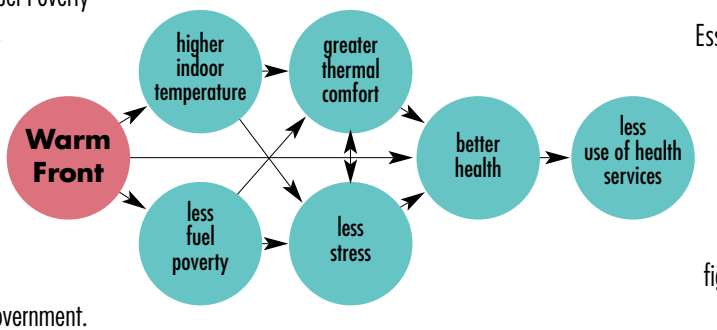
Main message: ***Joined-up thinking encouraged the UK Government to commission this Health Impact Evaluation of the* Warm Front Scheme.**

'The first priority is therefore to ensure that by 2010 no older householder, no family with children, and no householder who is disabled or has long-term illness need risk ill-health due to a cold home.' The UK Fuel Poverty Strategy, Department of Trade & Industry. 2001, page 10.

This Health Impact Evaluation of the *Warm Front Scheme* is a world leading research project which reflects 'joined up thinking' by the UK Government. Commissioned by the Energy Saving Trust on behalf of the Department for Environment, Food and Rural Affairs – responsible for energy efficiency – it is also supported by the Welsh Assembly, the Department for Business, Enterprise and Regulatory Reform which leads on fuel poverty and the Department of Health which supports 'upstream' measures to promote health and reduce demands on the National Health Service.

Compelling evidence[1] from the UK and beyond links cold housing with poor health and gave impetus to the UK Fuel Poverty Strategy published in 2001. It aims to remove the health risks of cold homes with measures addressing the main causes of fuel poverty – (a) poor energy efficiency of homes (b) the cost of energy and (c) low incomes. Launched in 2000, *Warm Front* is the Government's main tool for tackling fuel poverty in England via grants to improve home energy efficiency.

Figure 1: **Potential pathways to health**



Essentially, the evaluation explored the impact of *Warm Front* on a number of possible pathways to health, shown schematically in figure 1.

Though links between poor quality housing, fuel poverty and health are widely recognised, there are few robust studies showing positive links between better housing and better health[2], and fewer still address the extent to which energy efficiency improvements promote better health. This makes it difficult for many in the health sector to fully engage with the issue. So over the past 5 years a research team[3] drawn from three universities has monitored thousands of houses and surveyed their residents to test the hypothesised impact of *Warm Front*. The results of our enquiry appear as a series of scientific papers published (and forthcoming) in academic journals. This report distils some of the key findings for the wider policy community.

[1] Acheson D. *Independent Inquiry into Inequalities in Health Report*. The Stationery Office (London 1998) Available from www.archive.official-documents.co.uk/document/doh/ih/part2c.htm#'4

[2] Thomson H, Pettigrew M and Morrison D (2002) *Housing Improvement and Health Gain: Summary and Systematic Review*. Occasional Paper 5. MRC Social and Public Sciences Group. Glasgow.

[3] London School of Hygiene and Tropical Medicine, Sheffield Hallam University, University College London.

Science and policy

2

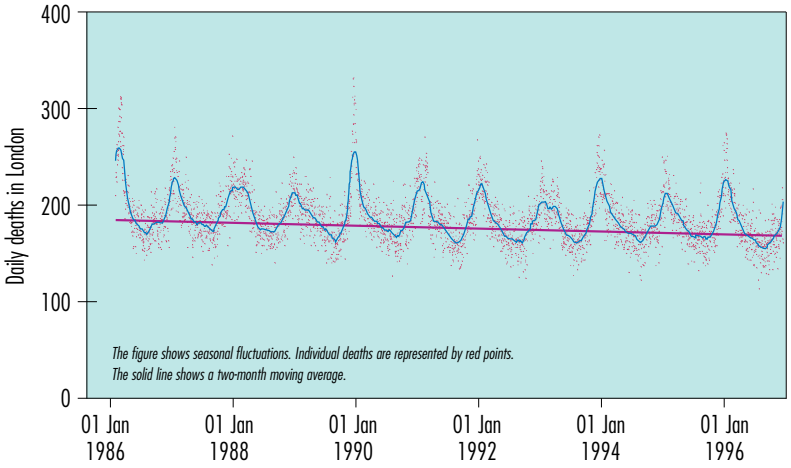
Main message: ***By providing robust scientific evidence, universities can assist the policy community in making cost-effective investment decisions.***

In Millennium year 2000, scientists and politicians finally 'shook hands.' Two concepts originating in the academic world had assumed political salience. *First*, Dr. Brenda Boardman's book on '*Fuel Poverty*,' published a decade earlier[4], resonated with a renewed government commitment to address all aspects of poverty.

Excess winter deaths

Second, the concept of '*Excess Winter Deaths*' (EWD) – already enumerated in a series of academic papers as a significant problem in the UK – had just been linked definitively to poor housing by Paul Wilkinson's team from the London School of Hygiene and Tropical Medicine.[5] Figure 2 shows the trend of excess winter deaths in London between 1986 and 1996.

Figure 2: **Excess winter deaths in London**



Three other sources of evidence helped set the scene for publication of the UK Fuel Poverty Strategy in 2001. *First*, in *Cutting the Cost of Cold: Affordable Warmth for Healthier Homes*,[6] a group of leading academics summarised the state of scientific evidence linking poor health with cold housing conditions and offered similar prescriptions for improvement. *Second*, the extent of the problem was revealed by the long awaited, and much trailed *Energy Supplement* to the 1996 English House Condition Survey (EHCS),[7] thanks to the persistence of government scientist, Richard Moore.

Causation?

But *third*, a systematic review of the *Health effects of housing improvement*,[8] reflected scientific concerns about the exact nature and strength of causal chains, about both the attribution of poor health to cold homes and especially better health to improved homes. A parallel can be drawn with early science on the link between smoking and lung cancer. Like Sir Richard Peto in the 1950's, scientists and policy-makers were faced with some biological evidence, some statistical evidence from a number of small 'intervention' studies (assessing the impact of housing investment) but not yet a definitive connexion which took account of all the complex influences on peoples' lives. The Government view was that because of its large scale, our Health Impact Evaluation of *Warm Front* would add to the weight of scientific evidence, helping legitimate its substantial investment in the UK housing stock.

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4 Brenda Boardman (1991) *Fuel Poverty: from cold homes to affordable warmth*. Bellhaven Press. London.

5 Results were known a year prior to formal publication in Wilkinson P, Landon M, Armstrong B, Stevenson S, McKee M. (2001) *Cold Comfort: the social and environmental determinants of excess winter deaths in England*, 1986-1996. Joseph Rowntree Foundation. York.

6 Rudge J. & Nicol F. (eds) *Cutting the Cost of Cold: Affordable Warmth for Healthier Homes*. E&FN Spon. 2000.,

7 Department of Environment, Transport and the Regions. (2000). *English House Condition Survey 1996: Energy Report*. DETR. London.

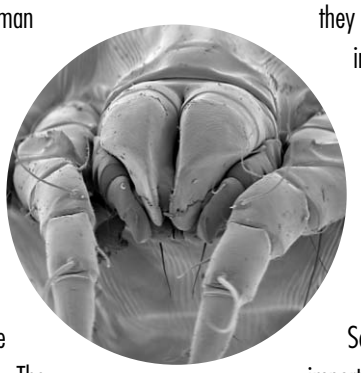
8 Hilary Thomson, Mark Petticrew, David Morrison. (2001) *Health effects of housing improvement:systematic review of intervention studies. British Medical Journal* 2001; 323:187-190.

Warm homes : better health?
4 Conundrums

Main message: ***Though politicians like cross-cutting programmes which deliver 'win-wins' across different policy domains, the science is nuanced. Our study illuminates a number of conundrums.***

(a) Biology versus thresholds

The *Fuel Poverty Strategy* refers to ample scientific evidence of a direct physiological link between cold conditions and increased risk of both heart and respiratory disease. Yet it was not absolutely clear how this human biology [9] [10] translates into minimum domestic temperatures. The *Strategy* recommends 18°C in living rooms to avoid risk to health, yet the *EHCS Energy Report* defines unhealthy living room temperatures as below 16°C and various reviews by the World Health Organization are inconclusive.[11] A human comfort zone above 21°C is also contentious, with 'objective' laboratory generated thresholds increasingly challenged by 'adaptive' [12] models of 'subjective' comfort – a 'malleable construct' of the human psyche. Or put another way, comfort can depend on whether you wear a cardigan.



(b) Damp, mould and mites

Dust mites thrive in warm humid conditions. Mould grows in cold damp conditions. Both are linked to respiratory problems, including asthma. The challenge for *Warm Front* is to create an indoor environment which discourages both mould and mites. Some energy efficiency measures will raise temperatures *and* reduce relative humidity, condensation and damp.[13] But there is a danger that draught-proofing may reduce ventilation and increase humidity. How can *Warm Front* strike a balance between these competing elements? Our health impact evaluation was designed to address the issue with innovative building science.

(c) Poverty versus lifestyle

Prior to the *Strategy*, scientists argued about the causes of between 20 and 40,000 excess winter deaths (EWD) in England and Wales. Do they reflect the pattern of environmental and economic inequalities in our society or do individuals bear responsibility? Pointing to societal causes, *Cold Comfort* highlighted housing conditions as a significant correlate of EWD in the UK. Pointing to contrasting European lifestyles, the Eurowinter Group maintained that winter illness and death is also caused by people unprepared when venturing outside in cold weather.[14] Scientists have yet to determine which are the most important. If lifestyle influences do predominate then the scope for making an impact with *Warm Front* is limited.

(d) Poverty versus fuel poverty

Logically, fuel poverty and poverty are connected. The *Strategy* identified low incomes as one of three determinants of fuel poverty and *Breadline Britain* identified the lack of warm living conditions as a key component of poverty.[15] Yet a large scale population study by Paul Wilkinson concluded that 'Elderly people are more likely to die during the winter, but being poor does not affect the risk of dying.' [16] Though other studies appear to confirm that EWD is not a function of socio-economic status, certainly the risk to health is increased by low temperatures. The issue to be resolved is the precise pathways between poverty, fuel poverty, inadequate heating and poor health.

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[9] James Goodwin. Cold stress, circulatory illness and the elderly. In: Rudge J, Nicol F, eds. *Cutting the cost of cold: affordable warmth for healthier homes.* London: E&FN Spon 2000.

[10] Ken Collins. Cold, cold housing and respiratory illnesses. In Rudge J, Nicol F, eds. *Cutting the cost of cold: affordable warmth for healthier homes.* London: E&FN Spon 2000.

[11] World Health Organization. *Health impact of low temperatures.* WHO Regional Office for Europe. Copenhagen, 1987.

[12] Brager GS, De Dear RJ. *Thermal adaptation in the built environment: a literature review.* Energ Buildings 1998; 27:83-96.

[13] Tadj Oreszczyn and Stephen Pretlove. Mould Index. In Rudge J, Nicol F, eds. *Cutting the cost of cold: affordable warmth for healthier homes.* London: E&FN Spon 2000.

[14] William Keatinge and Gavin Donalson. Cold weather, cold homes and winter mortality. In Rudge J, Nicol F, eds. *Cutting the cost of cold: affordable warmth for healthier homes.* London: E&FN Spon 2000.

[15] Geoff Green and Jan Gilbertson. Housing, poverty and health: the impact of housing investment on the health and quality of life of low income residents. *Open House International* 1999; 24:41-53.

[16] Paul Wilkinson, Sam Pattenden, Ben Armstrong, Astrid Fletcher, R Sari Kovats, Punam Mangtani and Antony McMichael. Vulnerability to winter mortality in elderly people in Britain: population based study. *British Medical Journal* 2004; 329: 647-0.

The *Warm Front* Scheme

4

Main message: ***The* Warm Front Scheme *is the main instrument of the UK Government's Fuel Poverty Strategy and has the potential to deliver significant health gains.***

We set out to evaluate the health impact of the *Warm Front Scheme* operating from June 2000 until it was upgraded in 2005 following publication of *The Government's Plan for Action.*[17] The National Audit Office provided a good review and critique of the *Scheme* as we were finishing our field work in 2003.[18] In brief, *Warm Front's* aim is to improve energy efficiency for vulnerable households in fuel poverty in the private rented and owner-occupier sectors. It provided grants of up to £1500 for insulation, energy efficiency measures and heating improvements. *Warm Front Plus* is an extension of the Scheme available to the over 60s which provides central heating and had then a grant maxima of £2500.

Cost-benefit

Warm Front, overseen and funded by DEFRA, was administered by two scheme managers, Eaga Partnership Ltd and TXU Warm Front Ltd. Expenditure of around £150 million a year during the period of the study was increased following the Government's 2004 Spending Review. Between 2001 and 2004 the Scheme assisted more than 900,000 vulnerable households by spending more than £600 million.

Figure 3: **Figure title**

Before *Warm Front* : spatial shrink

After *Warm Front* package

Eligibility

The target population is those in fuel poverty but only forensic examination of individual household accounts would reveal who they are and where they live. Because this test is difficult to apply in practice, eligibility is instead based on receipt of specific state income benefits. Filtered through this process are the groups most vulnerable to the effects (primarily the health effects) of fuel poverty; low income households with children; disabled people or those with long-term illness; and older (over 60) low income households.

Energy efficiency measures

There are two main types of energy efficiency measures made available to *Warm Front* recipients. *First* are improvements in the heating system. At the top end of the scale, the £2500 grant under *Warm Front Plus* facilitated the installation of a new central heating system. Less costly and within the £1500 grant limit for *Warm Front* recipients aged below 60, were measures to repair systems, install individual room heaters or replace defective central heating boilers. *Second* is insulation, to lofts, cavity walls, hot water tanks and via draught proofing, to doors and windows. Other measures include energy advice, energy efficient light bulbs, a thermal jacket to the hot water tank and timer controls for electric space and water heaters. If all goes well, homes will be transformed from (a) to (b) in figure 3.

[17] Department for Environment Food and Rural Affairs. (2004) Fuel Poverty in England: The Government's Plan for Action. DEFRA. London.

[18] National Audit Office (2003) Warm Front: Helping Combat Fuel Poverty. The Stationery Office. London.

Research design

Main message: ***Scientists from three universities and many disciplines developed an innovative and ethical method of evaluating the health impact of Warm Front.***

Evaluating the health impact of *Warm Front* was a complex business. How living conditions changed, how residents responded, how far sustained improvements in health and well-being replaced the stresses of the improvement process, the implications for winter mortality – all these issues required a research input from a combination of building science, social science and environmental epidemiology.

Measurement and modelling

In order to measure all these dimensions, the team deployed a battery of instruments shown in figure 4.

Figure 4: **Measuring instruments**

Instrument	*Measurement*	*Building Science*	*Social Science*	*Environment Epidemiology*
1. Property survey	property characteristics; energy efficiency	✔	✔	✔
2. Electronic data loggers	indoor temperature and relative humidity	✔	✔	✔
3. Resident interview	income, subjective health, well-being, comfort, stress		✔	✔
4. Diaries	comfort, temperature, daily activities	✔	✔	
5. In-depth interviews	process, opinion, impact		✔	
6. Intensive building survey	air infiltration, insulation fuel consumption	✔	✔	

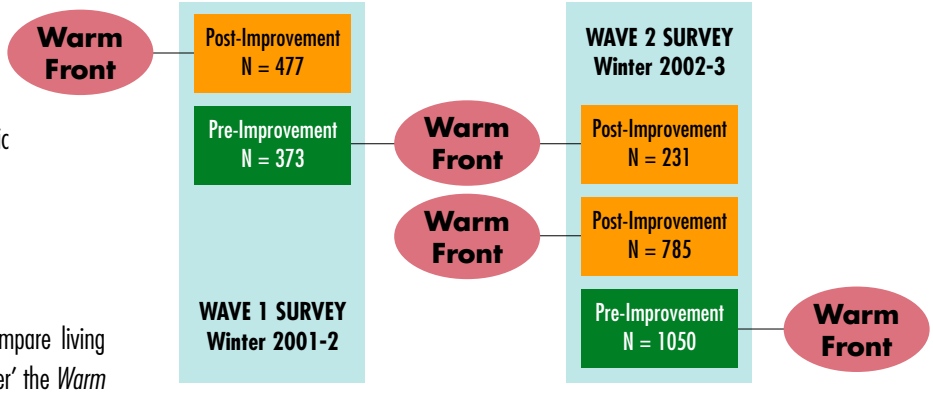
The research team planned to survey about 4000 properties and interview one resident in each household, asking them also to keep daily diaries for a couple of weeks afterwards. Electronic data loggers recorded temperature and humidity in the living rooms and bedrooms of about half of these properties. There were 49 in-depth interviews and intensive surveys of 191 properties.

Realising from the onset that it would be difficult to evaluate some health impacts directly (and almost impossible to detect a reduction in deaths) the study also used modelling techniques. Better health and fewer winter deaths were estimated by 'triangulating' evidence from other scientific studies linking health to rising domestic temperatures.

Before and after

Ideally, a robust study would (a) compare living conditions and health 'before' and 'after' the *Warm Front* measures were installed, and (b) for the same period deploy a 'control group' of 'non-intervention' properties to account for changes resulting from other factors, such as an increase in the Winter Fuel Allowance. However, ethically it was difficult to justify forming a control group of eligible residents by deferring their receipt of *Warm Front* measures another winter. So the team devised an innovative survey sequence to compare pre- and post- intervention groups at two points in time. Technically this facilitated both a 'cross-sectional' and 'longitudinal' analysis.'

Figure 5: **Survey sequence**



Targets and targeting

6

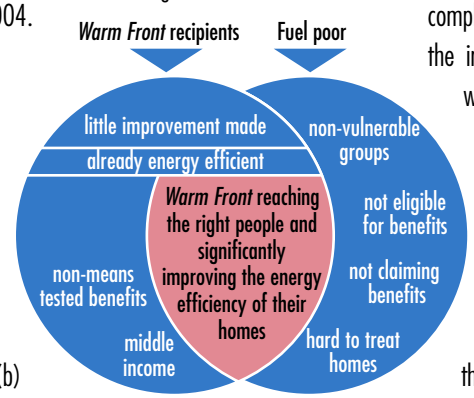
Main message: ***Though a government objective is to target Warm Front to householders in fuel poverty, in practice such selectivity is difficult to achieve without intrusive checks on status.***

Who and where are the vulnerable households in fuel poverty? Finding them has been a major challenge for *Warm Front*, highlighted by the National Audit Office (NAO) in 2003,[19] criticised by the Public Accounts Committee, then addressed by the Government's Plan for Action in 2004.

Mismatch

The problem is a mismatch between fuel poor households and eligibility for *Warm Front* measures. The result is (a) many fuel poor households not claiming or ineligible for *Warm Front*, and (b) many households eligible for *Warm Front* but not in fuel poverty. The NAO identified causes (figure 6) and Tom Sefton [20] identified numbers – 82% of 2.8 million eligible households not in fuel poverty and 62% of 1.4 million fuel poor households not eligible for *Warm Front*.

Figure 6: **Mismatch**



Ethical dilemma

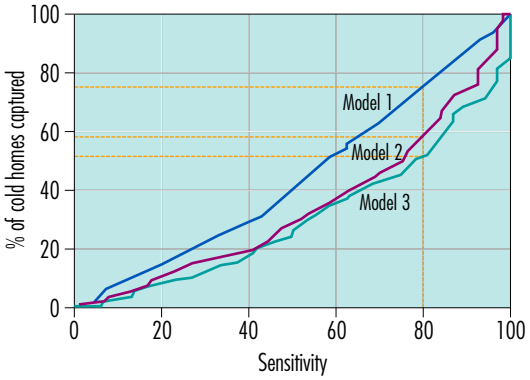
At the heart of the problem is a dilemma. More precision could be achieved by thoroughly investigating the financial circumstances and housing conditions of potential beneficiaries. It's an option favoured by the Energy Retail Association, but 'checking up' on applicants or trawling records to identify potential clients is intrusive and costly to administer.

Modelling and measuring

Instead, *Warm Front* identifies low incomes as proxy for fuel poverty, retaining a 'state benefit passport' approach to eligibility. A complex model estimates both the extent of fuel poverty and the impact of *Warm Front*. The key outcome of 'adequate warmth' is predicted by modelling income, fuel costs and energy efficiency.

Our study throws new light on targeting by identifying cold homes.[21] If low temperatures of below 16°C in either living room or bedroom are signifiers of fuel poverty, then what characterises these households? Can these common characteristics help locate fuel poverty?

Figure 7: **Targeting cold homes**



Our results are only modestly encouraging. Figure 7 shows three models of increasing complexity. Model 1 includes three variables available to a local authority without a visit – property age and type plus the neighbourhood index of multiple deprivation. On this basis it would be necessary to target 73% of homes in England to capture 80% of the households with living room temperatures of less than 16°C. A refined model 2 (adding a short interview with the householder to ascertain age, sex, educational attainment, household size and satisfaction with the heating system) targets 57% of households to capture 80% of cold homes. Model 3, adding in an energy efficiency rating, focuses on only 50% of households for the same result.

Even the most refined of our models has limited potential for identifying cold homes, presumably because of multiple influences on home heating. But the approach may help to target fuel poverty more effectively than passport eligibility.

[19] Report by the Comptroller and Auditor General (2003). *Warm Front: Helping to Combat Fuel Poverty.* National Audit Office. The Stationery Office. London.

[20] Tom Sefton. (2004) *Hitting the Target: An evaluation of the effectiveness of Warm Front in helping to meet the Government's fuel poverty target.* London School of Economics. London.

[21] Emma Hutchinson, Paul Wilkinson, Sung Hong, Tadj Oreszczyn & the Warm Front Study Group. *Can we improve the identification of cold homes for targeted home energy-efficiency improvements? Applied Energy* 83 (2006) 1198-1209.

Application process

Main message: **Warm Front *recipients are generally positive about the application process, probably because they exercised choice by signing up.***

Shadows

Though family death and divorce cause most stress in life, the process of renovating a house is high on the list: wherever you live and in almost all circumstances. So we anticipated that the process of planning and installing *Warm Front* measures might cast a shadow over residents' lives, possibly negating positive health impacts of warmer, more comfortable homes.

Our earlier research in Liverpool had highlighted the problem, concluding: '*levels of stress associated with the redevelopment process are significantly associated with poorer health and in the short term appear to counterbalance the benefits of improved living conditions.*'[22]

Our Liverpool findings were confirmed by Terry Allen's investigation of a council estate near Bradford. In his article[23] *Housing Renewal – Doesn't it make you sick?* he highlights how personal tenant control over the process is linked to health, but also how difficult this is to achieve with 'monolithic' programmes on large council estates.

Application process

Warm Front is a big but not monolithic *Scheme*. Indeed some critics say the *Scheme* 'pepper pots' properties rather than systematically improving all the housing in a neighbourhood like its sister scheme *Warm Zones*. The upside is individual choice to join the *Scheme* or not. And choice implies a degree of control.

Our 49 'in-depth' qualitative interviews of *Warm Front* recipients[24] reveals the process of applying to EAGA, the scheme manager, was generally straightforward – "*no bother*" and "*relatively painless*". But then there was a delay of weeks, even months before *Warm Front* measures were installed, as contractors surveyed the property to determine the exact specification for heating systems and insulation. In some instances delays could cause confusion and anxiety – "*so many people came it was unreal*" but most people were phlegmatic:

"Yes it was a bit long drawn out but obviously there were different channels that had to be gone down, grants and what have you, but I think it is well worth the wait and it was put in before the next winter".

"..Yes it seemed a bit lengthy… Yeah, between four and six months but of course there's a lot of people making applications so it is going to take a time, sit back and you know as long as it came before winter came that was alright that was the important thing".

The final result of a warmer, more comfortable home appears to have compensated for earlier anxieties about delay and uncertainty. And the speedier process introduced by DEFRA in 2004 will have helped minimise this downside.

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[22] Critchley R, Gilbertson J, Green G, Grimsley M. (2004) *Housing Investment and Health in Liverpool.* CRESR. Sheffield Hallam University.

[23] Terry Allen. Housing Renewal – Doesn't it make you sick? *Housing Studies, (2000) Vol 15, No 3, 443-461.*

[24] 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 and Medicine 63 (2006), 946-956.

The works

Main message: ***Generally recipients are also positive about the work of installing Warm Front measures, quickly recovering from the disruption.***

Installation of measures

Most residents of the qualitative study found the installation of energy efficiency measures relatively proficient. Over a third thought the contractors were *"friendly"*, *"polite"* and *"cleaned up afterwards"*. A quarter were impressed with their efficiency and speed in fitting boilers and other heating measures, and with the quality of the equipment. Typically, a single pensioner from Manchester said:

"There was nothing wrong with the process; they were just very, very nice. They just came in and did the work; they never made a mess and they told me how to use it and everything else."

For an older couple living with an elderly parent in Newcastle:

"The boiler is absolutely exceptional, really is...just the quality of it, instant hot water, instant heat you switch it on and the radiators [are] hot in three, four minutes easy".

There were a few cases where work was not carried out to residents' satisfaction: indeed one recipient reported a flooded cellar and another was taking the contractor to court. Typically, however, most accepted a degree of inconvenience during installation. On the whole the results were well worth it.

Feelings about *Warm Front*

Overall most people we talked to were very satisfied with *Warm Front*. Some talked about feeling *"grateful"* that such a *Scheme* existed and being able to benefit from having the work done. Some were surprised to get government money for improvements to their own homes.

Being a recipient of a government scheme did concern some householders. Around a fifth felt they didn't have much choice over the type of boiler or control over how the work was undertaken. In part because they felt they did not have the sense of authority that a 'paying customer' would have.

"I accepted simply because we was going to get a better installation than the existing one and 'half a loaf is better than none' and that was the way I looked at it. I was willing to compromise on my own little faddishness about design etc. for what I could get for no cost so that was all I did."

Although this was usually seen as an inevitable aspect of getting *"something for nothing"*, a small minority did find the feelings of powerlessness difficult.

"I think I've felt really bad, I've felt like I was asking for something, do you know, like begging? I've felt like I was begging, and I didn't want to be in that situation at all."

Pointers

Some participants in our qualitative study experienced problems with their applications and/or installations which could potentially influence their well being and quality of life. Overall there was little qualitative evidence of the *Warm Front* process casting a shadow over the health of recipients.

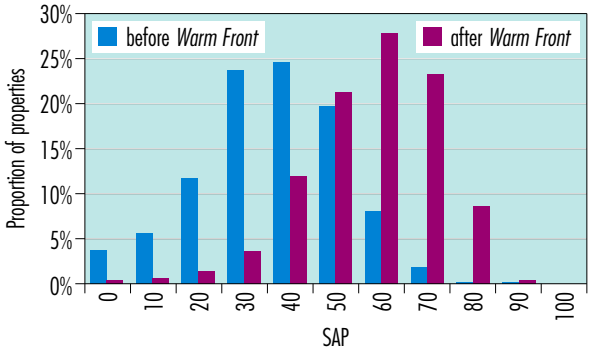
Temperature

Main message: ***Installation of Warm Front measures – insulation and better heating systems – had exactly the intended effect. Energy efficiency improved and indoor temperatures increased. The coldest properties benefited most. However a significant minority of properties are still below the 18°C threshold, posing a health risk.***

Energy efficiency

Calculated using a Standard Assessment Procedure (SAP)[25] the energy efficiency of 'post-intervention' properties averaged 62 (on a scale –10 to +120) compared with 41 for those awaiting *Warm Front* measures. This new SAP was above the English average in 2001 but below the Government benchmark of 65 for 'Decent Homes.' Figure 8 compares the range of SAPs before and after *Warm Front* measures. The 'tail' is explained mainly by older properties not amenable to cavity wall insulation. Also, younger or disabled householders did not receive a complete upgrade of their heating systems because of prevailing grant limitations.

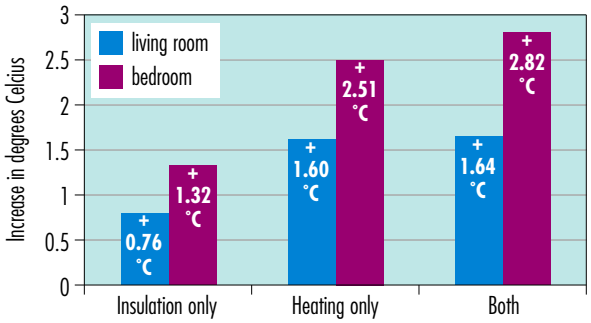
Figure 8: **Energy efficiency: 'before and after'**



Temperature

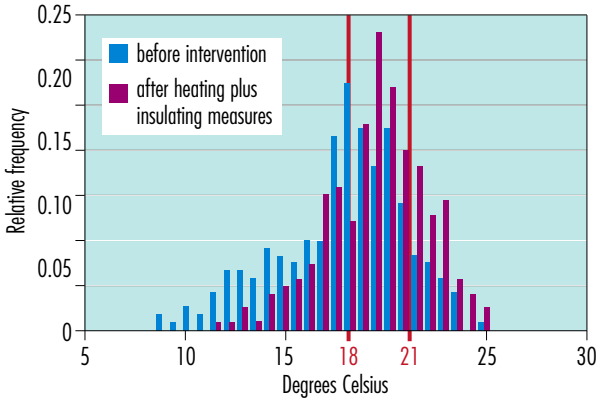
From perhaps the most comprehensive collection of dwelling-related temperature data for English homes,[26] we report a significant rise in temperature in post-intervention properties. The SAP rating of a property was the most significant predictor of temperature. In the least energy efficient (SAP < 41) living room temperatures averaged 17.5°C whereas in the most energy efficient they averaged 19.8°C. Figure 9 shows, insulation and heating measures both had an impact. Combined, they raised living room temperatures by 1.64°C and bedroom temperatures by 2.82°C.

Figure 9: **Change in standardised temperatures with *Warm Front* intervention**



Though the headline increases are modest – from 17.9°C to 19.6°C in living rooms and from 15.9°C to 18.3°C in bedrooms – many properties are lifted above the 18°C threshold which theoretically avoids a risk to health. Indeed one of the features illustrated by figure 10 is shortening the 'tail' of coldest properties where the rise in living room temperatures was around 2.5°C compared with 1°C at the top end.

Figure 10: **Range of living room temperatures**



A minority of post-intervention properties are still below the 18°C threshold – households either remain in fuel poverty or prefer cooler living conditions.[27]

[25] BRECSU (for DEFRA) 2001. *The Government's Standard Assessment Procedure for Energy Rating of Dwellings, Version 9.70.* ed., Garston, Watford, BRE, 2001.

[26] Tadj Oreszczyn, Sung Hong, Ian Ridley, Paul Wilkinson and the Warm Front Study Group. Determinants of winter indoor temperatures in low income households in England. *Energy and Buildings.* (March 2003) Vol.38 Issue 3: 245-252.

[27] Roger Critchley, Jan Gilbertson, Michael Grimsley, Geoff Green and the Warm Front Study Group. Living in cold homes after heating improvements: Evidence from Warm Front, England's Home Energy Efficiency Scheme. *Applied Energy* 84 (2007) 147-158.

Humidity

Main message: ***Though insulation can reduce ventilation and increase humidity, there is no evidence of Warm Front having this effect. On the contrary, higher indoor temperatures produced lower humidity and less dampness.***

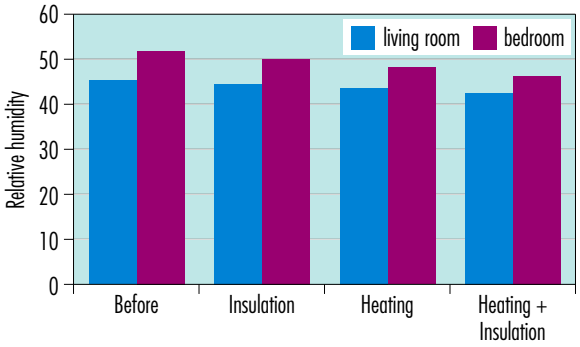
Building scientists point to a possible downside to the *Warm Front Scheme*. Better insulation could reduce ventilation, tending to increase relative humidity inside the home. Figure 11 charts consequences for damp, mould and respiratory problems. House mites also thrive in humid conditions and are linked to asthma and eczema.

Figure 11: **Relative humidity: causes and consequences**

Ventilation

In theory retrofit measures, combining cavity wall and loft insulation plus draught proofing, should reduce the air infiltrating into the property by a quarter. In practice, the gaps opened up by retrofitting gas central heating increased air infiltration. When we pressure tested a sample of 191 houses, background ventilation rates in post-intervention houses were on average almost as high as in those awaiting *Warm Front* measures.[28]

Figure 12: **Relative humidity before and after *Warm Front* measures**



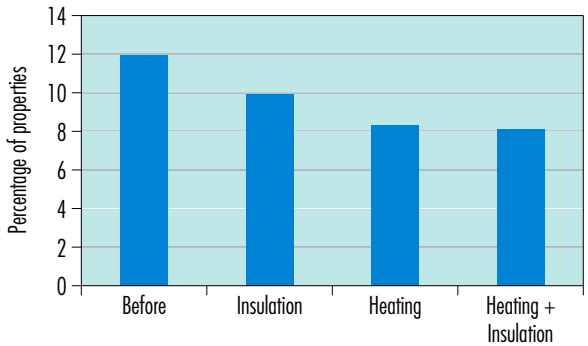
Relative humidity

In a larger sample of 1095 properties monitored for relative humidity, there was a small but significant difference between pre- and post-intervention properties, the effect of raising temperatures.[29] Figure 12 shows that insulation and heating measures both make a contribution. When combined they reduce relative humidity from 46.4% to 42.8% in living rooms and from 52.5% to 47.2% in bedrooms, though these are averages and mask quite a variation.

When relative humidity is high, moisture condenses on external walls, providing ideal conditions for mould growth. Figure 13 shows how *Warm Front* measures have cut the prevalence of severe mould from an average of 12% to 8%. Where *Warm Front* has increased energy efficiency up to and beyond a SAP of 70, then the proportion with severe mould falls by half to 6.8%

The question remains; 'why does even a small percentage of energy efficient properties suffer from mould?' The answer lies in the great variation in how occupants live their lives. For example, some properties have cold spots behind wardrobes where relative humidity is high and mould will grow. In others, occupants may produce a lot of moisture or may not adequately ventilate their homes. So their lifestyles contribute to high humidities and mould growth. However, fabric of the property is of paramount importance.

Figure 13: **Severe mould**



Mould Severity Index derived from the 1996 English Housing Condition Survey

[28] Sung Hong, Ian Ridley, Tadj Oreszczyn,The Warm Front Study Group. *The impact of energy efficient refurbishment on the airtightness of English dwellings.*

[29] Tadj Oreszczyn, Ian Ridley, Sung Hong, Paul Wilkinson, Warm Front Study Group. Mould and Winter Indoor Relative Humidity in Low Income Households in England. *Indoor Built Environment 2006*; 125-135.

Fuel

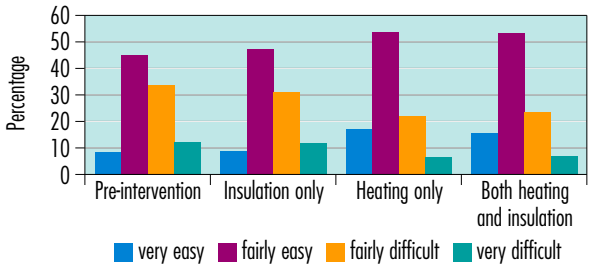
Main message: ***Our evidence on fuel consumption is contradictory. Though fewer residents reported difficulty paying fuel bills after Warm Front, their overall fuel consumption increased. This unresolved conundrum bears on the climate change and fuel poverty agendas.***

Warm Front is designed to reduce fuel poverty. In theory, improved energy efficiency gives recipients two options. Either they (a) reduce fuel consumption whilst maintaining adequate temperatures or (b) boost temperatures using the same amount of fuel as before. The second option is commonly referred to as 'take back.' Both alleviate fuel poverty.

Positive perceptions

Asked about difficulty paying their fuel bills, 2171 surveyed residents indicated a third "win-win" scenario of reduced fuel costs alongside the confirmed increase in temperatures. Heating measures (figure 14) tended to have the most significant effect in reducing the percentage reporting difficulty. Since our analysis accounts for income and fuel price variations, the logical implication is that fuel consumption has fallen, reducing the prevalence fuel poverty.

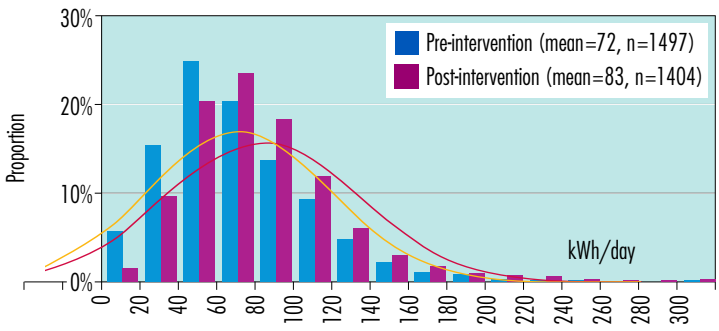
Figure 14: **Difficulty in paying fuel bills**



Conundrum

A closer 'objective' investigation of metered fuel consumption revealed an apparent contradiction with these 'subjective' resident perceptions. Fuel consumption actually rose on average after *Warm Front* measures (figure 15) against the 60% reduction predicted by the government's preferred model.[30]

Figure 15: **Increase in fuel consumption after *Warm Front* measures**



This conundrum was first highlighted in 2005 (published in 2006)[31] and explanations sought in a further report commissioned by DEFRA.[32] The big question is 'why does fuel consumption remain fairly constant when the government model predicts up to a 60% reduction after energy improvements?'

Explanation

Explanations fall into two categories. First, we question the theoretical assumptions of the government model, which are based on comparatively modern properties. Second, there are three uncomfortable discoveries which reduce energy efficiency below its theoretical value.

- *Our intensive infrared images of 85* Warm Front *dwellings revealed missing areas of both loft (13%) and cavity wall (20%) insulation.*
- *Monitored ventilation rates were higher than predicted because of the gaps opened up by retrofitting central heating and because occupants of warmer homes are more likely to open windows.*
- *Residents may not know how to use new central heating systems effectively; some may even resort to using their old fires.*

These only partly explain the discrepancies between 'modelled' and 'monitored' fuel consumption. Though the issue is of vital importance to both the Climate Change and Fuel Poverty agendas, the conundrum remains largely unresolved. More focused research is required to match theory with practical realities.

[30] BR Anderson et al (2002) BREDEM-12 (BRE Domestic Energy Model). BRE Press. Bracknell.

[31] Sung Hong, Tadj Oreszczyn, Ian Ridley, Warm Front Study Group. The impact of energy efficiency refurbishment on the space heating fuel consumption of English dwellings. *Energy and Buildings* 38 (2006): 1171-1181.

[32] Sung Hong, Tadj Oreszczyn, Warm Front Study Group. (2006) Additional analysis of the Health Impact Evaluation of Warm Front energy efficiency data. University College London.

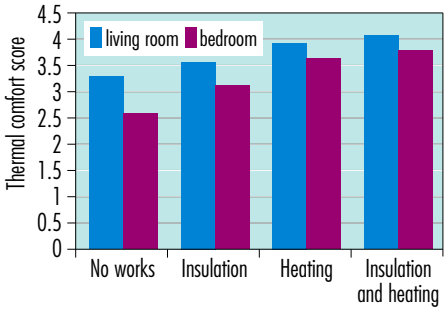
Comfort

12

Main message: ***Residents reported greater thermal comfort after Warm Front, feeling most comfortable at only 19.1°C. Nearly 2°C below the Government's recommended threshold, this average comfort vote has a positive bearing on fuel consumption and climate change targets.***

Patient and painstaking, 2402 residents recorded their perceptions of warmth and comfort with over 80,000 diary entries. Thermal comfort is assessed on a seven point Bedford Scale, ranging from *'much too cool'* (1) via *'too cool'* (2) and *'comfortably cool'* (3) to a neutral *'comfortable'* (4); then by two stages, *'comfortably warm'* (5) *'too warm'* (6) to *'much too warm'* (7). Figure 16 shows how *Warm Front* works significantly raised comfort levels – from an average 'too cool' to 'comfortably cool' in bedrooms, and in living rooms from 'comfortably cool' to 'comfortable.'

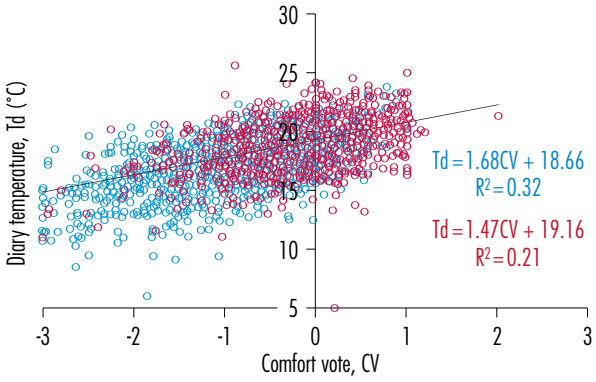
Figure 16: **Thermal comfort**



Comfort and temperature

Predictably, occupants' perceptions of comfort are correlated with their readings of indoor temperature. Figure 17 shows the scatter of recordings[32] both before (in blue) and after (in red) *Warm Front* measures. Here the Bedford Scale is rebased from minus 3 to plus 3, with zero as neutral or *'comfortable'*. Note the average 'Comfort Vote' shifts from 18.66°C to 19.16°C, with a reduced 'tail' of residents saying their living room is too cool.

Figure 17: **Living room thermal comfort and temperature**



[32] Sung Hong, Tadj Oreszczyn, Jan Gilbertson. (Forthcoming) *Field study of thermal comfort in low-income dwellings before and after energy efficiency refurbishment.*

[33] Tadj Oreszczyn, Sung H. Hong, Ian Ridley, Paul Wilkinson. Determinants of winter indoor temperatures in low income households in England. *Energy and Buildings* 38 (2006) 245-252.

[34] Roger Critchley, Jan Gilbertson, Michael Grimsley, Geoff Green. Living in cold homes after heating improvements: evidence from Warm Front, England's Home Energy Efficiency Scheme. *Applied Energy* 84 (2007) 147-158.

Variation

There is wide variation in temperatures and comfort even after *Warm Front* measures. Though some residents are clearly constrained by difficulties paying bills,[33] a quarter say they are comfortable at temperatures lower than recommended in the Government's *Fuel Poverty Strategy*. Individual metabolism accounts for some of these preferences; as do more layers of clothing. Others choose lower temperatures, especially in bedrooms, because they believe ventilation is good for health. Below living room temperatures of 18°C there is a potential conflict between subjective feelings of thermal comfort and scientific evidence (section 3) of an increased risk to health.[34]

Conundrums

The bad news on fuel consumption (highlighted previously) is matched by good news on the temperature which corresponds to the neutral 'comfort vote.' Occupants saying they are *'comfortable'* (in the middle of the Bedford Scale) record average room temperatures of 19.0°C. This average is below the Government's recommended comfort temperature of 21°C, with positive implications for fuel consumption and Climate Change targets.

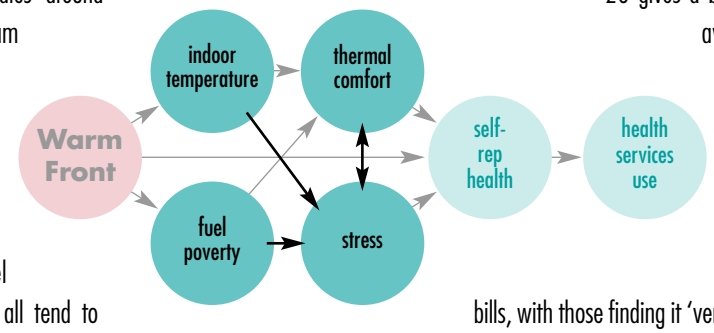
As with fuel consumption, the reality of 80,000 recorded comfort votes does not match predictions made by using Government's preferred model. We inserted the property characteristics of our study sample into the official model and accounted for how occupants live their lives – including the clothes they wear and the activity they undertake. The result was a 'Predicted Vote' for *'comfortable'* at a mean temperature of 20.4°C, 1.4°C higher than the 'Comfort' Vote revealed by our study. Maybe the difference is accounted for by the lower than average incomes and modest aspirations of our study population. Further investigation is needed.

Stress

Main message: ***By focusing on physical health outcomes, the Fuel Poverty Strategy neglects the major psychosocial benefits of Warm Front, including the alleviation of stress.***

Living conditions profoundly influence a person's state of mind. In a series of studies around Glasgow, Ade Kearnes and his team reveal how improving the *physical* condition of a dwelling confers *psychosocial* benefits on their occupants[35],[36]. So it proved with *Warm Front*. Raised temperatures, alleviation of fuel poverty and better thermal comfort all tend to reduce stress (figure 18).

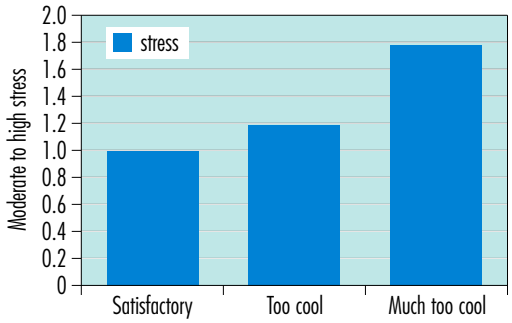
Figure 18: **Pathways to stress**



difficulty paying their fuel bills. Figure 20 gives a baseline value of 1 to the average stress level of residents who said they could pay their bills 'easily.' Higher stress levels were reported by residents with difficulty paying fuel bills, with those finding it 'very difficult' 2.5 times more likely to report high or moderate stress.

Comfort and stress

Figure 19: **Comfort and stress**



Low indoor temperatures are linked to stress but not as strongly as occupants' own assessment of thermal comfort. For those reporting 'satisfactory' thermal comfort (mid-point on the 7 point scale in the earlier *Comfort* section of this report) the average stress level is given a baseline value of 1 (figure 19). Higher stress levels were reported by residents saying their bedroom and / or living room were 'too cool.' Those reporting conditions as 'much too cool' were over 75% more likely to report high or moderate stress.[37]

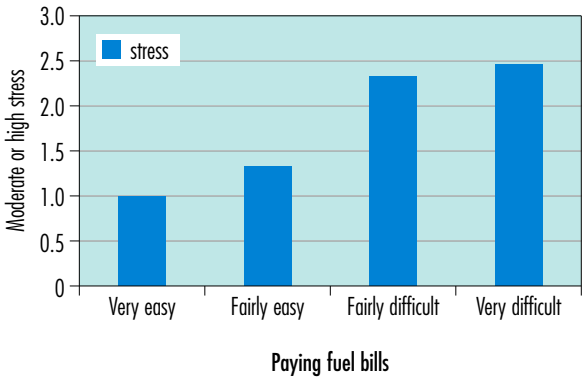
Complex picture

We have already shown how *Warm Front* has a positive effect on these psychosocial factors and will show next how they link forward to the health of occupants. The picture is of complex interrelationships. Though discomfort and fuel poverty are clearly connected, statistical analysis shows both contribute independently to stress. Evidence of these psychosocial benefits of *Warm Front* adds an important new outcome to the government's *Fuel Poverty Strategy*, which has hitherto focused on physiological benefits.

Fuel poverty and stress

There is an even stronger link between stress and fuel poverty. We assessed fuel poverty by asking householders whether they had

Figure 20: **Fuel poverty and stress**



[35] Ade Kearnes, Rosemary Hiscock, Ann Ellaway and Sally Macintyre. (2000). 'Beyond Four Walls.' The psychosocial benefits from the home: Evidence from West Central Scotland. *Housing Studies*, Vol 15, No.3, 387-410.

[36] Rosemary Hiscock, Ade Kearnes, Sally Macintyre, Ann Ellaway. (2001) Ontological security and psychosocial benefits from the home. Qualitative evidence on the issues of tenure. *Housing Theory and Society*, 18, 50-66.

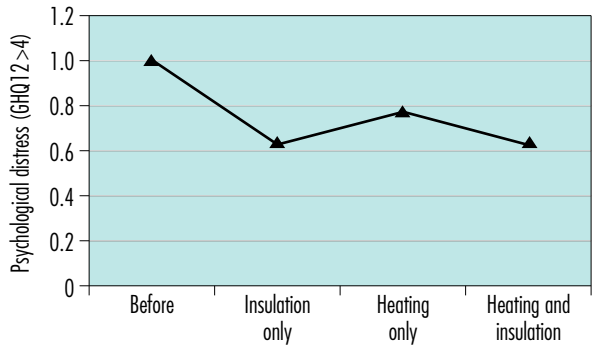
[37] Michael Grimsley, Jan Gilbertson, Geoff Green. (Forthcoming) *Psychosocial routes to health gain.*

Mental health

Main message: ***Relief from financial pressures is associated with a reduction in anxiety and depression. Reducing fuel poverty is a major route to improving mental health.***

We deployed a battery of health measures to gauge the impact of *Warm Front*. But first impressions were that only mental health showed *significant* improvement. And only in response to the General Health Questionnaire (GHQ12) which assesses levels of depression and anxiety.[38] Compared with the responses of residents before *Warm Front* intervention, those in receipt of heating and insulation measures were nearly 40% less likely to report a high level of psychological distress (figure 21).[39] Other mental health indicators reinforced this trend despite the disruption caused by the process of installation referred to in section 8 of this report.

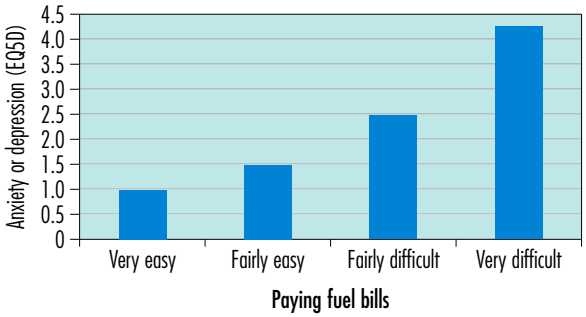
Figure 21: ***Warm Front* reduces psychological distress**



Fuel poverty

Raised temperatures and thermal comfort are also associated with better mental health. Occupants maintaining bedroom temperatures at 21°C were 50% less likely to suffer high levels of psychological distress than those with temperatures less than 15°C. Fuel poverty was even more significant. Compared with householders who paid fuel bills easily (baseline value 1) those with great difficulty paying were over 4 times more likely (figure 22) to suffer anxiety or depression (on the EQ5D measure) or psychological distress (on the GHQ12 measure).

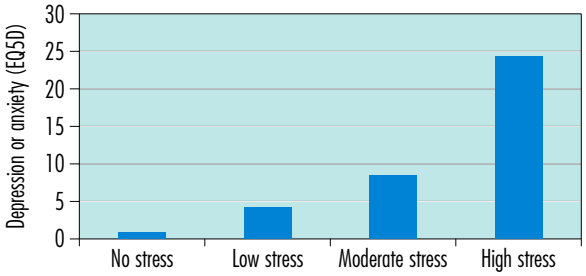
Figure 22: **Fuel poverty increases depression**



Stress

Stress was the most significant predictor of poor mental health (figure 23). Compared with stress-free householders (baseline value 1) those with high stress levels were almost 25 times more likely to report anxiety or depression (EQ5D measure) and 21 times more likely to suffer psychological distress (on the GHQ12 measure).

Figure 23: **Stress and depression**



Policy pathways

Of course there is an intimate and predictable relationship between stress and distress. Both are towards the end of a causal chain linking mental health back into the material circumstances of a household. *Warm Front* improves living conditions and comfort, but it is the *Scheme's* alleviation of fuel poverty which has the greater impact on improving mental health. This confirmation [40] that relief from financial pressures is associated with better psychosocial health, adds an extra dimension to the government's *Fuel Poverty Strategy*.

[38] Kerry Sprotson & Paola Primatesta (editors) *Health Survey for England*, 2003: Volume 3; Methodology and Documentation. The Stationery Office.

[39] Michael Grimsley, Jan Gilbertson, Geoff Green. (Forthcoming) *Psychosocial routes to health gain.*

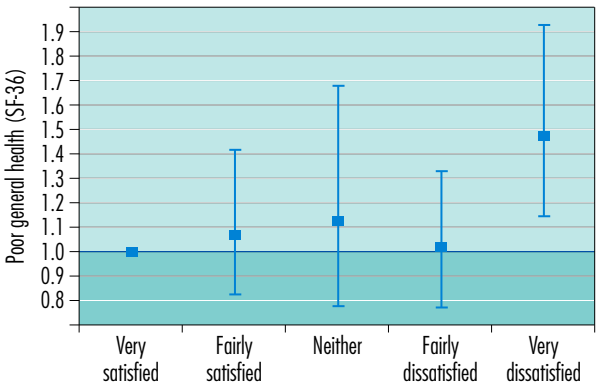
[40] Mark Taylor, David Pevalin and Jennifer Todd. (2006) *The Psychological Costs of Unsustainable Housing Commitments.* ISER Working Paper. University of Essex.

Body and soul

Main message: ***Resident satisfaction with living conditions is linked to better general health. Better mental health may over time lead to better physical health.***

The Government's *Fuel Poverty Strategy* highlights how cold homes can damage physical health. Over time, measures to improve energy efficiency should help alleviate these problems. Yet our study found no direct link between *Warm Front* measures and better physical health, possibly because their full impact was delayed beyond the study period.

Figure 24: **Heating satisfaction and general health**



General health

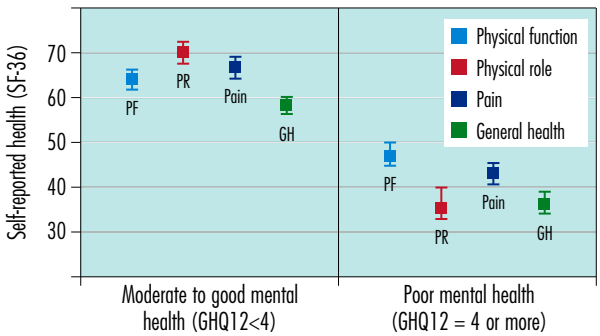
However, these neutral headlines mask a more positive picture. Not all *Warm Front* measures lead to significant improvements in living conditions, but where they do, there is evidence of better physical as well as mental health. Our survey of 2640 occupants shows fewer draughts are linked to better '*General Health*' (using the Short Form 36 measure) as are perceptions of living conditions.[41]

Compared with those satisfied with their accommodation, those who were very dissatisfied were 80% more likely to report poor General Health, even after adjusting for other influences. Similarly, compared with those who were satisfied with their heating system (baseline value 1), those very dissatisfied were on average nearly 50% more likely to report poor '*General Health*'. This statistically significant average is shown in figure 24 within 95 per cent confidence limits.

Mind and body

There is scientific evidence – most famously in the Whitehall studies [42] [43] – that poor mental health is a prelude to poor physical health. Insofar as *Warm Front* improves mental health (see previous section) then in time, improvements in physical health should follow. Despite the limited time frame, the results of our study signalled a strong association between the two. Figure 25 shows the relationship between mental health (using the GHQ12 measure) – and the four physical dimensions of health (on the SF-36 measure) on a scale 1-100. For example, occupants reporting moderate or good mental health had an average pain score of 67, a full 24 points higher than those suffering psychological distress.

Figure 25: **Physical and mental health**



Policy pathways

Though the timeframe of our study prevented a full assessment of health impact, we nevertheless signal probable improvements in physical health further down the timeline. Our study supports the 'existence of a complex web of linkages, having important implications for health, between the nervous system and other body systems.' [44]

[41] Michael Grimsley, Jan Gilbertson, Geoff Green. (Forthcoming) *Psychosocial routes to health gain.*

[42] Michael Marmot & Eric Brunner. (2004) Cohort profile: The Whitehall II study. *International Journal of Epidemiology.*

[43] Nicholson A., Fuhrer R., (2005) Marmot M Psychological distress as a predictor of CHD events in men. *Psychosomatic medicine.* 67.

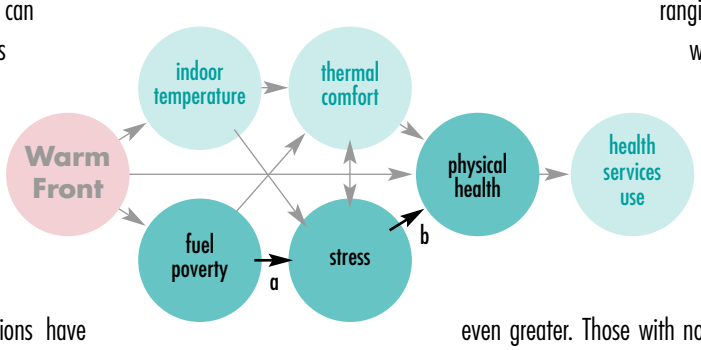
[44] Evans R.G. , Hodge, M. and Pless, IB (1994) If not genetics, then what? Biological pathways and population health. In Evans, R.G., Barer, M.L. and Marmor, T.R. (editors) *Why are some people healthy and others not? The Determinants of Health of Populations?* Berlin/New York: de Gruyter, 161-88.

Physical health

Main message: ***Though we have no direct evidence of Warm Front having an impact on physiological health, there is evidence of an indirect pathway via the alleviation of fuel poverty and stress.***

Though the Government's *Fuel Poverty Strategy* highlights how cold homes can damage physical health, perhaps more damage is inflicted by the stress of fuel poverty. Addressing these psychosocial determinants may be the more important route (highlighted a and b in figure 26) to better physical health. Earlier sections have shown how *Warm Front* reduces fuel poverty. What is the evidence on the subsequent pathway to physical health?

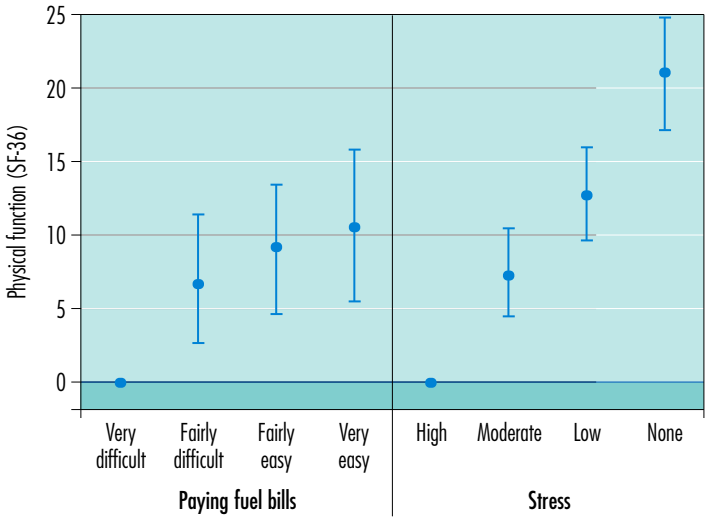
Figure 26: **Fuel poverty, stress and physical health**



Physical health

Our study revealed[45] both fuel poverty and stress are linked to all four dimensions of physical health covered by the Short Form 36 (SF-36) measure. On a scale of bodily pain ranging from 0-100, residents who said it was easy to pay fuel bills were on average 13 points higher than those who reported great difficulty. And the differentials for stress were even greater. Those with no stress were on average 23 points higher than those reporting high levels of stress. The pattern was repeated for general health (with its large physical component) and for physical role and physical functioning (figure 27). Differences in physical function correspond to the scale of fuel poverty and stress; with every point of statistical significance (as illustrated by the 95% confidence limits).

Figure 27: **Fuel poverty and physical health**



Though the logical sequence is for difficulty paying fuel bills to cause stress, the outcomes in figure 27 reflect the independent contribution of both, with stress the more important.

Pathways

Undoubtedly there is a two way relationship between physical function and stress. Those at the bottom of the scale – 'very limited in performing all physical activities including bathing or dressing'[46] – are less likely because of this incapacity to be economically active and more likely to be fuel poor. On the other hand, our study results are consistent with the causal model developed by the Whitehall Studies. "Social and psychosocial circumstances can cause long term stress... lack of control over work and home life have powerful effects on health... turning on the stress response diverts energy and resources away from many psychosocial processes important to long term health maintenance. Both the cardiovascular and immune systems are affected.'[47] In time benefits from the *Warm Front Scheme* may help to reverse this process.

[45] Michael Grimsley, Jan Gilbertson, Geoff Green. (Forthcoming) *Psychosocial routes to health gain.*

[46] John Ware. (2006) SF-36 *Health Survey Update.* Quality Metric Incorporated.

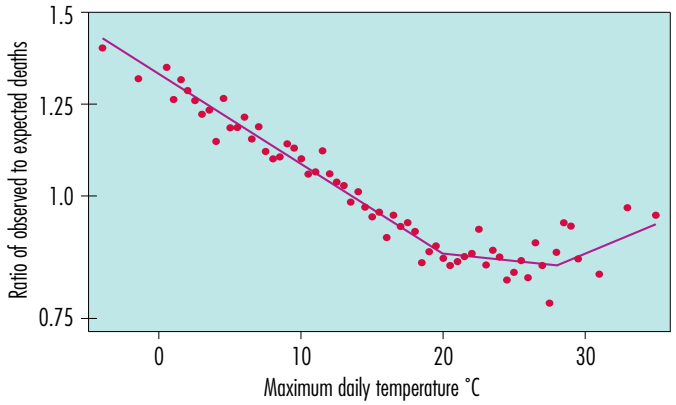
[47] Richard Wilkinson and Michael Marmot (2003) editors. *Social Determinants of Health: the Solid Facts.* WHO Regional Office for Health. Copenhagen.

Death

Main message: ***Cold indoor temperatures are significantly linked to excess winter deaths in England, primarily because of heart failure.***

Death from cold is headline news and is indeed the grim reality for many older people. Mortality peaks in the coldest winter months (see sections 2 & 3) and in England and Wales as a whole there are between 20,000 – 40,000 excess winter deaths a year. Influenza, coughs and colds account for some of these but perhaps half are attributable to cold conditions. In their influential report *Cold Comfort,*[48] Paul Wilkinson and his team plotted daily deaths against temperatures, concluding that mortality falls with warmer weather (figure 28). That is until temperatures reach the mid-20s˚C, when heat-related illnesses start to take their toll.

Figure 28: **Mortality drops as outdoor temperature rises**

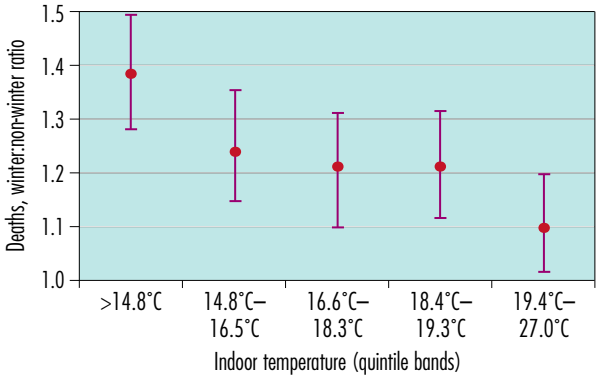


Note: mortality rises slightly above 28C. Source: Cold Comfort

Cold or cold homes

A key question for the *Fuel Poverty Strategy* is whether these cold-related deaths are caused (a) by cold housing conditions or (b) people unprepared when venturing outside in cold weather. There is a big scientific debate about the balance between these two explanations (see also section 3) with the EuroWinter Group pointing outdoors.[49] [50] The *Warm Front* study provided an opportunity to go deeper into indoor housing determinants as an alternative explanation.[51] In this case[52] utilising national rather than *Warm Front* data, we found that the trend was for the winter: non-winter mortality ratio to decrease by 1.3% per degree Celsius rise in temperature. This gradient did not apply to deaths from respiratory disease, but the trend for cardiovascular (heart) deaths was highly significant. Figure 29 shows how the ratio falls as indoor temperatures increase. Put another way, for every degree Celsius increase in indoor temperature, the ratio falls by 2.9%.

Figure 29: **Indoor temperatures by winter ratio of cardiovascular deaths**



Room for improvement

To reduce winter deaths the spotlight must be on those caused by cardiovascular disease. A theoretical maximum of around 18,000 is attributable to cold conditions and only a proportion to cold housing. Theoretically, most of these might be prevented if the housing stock were somehow transformed to the standard of the very warmest houses. Up to 10,000 deaths in the UK might be prevented if indoor temperatures were raised to 21˚C. Or up to a 1000 deaths might be prevented if temperatures in the coldest properties were raised by 2˚C.

[48] Paul Wilkinson, Megan Landon, Ben Armstrong, Simon Stevenson, Sam Pattenden, Martin McKee M & Tony Fletcher (2001) *Cold Comfort: The Social and Environmental Determinants of Excess Winter Deaths in England, 1986-1996.* Report for the Joseph Rowntree Foundation.

[49] William Keating (2001) Winter Deaths: Warm Housing is not enough. *British Medical Journal:* 323: 166

[50] William Keatinge (2004) Winter mortality in elderly people in Britain: Action on outdoor cold stress is needed to reduce winter mortality. *British Medical Journal:* 323: 166

[51] Paul Wilkinson, Sam Pattenden, Ben Armstrong, Astrid Fletcher, R Sari Kovats, Punam Mangtani and Antony McMichael. Vulnerability to winter mortality in elderly people in Britain: population based study. *British Medical Journal:* 2004; 329: 647-0.

[52] Paul Wilkinson, Ben Armstrong, Zaid Chalabi (Forthcoming) *Dependence of winter- and cold-related mortality on indoor temperature.*

Health impacts

Main message: ***Overall we assess the* Warm Front Scheme *as having a positive impact on (a) improving mental health (b) alleviating respiratory problems in children and (c) reducing deaths of older people. The investment is cost-effective in extending years of life.***

Benefits

Overall we assess the *Warm Front Scheme* as having a positive impact on (a) improving mental health (b) alleviating respiratory problems in children and (c) reducing deaths of older people. Of these three benefits (figure 30), our study *directly* detected an improvement only in mental well-being (see section 14). Prevalence of anxiety or depression ('common mental disorder') fell from 300 to about 150 per 1000 occupants after *Warm Front* measures. This is a significant impact. For every 10,000 properties (with two adults) improved by *Warm Front* about 3000 occupants will be relieved of anxiety or depression.

Figure 30: **Summary of Health Impacts**

	Respiratory	*Mental well-being*	*Mortality*
Hazard	*Damp/mould*	*(1) indoor cold (2) psychosocial routes*	*Winter low indoor temperature*
Main at risk group	*Children*	*All adults*	*Elderly*
Baseline rate (per 1000 a year)	*110*	*300*	*27 CVD deaths*
Change following heating + insulation	*Dwellings with mould severity index >1 Reduced from12% to 8.2%*	*Depression and anxiety reduced by 48%*	*2.2˚C warmer*
Attributable reduction	*c3 children with symptoms*	*c150 people with depression and anxiety*	*c0.4 winter deaths per year*

Death caused by cold is too rare an event for our study to detect a reduction in death rates. So the *Scheme's* impact was estimated indirectly using modelling techniques.[53] For the vulnerable group of elderly occupants, the underlying rate of cardiovascular death is around 27 per 1000 a year.[54] An average increase in indoor temperature of 2.2˚C, following combined heating and insulation measures, will reduce annual winter deaths by 0.4 per 1000 occupants. For typical pensioner couple households this means an estimated annual reduction of 80 deaths per 100,000 dwellings improved.

Children are most vulnerable to damp conditions but were not interviewed directly. Again, modelling techniques produced estimates. For those under 14 the underlying rate of respiratory symptoms leading to contact with the health service is about 11%[55], giving a baseline rate of 110 per 1000. A fall in exposure to mould from 12% to 8% following *Warm Front* will reduce the estimated prevalence of respiratory symptoms by 3 cases per 1000 children.

Cost-benefit

How do costs and benefits compare? Both are modest (figure 31) if we simply focus on death. The combined cost of insulation and upgrading the heating system averaged £1410.[56] The resulting increase in temperature added an extra 0.56 months to the lives of a 65 year old couple living together – 0.33 months for the man and 0.22 for the woman.[57] These extra few days may seem negligible, but grossed up over many beneficiaries, the impact is thousands of life years saved each year. Over ten years the average cost of extending a recipient's life by one year is £12,905 if only insulation is installed. Upgrading the heating system results in higher temperatures but is less cost-effective (at £26,629) in saving lives.

Figure 31: **Costs and years of life saved**

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*

[53] Zaid Chalabi & Paul Wilkinson. (Forthcoming) *Mortality and non-mortality impacts of the Warm Front Home Energy Efficiency Scheme.*

[54] Office of National Statistics (2000) *Mortality Statistics. Review of the Registrar General on deaths in England and Wales, 1998.* The Stationery Office. London.

[55] David Ormandy, Stephen Battersby, Megan Landon, Richard Moore and Paul Wilkinson (2003). *Statistical evidence to support the Housing Health and Safety Rating System. Vol 2 – Summary of Results.* Office of the Deputy Prime Minister. London.

[56] Comptroller and Auditor General. (2003) *Warm Front: helping to combat fuel poverty.* Report No:HC 769. The Stationery Office. London.

[57] Zaid Chalabi, Jack Dowie, Ben Armstrong, Paul Wilkinson. (Forthcoming) *Analysis of the health impact of England's Home Energy Efficiency Scheme.*

Conclusion

Main message: ***Our study broadly confirms Warm Front 'wins' across the two policy domains of health and fuel poverty, plus a possible 'win' slowing climate change.***

Win: win: win?

Improving the energy efficiency of English homes is a demonstration, par excellence, of 'joined-up' government policy.[58] *Warm Front*, the UK Government's flagship programme to reduce fuel poverty in England, also has the potential to improve health and help slow climate change. Commissioned to evaluate health impacts, our study broadly confirms 'wins' across all three domains whilst also revealing some uncomfortable truths and unresolved conundrums.

An **executive summary** at the beginning of this report summarises the key messages from each of 18 sections. Footnotes refer to supporting evidence in 15 scientific papers written by the research team. The impact of *Warm Front* across the three policy domains is summarised in Figure 32.

Figure 32: **Projected effects of *Warm Front***

Impact of Warm Front *measures detected by study*	*Probable effects*		
	Health	*Fuel poverty*	*Climate*
(+) Indoor temperature	*(+)*	*(+)*	-
(–) Mould	*(+)*	-	-
(–) Difficulty paying fuel bills	*(++)*	*(+)*	*(+)*
(?) Fuel consumption	-	*(?)*	*(?)*
(+) Thermal comfort	*(+)*	*(+)*	*(+)*
(–) Stress	*(++)*	*(++)*	-

Health

Better **living conditions** have a significant impact on health. Increased temperatures (section 6) are linked to better health (13, 15) and fewer winter deaths (17,18). Less mould (10) reduces respiratory problems (18). **Psycho-social** pathways to health are even more significant. The main route to health gain is via the alleviation of fuel poverty. Warm Front recipients were less stressed (13) because it was easier to pay fuel bills (11). Less stress was strongly associated with better mental (14) and physical health (16). We conclude that Warm Front has a significant impact on the health of recipient households.

Fuel poverty

Our study is positive but less conclusive about a 'win' for **fuel poverty** which compares (a) income against (b) fuel expenditure in achieving (c) warmth. Contested definitions suggest caution. We used households' self-reported 'Difficulty paying fuel bills' as a proxy for fuel poverty and showed how prevalence was reduced (but not eliminated) by *Warm Front*. An 'objective' ratio of fuel expenditure to income was difficult to pin down.

More than any other, our study illuminated warmth as the third element (c) in the fuel poverty equation. Residents' self assessment of thermal comfort (12) increased after *Warm Front*, when they felt most comfortable at a living room temperature of 19.2°C. Still nearly 2°C below the Government's recommended threshold, this average 'comfort' vote (c) implies lower demand for fuel (b) and therefore less fuel poverty than in the official formulation.

Climate change

There are mixed messages on climate change. Prima facia, less reported difficulty paying fuel bills implies less fuel consumption to achieve improved temperature and thermal comfort. Better energy ratings using Standard Assessment Procedure points in the same direction. Yet our objective measures also show an increase in fuel consumption (11) after *Warm Front* measures.

It is a conundrum we have yet to resolve by building science. Our qualitative interviews may provide an answer. Recipient's said 'Now we can use the whole house instead of huddling around a living room fire.' Fuel takes a bigger share of their household budget because they now put more value on their home as a 'haven.'

[58] Geoff Green (forthcoming) *Warm Front on Climate, Poverty and Health: Evaluation of a UK Government Programme to improve domestic energy efficiency.*

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SHARPENS YOUR THINKING

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