Estimating the health impacts of Northern Ireland's Warm Homes Scheme 2000-2008.

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Introduction

Being unable to afford a warm home (or fuel poverty) has been a known human health risk for some time, but it is only recently that the extent of risk has become evident. This is mainly attributable to findings from evaluations of the Warm Front scheme in England and Wales, and the Central Heating Programme in Scotland. At least 30 peer-reviewed publications on the health impacts of fuel poverty in the UK have emerged in the last 2 years. They provide the first large-scale body of scientific evidence that a lack of affordable warmth is a primary contributor to health inequalities.

The health effects of fuel poverty are now believed to extend throughout the lifespan, from effects on newborns (e.g. Frank et al., 2006) through to effects on people in their last months of life (e.g. Morris, 2007). These health effects influence both mortality rates (deaths) and morbidity rates (illnesses). Health effects (and therefore health costs) are also apparent in both mental and physical domains (Green & Gilbertson, 2008), incurring a double burden.

Most of the Warm Front/Scottish Heating Programme evaluations are recent, and some are still in press. As a consequence, there is little published information on the precise health costs associated with fuel poverty. Data from England, Scotland and Wales are still being collated. Ahead of the publication of these more comprehensive analyses, the present report details 2 short desktop assessments of health effects from a similar scheme in Northern Ireland, namely the Warm Homes scheme (NIWH).The report examines health effects of NIWH from 2 perspectives :

1. Benefits of NIWH to quality of life

2. NHS savings – this estimates the probable savings that have been made to the NHS (2000-2008) as a consequence of having treated fewer cold-related accidents and illnesses post-NIWH. Although social and health scientists dispute the idea that public health and wellbeing can be equated with health agency savings (e.g. Sefton, 2003), estimates are made here for the purposes of planning and financial assessment.

Section 1 : Methods for estimating Quality of Life Impacts

A. Applying a cost-offset model

> *"Action in one sector pays dividends in other sectors,*
> *and this is probably most evident in the field of housing,*
> *which has a big influence on many aspects of individual*
> *people's lives as well as on the wellbeing of the*
> *communities in which they live"*
> (Gilbertson et al., 2008).

The NI Warm Homes scheme (NIWH) retrofits houses and directly improves SAP ratings (i.e. energy ratings of dwellings). Although improvements in the health of inhabitants is also central, NIWH is not a health intervention per se. The type of cost-benefit model most appropriate is therefore a cost-offset model, in which the costs of an intervention can be offset against benefits which do not accrue directly from the intervention itself (Sefton, 2003). A cost-offset approach is implemented here.

B. Estimating the lifespan of treatment

Estimates of cost-effectiveness in some GB schemes (Warm Front and Decent Homes) assumed a 15-year lifetime for each retrofit. The same lifespan is imputed here.

C. Estimating the number of people who will benefit

In a 15-year lifetime of treatment, a home is unlikely to be inhabited continuously by the same occupants (or even the same type of occupant). The Eaga database for NIWH indicates that, in descending order of prevalence, the initial inhabitants of retrofitted houses have been :

- single pensioners,
- pensioner couples,
- other vulnerable householders (e.g. disabled people).

Over the course of a 15-year treatment, the estimates made here assume that every NIWH household will be occupied throughout, and will be lived in by :

- a single pensioner for 5 years
- a pensioner couple for 5 years
- a family of 1.5 adults and 1.5 children for 5 years

This approach permits a broader assessment of who, and what type of people are likely to be exposed to NIWH in a 15-year treatment lifespan, and therefore a more representative assessment of health impacts. Some effects, for example, are more likely to be found among senior citizens (e.g. fewer falls and accidents), and other effects among children (e.g. improved respiratory health). Both feature in the impact assessment when it is approached in this way.

Between 2001/2 and 2007/8, NIWH treated 60,223 households (NIAO, 2008). Table 1 illustrates how estimates were calculated for the number of people who will benefit from NIWH.

Table 1 : Number of people who will benefit from NIWH 2001 – 2008.

Inhabitants	Duration in years	Number of homes treated= 60,223	Total inhabitant years
1 elderly person	5 years		301,115
2 elderly people	5 years		602,230
1.5 younger adults	5 years		451,673
1.5 children	5 years		451,673
Total elderly person years			*903,345*
Total younger adult years			*451,673*
Total child years			*451,673*

D. Assessing cost offsets – sources of evidence.

In this analysis, assessment of likely health effects is primarily based on the model applied by the Warm Front and Decent Homes research team to English data. This combines two sources of modelling, namely HHSRS and the QALY. First, the national Housing Health and Safety Rating System (HHSRS, 2006) is used to calculate :

a) risk estimates for homes *before* treatment, based on known HHSRS housing risks to health (e.g. cold indoor temperatures, damp, mould and condensation, etc.);

b) risk estimates *after* treatment, based on

known HHSRS effects of treatment,

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estimates from recent Warm Front evaluations.

The difference between estimates a) and b) reflects the likely effects of Warm Front treatments. Risk estimates from the HHSRS are based on likelihood of "harm requiring medical attention", and are therefore well suited to assessments of costs and benefits incurred to both people and the health service.

Wherever it is rational to do so, the same effects of treatment are assumed for NI as were imputed in the evaluation of Warm Front interventions in England, since both schemes invested roughly similar degrees of upgrading in a house. Where estimates from Decent Homes are used, estimates are divided by 4, since Decent Homes invested roughly 3 to 4 times more per home than did NI Warm Homes. This is probably an over-adjustment given that the first 50% of investment in a retrofit probably has greater benefits than the rest, because of the principle of diminishing returns.

The HHSRS defines 29 potential hazards, of which 6 are used in this cost-offset analysis. Table 2 gives details of them.

Table 2 : HHSRS hazards relevant to fuel poverty, who they impact, and sources of evidence used in this report.

Hazard	Whose health affected?*	Sources of estimates drawn on for this report
Excess cold	Seniors Other adults	HHSRS criterion NI research
Damp and mould growth	Children	HHSRS criterion
Falls on level surfaces	Seniors	HHSRC criterion
Falls on stairs	Seniors	HHSRC criterion
Fires	Seniors	HHSRC criterion
Flames and hot surfaces	Children	HHSRC criterion

HHSRS assumes that each hazard affects either all people, or only one target group. This is rational when estimating some of the effects of NIWH, since research evidence confirms this assumption of focal or generic risk. Respiratory benefits, for example, are only significant amongst children. However, NI research indicates that excess cold has significant effects on younger adults, not just senior citizens, and this evidence is included in estimates here.

HHSRS hazards cause different levels of harm, from a scratch to death. The HHSRS defines 4 Classes of harm and also estimates the likelihoods and spread of each Class of Harm, based on the type of hazard and who is most at risk. These likelihood estimates are applied here (they were also used by Warm Front analysts).

Each level of accident will, in turn, generate different costs to the householder and the health service. To calculate these costs, the Warm Front team elected to use the QALY system, an acronym which stands for "quality adjusted life-year". It is a measure of health which takes into account quantity and quality of life costs that are incurred from an accident. QALYs are widely used in the assessment of health effects of interventions, not least of all because they provide adjusted estimates based on the severity of accident and the age of the person who has been harmed. Other approaches were deemed less suitable – for example, the VSL system (i.e. value of a statistical life) calculates costs based on premature and unexpected loss of health.

Given that cold and damp housing is seldom associated with health events of this nature, VSL seemed less useful for the present purpose.

Warm Front estimated a QALY unit @ £40,000 per annum, which is applied here too. The unit value was chosen because it was current in 2005 (Mason, et al., 2005), which was roughly the mid-point of NIWH.

Relevant evidence published in the last year, as well as evidence from Northern Ireland, have also been included in estimates here – these were not available to Warm Front at the time of their evaluations, and may improve accuracy. For example, findings from a recent study of the effects of fuel poverty on children's mental health in England (Barnes, et al., 2008), as well as local NI research on mortality risks from cold are factored into estimations here (Morris, 2007).

Although there are at least 20 different models for assessing cost-offsets associated with health-related interventions, this combination of HHSRS and QALYs seems apt for the assessment of NIWH. QALYs offer a rounded measure of improvement, representing physical and mental well-being as well as monetary costs to a health organisation such as the NHS. This seems appropriate given that housing improvements aim to protect human health and mental well-being. Furthermore, linking QALYs to improvements in the hazard rating of a house provides a supplementary combination of "human" and "house" which further reflects the nature of Warm Homes - in other words, the model applied here is suited to the goals of this particular intervention programme.

One limitation of HHSRS is that it pays scant attention to the mental health risks of living in a house which contains significant hazards. This is not unexpected, since HHSRS used evidence-based estimates. At the time the most recent edition of HHSRS was published, there was little or no empirical evidence that housing incurred mental health risks. It is now becoming acknowledged that chronic exposure to risk in one's home can result in elevated levels of anxiety and depression. In particular, Warm Front evaluations indicate unexpectedly wide-ranging and significant effects of retrofitting on mental health (e.g. Green & Gilbertson, 2008). Estimates made here have incorporated a fuller acknowledgment of these.

Factoring in mental health effects is a particularly useful inclusion in the context of Northern Ireland, which has the highest prevalence of mental health problems in the UK (25% higher than other regions of the UK) (Bamford, 2007). This is largely attributable to the combination of historically higher levels of poverty and deprivation in NI, as well as prolonged exposure to political conflict and related violence. Interventions which are able to lower prevalence rates in NI are, therefore, especially indicated. Since fuel poverty levels are also higher in NI and its climate less clement, the mental health benefits of tackling fuel poverty could be argued to merit a regionally strong emphasis.

It is noteworthy that the next edition of HHSRS will – for the first time - incorporate mental health effects (Ormandy, 2008, pers. comm.).

Two types of mental health effects of NIWH are estimated here, namely effects on adults and effects on children.

Mental health effects on adults : Neither Warm Front nor Decent Homes have completed a cost-offset analysis incorporating the direct impacts of fuel poverty on mental health i.e. the stressors originating in worry about debt and/or enduring a cold home. However, preliminary results from both schemes suggest that these are likely to be considerable. The next 2 paragraphs detail how the cost-offset calculation for adult mental health was made. Of note are the multiple levels of correction that have been applied so as to generate a very conservative estimate of cost offsets.

Warm Front evaluators estimate that, for every 1000 in fuel poverty, 300 would be raised above borderline depression levels as a result of treatment (Green & Gilbertson, 2008). Benefits to mental health are first discounted to account for the fact that about half those suffering from anxiety/depression do not seek NHS treatment (Kings Fund, 2008). Hence 300 per 1000 becomes 150 per 1000. This value was heavily discounted again to 38 per 1000 to reflect the fact that most who seek treatment do not persist with it. Effects are calculated for adults and senior citizens only (i.e. exclude children). A 5% prevalence rate for combined chronic and mild

depression/anxiety in the adult population is assumed in the calculations (Kings Fund, 2008). Class weightings have also been set at conservative levels.

Mental health effects on children : There is only one study so far which has :

a) explicitly examined the mental health effects of fuel poverty on children, and

b) is of sufficient size, detail, and methodological calibre to be relied upon.

The study was completed earlier this year, but has not yet been signed off by its funders (Eaga and Shelter) and so remains unpublished. It is, however, of the highest quality. The study followed a large cohort of children (n = 14,000) over a period of 5 years and distinguished between children who were never/occasionally/usually living in fuel poverty. When many other factors had already been accounted for in the statistical analyses, results indicate that fuel poverty has highly significant effects on children's risk-taking (e.g. early alcohol and tobacco abuse) and truancy. In addition, it is the single housing risk factor to be associated with 4 or more negative outcomes in children's overall mental health status (Barnes et al., 2008). It is important to note that these results emerged when the cohort of children "*usually*" living in fuel poverty were compared with children "*occasionally*" in fuel poverty – this generates a very conservative estimate of mental health effects, since a more usual comparison would be between "*usually*" and "*never*".

On the basis of this study, children's mental health effects are included in the analyses here. The effect sizes in the study suggest that 75 per 1000 children might be removed from an at-risk mental health category as a result of living in warmer homes – to ensure conservative estimates, this has been discounted to 38 per 1000. The same population prevalence (5%) is assumed as for adult mental health – it is a low estimate (King's Fund, 2008).

E. Combining HHSRS and QALYs : A worked example using a fall on the stairs

Assume a sample of 10,000 homes, each lived in by a single pensioner. Using hospital admission and other medical records for England, the HHSRS estimates that, each

year, a fall on the stairs is likely to happen in 1 of 245 homes. In a sample of 10,000 homes, therefore, 41 people are likely to fall down the stairs in any one year (10,000/245).

HHSRS indicates that 2% of these falls result in death or severe injury. 7% result in considerable harm. 22% in harm, and 70% in a few cuts and bruises. Of the 41 people who have fallen, this means that (with some rounding error) :

1 person will die (2% of 41);

3 will come to considerable harm;

9 will be less seriously hurt;

28 will have cuts and bruises.

These % likelihood estimates are different for each hazard.

Applying a QALY weighting :

The number of deaths or very serious injuries (n) converts to a

QALY score of $(41 * 0.875) = .9$

QALY for considerable harm $(41 * 0.625) = 1.9$

QALY for less seriously hurt $(41 * 0.375) = 3.4$

QALY for minor hurt $(41 * 0.125) = 3.5$

TOTAL QALY SCORE $= 9.7$

A QALY of 1 is the equivalent of 1 year of perfect health. Its monetary value is set at £40,000. The total annual cost of falls from stairs in the homes of 10,000 pensioners living alone is, therefore, £388,000 $(40,000 * 9.7)$. Over 15 years, the cost would be £5,820,000.

E. Imputing maximum and minimum estimates for savings

After so much estimation, combination, and re-calculation, the eventual estimates become rather rough-and-ready. Acknowledging this, Warm Front analysts

calculated a lower and upper estimate of health benefits, which is also done here. Any contributors to health which are imputed in *this* report, but were *not* imputed in the Warm Front or Decent Homes analyses (e.g. mental health of adults and children) have minimum savings set at 50% of maximum savings.

Section 2 : Direct cost benefits to NHS

Calculating NIWH benefits to the NHS is not straightforward. Depending on the circumstances, people who fall down the stairs can incur many different types of injury. Class IV harms include a sprained wrist, concussion, bruised pelvis, a broken finger, cracked ribs, strained knee ligaments, and many more. Each of these incurs a different average NHS cost for treatment in hospital. If the condition is treated in a Health Centre, the cost is also different. NI costing data are collated for discrete procedures (e.g. a tonsillectomy), and hence do not include the costs of follow-up treatment after the procedure (e.g. outpatient visits, GP consultations post-operatively, district nurse visits, etc.).

Monte Carlo or similar simulations are helpful in these contexts, because they allow the range of most likely outcomes to be more accurately costed by running averages through a cycle of random combinations (usually between 200 and 10,000) yielding a best approximation. This requires evidence-based parameter setting and constraint definition, neither of which were feasible for this short report.

Instead, each Class of harm for each hazard listed in Section 1 is assigned an average cost, based on a likely outcome. Costs are based on statistics for Northern Ireland 2005/6. The estimates made are as follows :

Class IV Harms : for all of these, a fully absorbed cost of £93 is assumed. This is the cost associated with a single consultation in a Hospital A & E department in Northern Ireland. The exception is for mental health conditions, where Class IV harm is generally treated by GP's.

Class I to III Harms : the cost of each procedure is made up from fully absorbed costs of :
  a) a typical hospital procedure for the type of cold-related incident

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  b) a cost based on a random mix of outpatient visit, district nurse visit, GP consultation, and treatment nurse consultation.

The typical hospital procedures are as follows :

Excess cold
Class III : COPD
Class II :   pneumonia.
Class I :   myocardial infarction.

Damp/mould and children
Class III : asthma Class
II :   pneumonia
Class I :   not applicable

Falls and fires
Class III : minor musculoskeletal procedure
Class II :   elbow replacement
Class I :   primary hip replacement

Flames and hot surfaces
Class III :   minor musculoskeletal procedure
Class II : moderate burn
Class I :   major burn with skin graft

Adult mental health
Class IV : GP-led treatment
Class III :   depression/anxiety with one hospital admission
Class II :   depression/anxiety with two hospital admissions
Class I :   suicide attempt

Child mental health
Class IV : GP-led treatment
Class III :   conduct disorder with minor psychological service treatment
Class II :   conduct disorder with moderate psychological service treatment
Class I :   suicide attempt 1342

As for QALY estimates, three different household occupant mixes are assumed
(single pensioner, pensioner couple, and adults with children). The calculations
assume that costs devolve from a discrete accident or harm, and do not factor in
longer-lasting needs for post-accident treatment (such as a lifetime of drugs for angina
or asthma) . This greatly underestimates likely costs in some cases, particularly those
involving children (fewer asthma attacks in the 5 year occupancy of a Warm Home
will lead to a lifetime's better health in some cases).

Section 3 : Results

Table 3 summarises offset data for HHSRS hazards, adult and child mental health, and NHS savings. All calculations are based on reduction in likelihood of harm post-retrofit.

The estimated _minimum_ offset is £25.36M.
The estimated maximum offset is £45.80M.

With an NIWH cost of £109M (NIAO, 2008), this means that between 23% and 42% of NIWH costs could be offset against health costs as estimated using one of the conventional models (i.e. QALYs).

Viewed in terms of NHS savings, and also using a highly conservative model, it is estimated that between £0.94M and £1.71M of the cost of NIWH can be offset against direct savings to the NHS (between 1% and 2% of the funds invested in NIWH).

Table 3 : Summary data : HHSRS, QALY and NHS-savings estimates of reduced risk post-retrofit.

Harm	Who?	N	Post-NIWH reduction*	Combined QALYs	Max. QALY Gain £M	Min. QALY gain £M	Max. NHS saving	Min. NHS saving
Excess cold	Seniors	903,345	705 *375*	320.7 *170.7*	12.83	*6.83*	£478,088	*£254,304*
Excess cold	Other adults	451, 673	294 *147*	144.5 *77.0*	5.78	*3.08*	£215,140	*£114,437*
Damp and mould growth	Children	451,673	1355 *903*	210.2 *140.0*	8.41	*5.60*	£253,845	*£162,353*
Falls + fires	Seniors	903,345	680 *401*	174.5 *98.6*	6.98	*3.94*	£322,072	*£190,847*
Flames and hot surfaces	Children	451,673	224 *112*	39.5 *19.8*	1.58	*0.79*	£28,895	*£14,448*
Mental health and wellbeing	Adults	451,673 + 903,345	1189 *595*	170.3 *85.2*	6.81	*3.41*	£217,738	*£108,869*
Mental health and wellbeing	Children	451,673	594 *297*	85.23 *42.62*	3.41	*1.71*	£189,490	*£94,745*
TOTAL £M					45.80	*25.36*	1.71	*0.94*

* Estimated reduction in the number of each type of harm post-retrofit, based on HHSRS and other data sources (see Section 1). Maximum and *minimum* estimates.

Section 4 : Conclusions

Decisions about the choice of a models and how costs/benefits would be calculated (as described in Sections 1 and 2) were taken a priori. After analyses are completed, it is customary to compare offset outcomes with those in other studies. Warm Homes has not yet published their final estimates of cost offsets. Presently, therefore, Clinch & Healy's (2001) theoretical model - which calculated the potential costs and benefits of a future energy efficiency program for Ireland – best resembles the NIWH context. The installations they modelled were very similar to those of Warm Homes, although they calculated a 30-year lifetime for installations. Impact assessments were based on Irish hospital and mortality data, making their source for harm estimates very similar to the source of HHSRS estimates. Converting to a 15-year lifetime yields a cost offset to health of 39%, which is very close to the "conservative maximum" offset here (42%).

Given that NI Warm Homes is only indirectly a health intervention, a 42% offset is highly satisfactory. Imputing further from Clinch and Healy's Irish model, factoring in other benefits would create the following estimated offsets :

Health : 42% offset;

Employment (job creation, lost days from sickness and disability) : 70% offset;

Carbon reduction and energy savings 100% offset;

Other (e.g. education benefits, social cohesion and crime reduction) : 10% offset

Altogether this suggests that incorporating all the major benefits of a scheme such as NIWH could yield a 222% offset, indicating a 2.1 return on investment. Broadly

speaking, this resembles the return of the national retrofit program in New Zealand (Howden-Chapman, et al., 2007).

By contrast, the returns that accrue from savings to the NHS in treatment costs are small (estimated between 1%-2% of the cost of NIWH). This is not surprising given that NIWH is not a new drug treatment. Warm Homes and its associated schemes throughout the UK are focused on improving the quality of life of vulnerable people, which means that returns to quality of life offer a more appropriate "currency" with which to evaluate them. In addition, despite allegations to the contrary, the NHS is an extremely well-oiled and efficient health delivery system upon which it is difficult to make a significant impact with even the most sophisticated intervention. The fact that the average visit to an A & E department in Northern Ireland costs £93 and will usually include nursing care, medical tests, doctor assessment, drugs, bandages, equipment, laundry, building rental, etc. is testimony to this efficiency.

Suggestions for further modelling

To develop the "ideal" model of costs offset, would require approximately 10-12 months of data collection, input, and modelling. This is not recommended in the present context, since even best practice models rely heavily on best-guess approximations. When evaluating housing retrofits and their association with human benefits, there are more approximations than actual data. A larger and more elaborated model is probably not merited because of this. The comparison between the desktop impact assessment for NI Warm Homes reported here, and Clinch and Healy's model for the Republic of Ireland offers further support for this argument. Their model was a much more sophisticated one, but generated a very similar result.

Nevertheless, if a larger study were undertaken these are some recommendations :

1. Incorporate a model based on the Principles of Economic Analysis of Health Care Technology protocol (1995). This is the standard format for healthcare interventions. It is time-consuming to complete, and will be necessary but not sufficient for a fully developed assessment of cost offsets.

2. Incorporate a model based on fully-absorbed NHS costs of procedures, GP consultations, and drug costs – as used here – but using a Monte Carlo or similar simulation to generate more accurate estimates of savings.

3. Use DALYs rather than QALYs – the former give more consideration to age-discounting in the calculation of a life year. It requires purchase of expensive software, but would be worth the investment if a more detailed model were being built.

4. Factor into all models weightings based on the varied SAP rating improvements brought about by different Warm Homes treatments.

5. Undertake a full economic evaluation using benefits that include health, education, employment (both days lost to work, disability-related unemployment costs, and benefits of job-creation and training opportunities in retrofitting housing stock), and carbon emissions.

Maximising returns in the future

Health Impact Assessment is becoming an increasingly popular tool for planning. The analyses presented here suggest that some types of household are likely

to yield greater returns on investment than others. Taking into account the combined gains from increased employment, education, social cohesion, physical health, and mental health, it could be argued that fuel-poor families with young children offer higher than average rates of return, as do fuel-poor homes where there is a cardiac-respiratory risk, and also homes containing two or more senior citizens.

Using the data derived from this study of NI Warm Homes in the past, it would be possible to model and then compare a variety of retrofit strategies for the future. Many of these are likely to improve the returns on investment still further.

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