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A Public Health Evidence briefing

Warmer Housing: what are the choices?

Key Findings

- **Energy inefficient homes can contribute to excess winter mortality (EWM) which is a long-standing UK public health concern: the UK performs comparatively poorly with some of the least energy efficient housing in Western Europe.**

- **Options for reducing winter mortality by tackling fuel poverty include income support measures, one off payments, targeted reductions in fuel tariffs and home-energy efficiency programmes and universal fuel price regulation, although the latter is rarely used.**

- **Strategies for implementing these options include improving awareness of entitlements, targeting to those in greatest need and, within the context of longer term sustainability, seeking to achieve efficient heating of homes rather than simply increasing consumption of energy.**

Who is this evidence briefing for?

Policymakers, support staff, and other stakeholders with an interest in excess winter mortality and fuel poverty

Why was this evidence briefing prepared?

To summarise policy interventions that have been used to reduce the negative health effects of cold homes for policy makers.

What is the research question?

What are the health and welfare outcomes (benefits and any unintended consequences) of policies that have been used to reduce the impact of cold homes with potential application to the UK?

What is an evidence briefing?

Evidence briefings bring together **research evidence** and **local evidence** to inform deliberations about health policies

Table of contents

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Preface

The purpose of this public health evidence briefing

The purpose of this briefing is to inform deliberations among policymakers and stakeholders. It summarises the best available evidence regarding the design and implementation of policies for reducing the health impact of cold homes, particularly during UK winter months.

This briefing is intended to inform people with an interest in such policies (stakeholders) and to engage them in discussions about policies. It is not intended to prescribe or proscribe specific options or implementation strategies. Rather, its purpose is to allow stakeholders to systematically and transparently consider the available evidence about the likely impacts of different options**.**

How this briefing is structured

The key findings summarise the key messages. The main briefing sections are the problem, policy options, implementation considerations and evaluation and research priorities, glossary, acronyms and abbreviations, references and the appendices which includes the briefing methodology and the tables of included reviews and primary studies.

How this briefing was prepared

This evidence briefing brings together research evidence and UK initiatives to inform deliberations about tackling the problem of cold homes. We searched for relevant evidence describing the problem, the impacts of options for addressing the problem, barriers to implementing those options, and implementation strategies to address these barriers. We searched particularly for systematic reviews, other relevant UK studies and initiatives of the effects of policy options and implementation strategies. (The methods used to prepare this briefing are described in Appendix 1.)

Limitations of this briefing

This briefing is based largely on UK based studies and systematic reviews. Where we did not find an up-to-date systematic review, we have attempted to fill in these gaps through UK-based research, through focused searches and personal contact with experts, and through external review of the briefing.

Summarising evidence requires judgements about what evidence to include, the quality of the evidence, how to interpret it and how to briefing it. While we have attempted to be transparent about these judgements, this briefing inevitably includes judgements made by review authors.

Uncertainty does not imply indecisiveness or inaction

Many systematic reviews included in this briefing conclude that there is “insufficient evidence”. Nonetheless, policymakers must make decisions. Uncertainty about the potential impacts of policy decisions does not mean that decisions and actions can or should not be taken. However, it does suggest the need for carefully planned monitoring and evaluation when policies are implemented.

The problem

Background

Excess winter mortality (EWM) has been a long-standing UK public health concern. Given that comparative studies within and across countries have shown that higher EWM is not characteristic of colder regions, the UK performs comparatively poorly. The UK has some of the least energy efficient housing in Western Europe (1). Heat loss through the building fabric or through heated air escaping the building, can make housing difficult and costly to heat.(2) Poorly insulated housing has been associated with excess winter mortality.(3) Winter fuel payments (WFPs) and improvements to housing may be partly responsible for a gradual reduction in winter deaths.(4)

Health impacts of cold homes include increased risk of heart attack or stroke, respiratory illnesses, poor diet due to "heat or eat" choices, mental health issues, and worsening or/slow recovery from existing conditions.(5, 6) Those most at risk of ill health from fuel poverty include children the elderly, and long-term sick and disabled people.(6) A 2013 definition, following the Hills Fuel Poverty Review (7), defines fuel poverty for a household as being when:

- its income takes it below the poverty line (taking into account the cost of energy)
- its energy costs are higher than is typical for that household type.

Framing of the problem

Winter mortality is framed variously by different literatures, disciplines and agencies as income poverty, fuel poverty, home insulation, public health, energy market competition or consumer behaviour problem. Interventions to tackle EWM fall within five domains: health, housing, behavioural, energy and income policy interventions. Increasingly, programmes seek to integrate efforts across multiple domains; in particular, this briefing acknowledges the interplay of housing, health and income.

A Cochrane review highlights "well-established associations between poor housing and poor health".(8) Benefits may accrue from any intervention that increases the internal temperature of housing units during winter. However, interventions to upgrade the housing fabric, such as energy efficiency measures, may result in improved warmth, elimination or containment of mould or damp, and improved air quality as well as reduced fuel costs. Fuel poverty may extend to poor ventilation. Additionally, the warmer weather associated with climate change means that the problem of keeping houses cool is becoming a significant health issue during the summer months, particularly given a national lack of air conditioning. Policy makers need to decide whether increasing the internal temperature is the primary target for interventions or whether wider collateral benefits are also to be considered.

Many researchers hypothesise that reduction in exposure to housing conditions associated with poor health (for example poor air quality, dampness and humidity) will result in health improvement, but "the timescale for the impact on health is unclear and it may take years to emerge".(8) In addition, associated socio-economic factors may mediate between the potential for health improvement and housing improvement. The Cochrane review concludes

that “improved housing conditions may be regarded as an intervention which can tackle the complex dynamic between poverty and poor health”.(8)

Size of the problem

A recent update to a House of Commons briefing on fuel poverty trends[1] estimated that the percentage of fuel poor households in England was 13%, in Scotland 25%, in Wales 12% and in Northern Ireland 18% although these rates are not comparable due to differences in the methods used to calculate them.

Factors underlying the problem

Evaluations may not detect long term health impacts due to limited follow-up periods. Impacts on socio-economic determinants of health may be a valuable proxy indication of the potential for longer term health impacts.

Rapidly increasing energy costs and the current situation in the Ukraine means that the number of households who struggle to keep their houses warm is likely to increase. Additionally, the impact of climate change, potentially warmer temperatures and heatwaves mean that keeping homes from getting too hot is also becoming a key issue. This issue is important and the public health evidence briefing timely.

In summary:

- Excess winter mortality (EWM) is a long standing UK public health concern.
- The UK performs comparatively poorly for excess winter mortality with some of the least energy efficient housing in Western Europe.
- When framed as fuel poverty the problem extends to poor ventilation and lack of air conditioning.
- The scale and impact of the problem is likely to increase given general rises in fuel costs and, specifically, disruption to supply caused by the Ukraine conflict.

[1] https://commonslibrary.parliament.uk/research-briefings/cbp-8730/

Policy options

Three types of policy have been adopted in England to address fuel poverty; (i) income support measures, (ii) fuel price support (targeted reductions in fuel tariffs), and (iii) home energy-efficiency programmes.(9) Underlying factors addressed by these policies are low incomes, high fuel prices and energy inefficient homes, respectively.(10) Central to the strategy are direct payments to households at risk of fuel poverty, through winter fuel payments, cold weather payments and benefits entitlement checks.(9)

- **Winter fuel payments (WFPs)** are labelled but unconditional income transfers. (10) WFP is a non-means-tested, tax-free annual cash payment made usually in December to households with someone over Pension Credit age (currently, 65 years) to help with heating costs. This scheme aims to primarily to help pensioners and therefore excludes other groups at equal, or potentially greater, risk of fuel poverty, for example single parent households.
- **Cold Weather Payments (CWPs)** are made to low-income households when outdoor temperatures are at or below zero degrees Celsius for at least seven consecutive days. (10) CWP is a means-tested one-off payment made to recipients of certain benefits. Given CWP is contingent on temperature records, the fiscal impact of this benefit varies substantially from year to year.
- **The Warm Home Discount (WHD)** is a mandatory social price support measure that was introduced in addition to the WFP, and replaced social tariffs that were available to households vulnerable to fuel poverty. (10)

While WFPs and price supports may help to plug the income gap underlying fuel poverty, energy-efficiency measures are often considered a longer-term solution to fuel poverty.

- **Home energy-efficiency improvement measures** in England have been funded through such schemes and programmes early examples include Warm Front(11), the Community Energy Saving Programme (CESP), which focused on improving energy efficiency in households in the most derived areas across the United Kingdom and supplier obligations to reduce carbon emissions for example the Carbon Emissions Reduction Target (CERT), which aimed to make energy efficiency measures available to all consumers.(12) CERT and CESP have been replaced by the Energy Company Obligation (ECO) which is a government energy efficiency scheme to help reduce carbon emissions and tackle fuel poverty in Great Britain. Fuel poverty is a devolved issue, and each UK country has its own definition, targets and policies.

Following a Competition and Markets Authority (CMA) report (2016) a price cap for customers on pre-payment meters was introduced in 2017. An extension of this cap, known as the safeguard tariff, came into force in February 2018 for recipients of the Warm Homes Discount. On 1 January 2019, a wider tariff cap for 11 million customers on default tariffs came into force (subsuming the safeguard tariff). Originally intended to end in 2020, the cap has been extended - until 2023 if needed.

In response to increases to the default tariff cap, as a result of rising wholesale prices and additional costs for suppliers during the Covid-19 pandemic the Government announced a package of support to help households with rising energy bills. It included:
Energy Bill Discount Scheme - All domestic electricity customers in Great Britain will receive "an upfront discount on their bills" to be recovered in annual instalments over five years.
Council Tax Rebate - A non-repayable council tax rebate for all households in bands A to D in England (expected to benefit 80% of homes in England). Comparable support was available for Scotland, Wales or Northern Ireland. The House of Commons Library briefing *Energy price rises and the Energy Bills Rebate* gives details of these schemes.[1]

Other options
An evidence review produced for the Welsh Centre for Public Policy (13) mentions two community projects that attempt to address recognised problems in targeting recipients in need:

- **Targeting food bank users** with pre-payment meters and providing them with a fuel voucher seeks to align fuel provision to other forms of income support.
- **Energy local clubs** using technology (smart metering) to reduce energy purchasing costs for the community. Smart meters show when and how much power they are using and enable people to use energy at times when energy is cheaper - often late at night or early in the morning

Increased awareness of the indoor temperature using a bamboo brooch containing a thermometer (14) targeted vulnerable residents with a chronic health condition.

Experience from other countries.
In Scandinavian countries and the Netherlands, social support is provided but also significant effort is being put into improved energy efficiency of social housing stock.(15) In the UK stark differences exist between the energy efficiency of different tenures of housing with private rental sector the worst, social housing is generally much better. Recommendations from the annual report of the Fuel Poverty Committee 2021 include a recommendation around improving the energy efficiency of homes in the private rental sector to Energy Efficiency Rating Band C, they estimate this would improve the energy efficiency rating of 70% of homes that are currently rated D/E/F/G.(16) Some countries use fuel vouchers, to ensure that payment is targeted at heating of housing, in contrast to the UK "winter fuel payment" label. Cultural attitudes towards heating of housing may result in variation in practices; lack of New Zealand householder interest in warmer housing has been attributed to a 'masculine pioneer heritage', the dominance of the hardy male role model as a relic from the early settlement. Different age groups may hold different values although engrained attitudes can be reshaped by change, for example, by implementation of a new central heating system.

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[1] House of Commons Library. Research Briefing. Energy Bills Support Scheme: Government policy and FAQs. https://commonslibrary.parliament.uk/research-briefings/cbp-9461/#:~:text=The%20price%20of%20energy%20has,and%20the%20reaction%20to%20them

Winter Fuel Payments (WFPs):

WFPs are the most important benefits for people aged 65 or over directly related to Winter Mortality in the UK.(17) The total expenditure on the WFP has been estimated to range between £2 Billion and £3Billion per year.(18) Although WFPs can be spent on any goods and services, labelling the cash transfer as a 'winter fuel' payment attempts to 'nudge' recipients towards increasing domestic heating.(19, 20) By attempting to combat fuel poverty in this way, and thereby raising indoor temperatures, the programme is intended to reduce morbidity and excess winter mortality.(18)

One recent systematic review (21) specifically includes studies of WFPs but reviews only one study identified for this briefing.(18) Four primary studies examined the impact of WFPs in terms of health outcomes (4, 17, 18, 22).

Impacts of Winter Fuel Payments

What do Winter Fuel Payments achieve?

Approximately half (47%) of the WFP is actually spent on fuel.(19) Winter Fuel Payments and Warm Home Discount (a one-off discount on an electricity bill, between October and March) programmes are remarkably poorly targeted (7), the 2021 annual report of the Committee on Fuel Poverty highlights that winter fuel payments continue to be targeted at pensioners, many who are have higher incomes. The report estimated that <10% of WFP is target on fuel poor 2020 and the WHD is 20%. The WHD has more restrictive eligibility criteria than the WFP, but similarly favours those of retirement age.(23)

Health impact

The impact of WFPs is measured in relation to improved health or via surrogate measures such as raised household temperature levels. Health improvement is typically measured in terms of participant-reported health indicators or objectively recorded biomarkers.(24) Measures include blood pressure, inflammation, lung function, presence of chest infections, subjective health and depressive symptom ratings.

Other impacts - improve finance and wider improvements

Other impacts associated with improved thermal comfort and affordable warmth are linked to an effective increase in house size by increasing usable space. Increased usable space can promote improvements in diet, privacy, household and family relationships, as well as opportunities for leisure and studying.(25) Improvements in health following warmth improvements may also lead to reduced absences from school or work.

Current official ways of establishing entitlement are based on Low Income High Cost (LIHC) and the Low Income Low Energy Efficiency (LILEE). LIHC defines a household as fuel poor if their income is below the povery line and their houses has energy costs which are atypically high. The LILEE measure defines a household as fuel poor if their residual income is below the poverty line after fuel costs are considered and their home has an energy efficiency rating below Band C. Heterogeneity in households means that entitlement does not always target those at need and may in fact target those not at need (26)

Included studies

Iparraguire (2015) employed a *time series analysis* to demonstrate that WFPs were linked to about half of the decline in excess winter mortality (EWM) observed in England and Wales during the 1990s.(17) The time-series analysis only attempted to quantify direct effects of the payments.

Armstrong (2018) demonstrated that, since the introduction of WFPs, the gradient of association between winter cold and mortality [2.00%, 95% confidence interval (CI) 1.74% to 2.28%] per degree Celsius fall in temperature is somewhat weaker (i.e. that the population is less vulnerable to cold) than in earlier years (2.37%, 95% CI 0.22% to 2.53%). Years with above-average fuel costs were associated with higher vulnerability to outdoor cold. (4)

Crossley & Zilio (2018) used a *regression discontinuity design (RDD*), a quasi-experimental design where groups are assigned to an intervention or control according to a pre-intervention cut-off limit, to examine the causal effect of the WFP on health outcomes, including self-reports of chest infection, measured hypertension, and biomarkers of infection and inflammation.(22) They found a robust and statistically significant effect for only one of the four individual illness measures (serum fibrinogen – a measure of infection and inflammation). However, they observe that point estimates for all the markers point towards improved health outcomes.

Angelini et al (2019) considered the impact of WFP on indoor temperatures as recorded by nurse visits for around 12,000 individuals. Using a regression discontinuity design they conclude that WFP eligibility did not result in an increase in home temperatures.(18). The study did demonstrate that low levels of indoor temperature were associated with raised blood pressure, raised fibrinogen and CRP levels. These associations persisted even when demographic factors, socioeconomic background, the presence of health conditions, body mass index, and month of year and region were taken into account.(18)

Key conclusions

- ➔ *At a population level winter fuel payments appear to be responsible for a large amount of health improvement. However studies use aggregate not individual-level data and lack comparator regions.(18)*
- ➔ *Only one biomarker of infection and inflammation (fibrinogen) was found to change significantly as a result of increased indoor temperature. Evidence therefore uses indirect outcome measures and demonstrates a minimal effect.*

Table 1 - Summary of Findings Table for Winter Fuel Payments

Patients or population: UK Population 65 years and older
Settings: UK Winter Weather
Intervention: Winter Fuel Payments
Comparison: Non-receipt of/non-eligibility for payments

Outcomes	Impact	Number of studies	Quality of the evidence (GRADE)*
	Relative change		
Excess Winter Mortality (EWM)	13.5 % relative reduction (almost half of average 29.5% fall in EWM)	1	⊕⊕⊕◯ Moderate
Chest infections	−.024 [−050, .001] NS	1	⊕⊕◯◯ Low
Measured hypertension	−018 [−045, .009] NS	1	⊕⊕◯◯ Low
Biomarkers of infection and inflammation	Fibrinogen −058 [−.080, −036] Significant at p < .01. C-reactive protein −013 [−040, .015] NS	1	⊕⊕⊕◯ Moderate

*GRADE Working Group grades of evidence:
⊕⊕⊕⊕ **High**: We are confident that the true effect lies close to what was found in the research.
⊕⊕⊕◯ **Moderate:** The true effect is likely to be close to what was found, but there is a possibility that it is substantially different.
⊕⊕◯◯ **Low:** The true effect may be substantially different from what was found.
⊕◯◯◯ **Very low:** We are very uncertain about the effect.

Equity, costs, monitoring and evaluation

Policy discussions around WFP include extending the benefit to severely disabled people regardless of age, bringing forward the timing of payments for households not connected to the main gas grid, means testing the allowance, re-defining the eligibility criteria, withdrawing the allowance from pensioners paying higher rate income tax and making it a taxable benefit.(17) Findings of health benefits associated with WFP are consistent with wider research which found that a decline in Pension Credit support for low income pensioners is associated with a statistically significant increase in excess winter mortality.(27) A key tension arises between enhanced targeting of vulnerable or energy poor households versus the administrative complexity that might result.

Recent years have seen increased criticism of excess winter mortality as a public health measure.(28-30). In the UK the risk of winter mortality in UK depends on numerous factors that extend beyond fuel poverty, such as determinants of indoor temperature (outdoor temperature, temperature gradient, time of day, length of time in house), and other characteristics (household size; net household income; geographical region; age of the property; presence of central heating; satisfaction with the heating system; and cost of heating the dwelling to a minimum standard).(31, 32)

Home energy efficiency (HEE) interventions:

Interventions to improve the energy efficiency of homes are a common policy in many countries including the UK. These measures can be targeted towards specific populations – families on low income, families at risk of fuel poverty.

Impacts of HEE interventions

Home energy efficiency (HEE measures) installed in England between 2002–10 achieved a relatively modest impact in improving the indoor environment. Gains in winter temperatures (around +0.09 °C on a day with maximum outdoor temperature of 5 °C) are associated with an estimated annual reduction of ≈280 cold-related deaths in England (an eventual maximum annual impact of 4000 life-years gained), but these impacts may be appreciably smaller than those achieved by improvements in indoor air quality. Modelling studies indicate the potential importance of the medium- and longer-term impacts that HEE measures have on health, which are not observable in short-term studies. HEE improvements of similar annualised cost to current WFPs would achieve greater improvements in health while reducing (rather than increasing) carbon dioxide emissions. Householder framings of HEE measures (as home improvement, home maintenance, subsidised public goods and contributions to sustainability) do not dovetail with 'consumerist' national policy and may have implications for the uptake of HEE measures. (4)

Interventions that improve the energy efficiency of homes lived in by people with low incomes – can make a substantial difference, but those planned for 2016 were only believed to be able to reduce the problem by a tenth. (7) Furthermore, the 2021 annual report of the Committee of Fuel Poverty documents how the government has missed the 2020 milestone. (16) The schemes and funding was available but the government did not target households in highest levels of fuel poverty instead predominantly higher income households were targeted. The report also highlights that the 2025 milestone is a risk of being missed and makes recommendations for what the government would need to do to meet this target. These include using data effectively to identify and fuel poor households and target current and future programmes to helping these households to pay their energy bills and improve the energy efficiency of their homes. Additionally, the Winter Fuel Payment should be targeted to households most in need of help with paying their energy bills and programmes to improve the energy efficiency of their homes.

Home energy efficiency measures were reviewed in four reviews (9, 11, 27-28), see Table 1 Energy efficiency measures were also researched in six primary studies (17, 29, 30-33). The different sections start by presenting the review level evidence and then extend to evidence from primary studies.

Health impact

Powell (2018), an evidence review, covered 12 interventions from five countries and found some indications of health improvements from energy efficiency measures although the evidence is self-reported and anecdotal (13).

Curl & Kearns (2017) investigated the impacts of two home improvements energy efficiency measures on fuel poverty and mental health found that self-report of greater frequency of financial difficulty by households was accompanied by reports of worsening mental health. The efficiency measures were found to make limited difference to whether households had fuel affordability difficulties although this outcome was measured by self-report which can be subjective and future research should measure fuel use and costs before and after the improvement. Central heating improvements were potentially related to actual increased frequency of financial hardship while users understand how to use the new system. The researchers also suggest that advice and support provided while improvements are installed and with using the new system might increase the impact of similar programmes. Longer-term impact would also be more informative than the short-term outcomes measured in the study (33).

Armstrong (2018) found that HEE interventions have had a relatively modest impact in improving the indoor environment; indoor temperatures in the winter had an average increase of around 0.09 °C and there were modest impacts on air quality. The indoor temperature changes were associated with an estimated initial reduction of around 280 cold-related deaths nationally and a potential eventual maximum impact of 4000 life-years gained per year. Physics models built of resultant changes in ventilation indicate either a positive or negative impact on health. The qualitative study found four reasons for HEE interventions: home improvement, home maintenance, subsidised public goods and contributions to sustainability. Current UK policy frames HEE in consumerist terms which could improve initial uptake rates but avoids a commitment to environmental sustainability with the potential to undermine long-term public support (4).

Poortinga (2018) found that the impacts of energy performance investments in low-income areas on emergency hospital admissions were non-significant. The same outcomes reanalysed for people aged 60 were only significant for a significant increase in cardiovascular-related emergency hospital admissions (Δ0.0273, 95% CI 0.006 to 0.0479). In the absence of evidence of changes in physical health improvements were reported for subjective well-being and several psychosocial outcomes. The health economic assessment found no explicit cost reductions to the health service as a result of non-significant changes in emergency admissions for cardiorespiratory conditions (34).

Sharpe (2019) explored population data and found that nationally, there were 312,837 emergency admissions for asthma, 587,770 for COPD and 839,416 for CVD. While analyses for individual energy efficiency metrics were inconclusive; a unit increase in mean energy performance rating was associated with increases of around 0.5% in asthma and CVD admissions, and 1% higher COPD admission rates. Admission rates were also influenced by the type of dwelling, tenure status, living in a rural area, and minimum winter temperature. At a county-level there were 933 emergency admissions for asthma, 3071 for COPD and 7905

for CVD but no association was found for asthma admissions and loft insulation, wall insulation or glazing. However, an association was indicated between higher admission for COPD and CVD and loft insulation and further indications that areas with fewer homes with wall insulation had lower CVD admissions. This analysis relied upon estimates making the findings tentative. In the future sustainable measures should account for variable lifestyles, as well as the need for adequate heating and ventilation (35).

Sawyer 2022 found that following the Healthy Homes Programme, resident self-reported health and wellbeing significantly improved with interviews eliciting clear examples of improvements in physical health and wellbeing. For example, fewer chest infection, less anxious and depressing were reported. Interviewees also mentioned wider impacts like reduced social isolation (36).

Other impacts – improvement in finances

Berretta's (2021) meta-analysis on residential energy efficiency interventions (REEI) indicates that they significantly reduce energy consumption. Implementation and context are important given that studies evaluating the same type of REEI's reported differing impacts on energy consumption. Within the 16 included studies, there were 4 main types of REEIs: installation of efficient lighting, attic/loft insulation, electric heat pumps and bundled REEIs, whereby households chose which REEIs to introduce depending on which was cost effective and appropriate for their house. Boilers were replaced and attic insulation was installed in some households while others replaced their furnace and installed wall insulation or had their windows sealed etc. There was promising evidence that installing REEI bundles significantly reduced energy consumption. Installation of other individual energy efficiency measure(s) (EEM) produced smaller reductions in energy consumption with between-study differences with some estimating larger or non-significant changes and even an increase in energy consumption in one study. The review cautioned that there was limited evidence for installing EEMs based on small number high quality studies. Seven studies researched installation of bundled REEIs, five households made their choice following an energy audit, and overall found a significant reduction in energy consumption. Two studies on installing REEIs bundles targeted mainly at low-income households and appraised as having a low risk of bias demonstrated a significant reduction in energy consumption (37).

McAndrew (2021) and colleagues reviewed 153 household energy efficiency interventions and found overall evidence of effectiveness while advising caution in applying review results. Although the majority of studies (133) reported positive impact on outcomes, 13 of the interventions demonstrated limited or no effect on outcomes measured and negative impacts on outcomes were found in seven studies. The included interventions used diverse outcome measures making it difficult to compare effectiveness across different interventions. Included interventions ranged from interventions focusing on the individual and household level (micro) (90%), like smart meters, to interventions at the macro level for example policy-level interventions (8%). Few interventions focused on the micro and macro or multi-level (4%). The review found that the more activities that an intervention utilises the more likely it is to be successful. The majority of the interventions (121) targeted the general population, 24 were specifically for households with low incomes, 8 focused on households containing children and two were targeted to households with older people. The differential

effectiveness of interventions for population subgroups is not reported. Further research investigating the effectiveness of energy efficiency measures for specific population groups is needed (38).

Powell (2018) in an evidence review covering 12 interventions from five countries found some of the included evaluations produced minor reductions in residential energy bills (13).

Willand (2020) in a realist review aimed to consider the diversity of outcomes found in REEIs and provide potential explanations. The review included studies on retrofits, upgrade and refurbishment REEIs and found four common contextual mechanisms which influenced study outcomes. These were the attitudes of households towards REEIs, householders own heating and ventilation practices, the ability of householders to use the new equipment and the quality of the workmanship. Future REEIs design should address the needs of targeted households and the sociocultural context of the programme (39).

Sawyer 2022 found that many residents interviewed reported reductions in energy bills following installation of energy efficiency measures in the Healthy Homes Programme (36).

Poortinga 2018 energy performance investments in low-income areas found that indoor temperatures were raised and energy use reduced in the household monitoring study (34).

The reviews found limited and equivocal evidence of the effectiveness of energy efficiency measures even within studies of similar interventions. Bundles of REEIs or multiple activities were potentially the most effective. The realist review highlights the importance of considering the needs of the type of household the intervention is targeted the sociocultural context of where and how the programme is delivered. Individual primary studies reflect the same equivocal results found by the reviews.

Key conclusions

- ➔ *Energy efficiency measures can increase temperature*
- ➔ *Energy efficiency measures can reduce energy bills*
- ➔ *Similar annual expenditure on energy efficiency improvements to that for current WFPs would achieve greater improvements in health with the added benefit of reductions in carbon dioxide emissions.*
- ➔ *Energy efficiency measures achieve variable impacts on physical and mental health*
- ➔ *Energy efficiency measures can improve well-being and psychosocial outcomes*

Table 2 - Summary of Findings Table for Home energy efficiency interventions

Patients or population: UK Households
Settings: UK Winter Weather
Intervention: Installation of home energy efficiency measures
Comparison: Different or no home energy efficiency measures

Outcomes	Impact Relative change	Number of studies	Quality of the evidence (GRADE)*
Physical and mental health	Variable Improve No effect	5 3 2	⊕⊕◯◯ Low
Wellbeing and psychosocial outcomes	Improve	3	⊕⊕◯◯ Low
Energy bills	Reduce	5	⊕⊕◯◯ Low
Temperature	Increase around +0.09 °C on a day with maximum outdoor temperature of 5 °C	2	⊕⊕◯◯ Low

*GRADE Working Group grades of evidence:
⊕⊕⊕⊕ **High:** We are confident that the true effect lies close to what was found in the research.
⊕⊕⊕◯ **Moderate:** The true effect is likely to be close to what was found, but there is a possibility that it is substantially different.
⊕⊕◯◯ **Low:** The true effect may be substantially different from what was found.
⊕◯◯◯ **Very low:** We are very uncertain about the effect.

Equity, costs, monitoring and evaluation

Two studies reported a significant reduction in energy consumption; one a meta-analysis on installing REEIs bundles targeted mainly at low-income households and these were appraised as having a low risk of bias (28). Another review considered how improvements were targeted. The majority of interventions (121) were offered to the general population, 24 were specifically for households with low incomes, 8 focused on households containing children and two were targeted to households with older people. The effectiveness of the interventions for these population groups is not reported (27). The realist review concluded that future REEIs design should address the needs of targeted households and the sociocultural context of the programme (11).

The ability of householders to use the new equipment and the quality of the workmanship were two important contextual mechanisms found to influence the outcomes of installation of energy efficiency measures (11). The ability of householders to use the new equipment was also noted in another study that suggested that providing advice and support for households following improvements could potentially improve the outcomes of similar programmes (30).

Cold Weather Plan

The Cold Weather Plan for England (launched in 2011, produced annually), the latest plan is dated 2021 for Winter 2021-22.[1] The plan advises people on how to protect themselves from the potentially harmful impacts on their health of cold weather. Public Health England (2017) published evidence on adverse effects of cold on health and why it is important.[2]

Impacts of cold weather plan

Two included studies have researched the cold weather plan. One observational study considers the experiences of local decision makers on implementing the cold weather plan (40). Another observational study evaluated the effect of the cold weather plan on mortality related to cold weather (41).

Health impact

Murage (2018) an observational study found that since the introduction of the cold weather plan national mortality risk related to cold weather has declined significantly for people under 64 s (RR 1.34, 1.23–1.45, to RR 1.09, 1.00–1.19). However, there was a significant increase for people aged 75 and over (RR 1.36, 1.28–1.44, to RR 1.58, 1.47–1.70) and for people with respiratory disease (RR 1.78, 1.56–2.02, to RR 2.4, 2.10–2.79). There was variation in mortality risk by geographical area. The variations could be due to how the cold weather plan is implemented in different areas. 14 Sustainability and Transformation partnerships (STPs) were identified that were most in need of extra measures to reduce fuel poverty. Without information on how the cold weather plan is implemented in each STPs it is not possible to determine if changes in risk are from the cold weather plan or to fully understand the causes of the differences (30). The other study researching the cold weather plan considered implementation and thus will be discussed under implementation.

Other impact

Recent studies on the cold weather plan have not investigated other impacts.

Key conclusions

- ➔ *Significant decline in mortality risk related to cold weather for people under 64 since the implementation of the cold weather plan.*
- ➔ *Significant increase in mortality risk related to cold weather for people aged 75 and over and for people with respiratory disease*
- ➔ *Geographical variation in mortality risk*

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1031106/UKHSA_Cold_Weather_Plan_for_England.pdf

[2] https://khub.net/documents/135939561/174099487/Cold+Weather+Plan+-+Making+the+Case.pdf/69c22c83-1b1f-cfb9-0e2d-8f603a7b426e?t=1635339855693

Table 3 - Summary of Findings Table for Cold Weather Plan

Patients or population: England
Settings: UK winter weather
Intervention: Cold weather plan
Comparison: N/A

Outcomes	Impact	Number of studies	Quality of the evidence (GRADE)*
	Relative change		
Reduced national mortality risk for people under 64	(RR 1.34, 1.23–1.45, to RR 1.09, 1.00–1.19)	1	⊕⊕◯◯ Low
Increased national mortality risk for people aged 75 and over	(RR 1.36, 1.28–1.44, to RR 1.58, 1.47–1.70)	1	⊕⊕◯◯ Low
Increased national mortality risk for people with respiratory conditions	(RR 1.78, 1.56–2.02, to RR 2.4, 2.10–2.79)	1	⊕⊕◯◯ Low

*GRADE Working Group grades of evidence:
⊕⊕⊕⊕ **High:** We are confident that the true effect lies close to what was found in the research.
⊕⊕⊕◯ **Moderate:** The true effect is likely to be close to what was found, but there is a possibility that it is substantially different.
⊕⊕◯◯ **Low:** The true effect may be substantially different from what was found.
⊕◯◯◯ **Very low:** We are very uncertain about the effect.

Equity, costs, monitoring and evaluation

Heffernan (2018) a qualitative study found that the managers commented that while the NHS and LA commissioned different providers to support people through the cold weather plan the contracts often had no monitoring procedures meaning that commissioners were just trusting that services would be delivered (40).

Summary:

Winter Fuel Payments

- Only approximately 50% of Winter Fuel Payments are spent on fuel.
- Evidence suggests that current systems of Winter Fuel Payments imperfectly target those in need.
- Evidence for improved health benefits is weak with only measures of infection/inflammation showing significance.
- Some commentators suggest payments could be linked to other forms of income payments from the government.
- Excess winter mortality has been extensively criticised as a metric to inform public health intervention.

Home energy efficiency (HEE) interventions

- Evidence for improvements to temperature is modest.
- Outcomes assessed are generally short-term.
- Outcomes are generally self-reported which can be subjective.
- Evaluation of interventions for specific populations groups is limited.
- Future energy efficiency improvements need to be sustainable
- Energy efficiency improvements need to consider the target population and sociocultural context.

Cold Weather Plan

- Weak evidence of reduction in national mortality risk for people under 64
- Weak evidence of increase in national mortality risk for people aged over 75 years and with respiratory conditions
- Geographical variation in mortality risk suggests could be productive to target extra interventions for specific areas

Implementation considerations

Details of local initiatives

Npower fuel project
Initiative: A pilot project from Npower fuel bank (13) targeted food bank users with pre-payment meters and provided them with a fuel voucher to the value of £49.
Evaluation: The scheme is proving successful and Trussell Trust food banks are now involved enabling the scheme to be expanded.

Energy local clubs
Initiative: Energy local clubs (13) use smart metering to reduce energy purchasing costs for community.
Initiative: Installation of a biomass district heating unit has led to tenants in high-rise buildings, in South Lanarkshire, making significant energy savings.
Evaluation: These two initiatives have not been evaluated

Awareness of indoor temperature
Initiative: A pilot study (14) investigated with a bamboo brooch containing a thermometer, increasing vulnerable residents' awareness of indoor temperature to determine if it improved their health and wellbeing. Householders in the study had a chronic health condition and were already been assisted by Community Energy Plus, a private social enterprise.
Evaluation: Signs that households felt less cold or less poorly were not statistically significant. Responses did indicate though those households who reported the worst health before the study kept their homes at a higher average temperature. Also, fewer "over the counter" medications were sought by households with most awareness of indoor temperatures.

Barriers to implementation of Winter Fuel Payments
Current official ways of establishing entitlement, based on whether a household would need to spend more than 10 per cent of its income on energy, gives a misleading impression of trends. At times some of those affected are excluded while conversely people with high incomes are included. One reason is the sheer heterogeneity of fuel-poor households. (26)

Barriers to implementation of home energy efficiency measures
Willand (2020) found that the ability of householders to use new equipment influences the outcome of home energy efficiency studies. (11)

Curl & Kearns (2017) found that resident fuel consumption increased following installation of a new central heating system and suggested that advice and support should be provided while improvements are installed to increase the impact of similar programmes. (30)

Armstrong (2018) qualitative study found four reasons why households in England had HEE interventions: home improvement, home maintenance, subsidised public goods and contributions to sustainability. Current UK policy frames HEE in consumerist terms which could improve initial uptake rates but moves away from a commitment to environmental

sustainability which could harm long-term public support. To improve uptake of HEE interventions there is a need to align national and local policy objectives to those of householders.

Sharpe (2019) to be sustainable, household energy efficiency policies and resulting interventions need to consider the whole house approaches and need to consider 'greener' options. Consideration should be given to sustainable measures that account for diverse lifestyles, as well as the need for adequate heating and ventilation (32).

Barriers to implementation of the cold weather plan

Heffernan (2018) conducted a qualitative study interviewing managers reported that they had difficulty in engaging general practices. One of the local authorities had a "GP champion" who worked on raising awareness of the cold weather plan with local GPs. Publication of the plan earlier in the year was believed to offer more time to engage GPs. Local areas differed in how they identify vulnerable people with data-sharing often being hampered by data protection restrictions. Since initial implementation of the plan in the winter of 2012-13 guidance for identification of vulnerable people has become clearer (40).

Evaluation and research priorities

The aim of this evidence briefing is to foster dialogue and judgements that are informed by the best available evidence. The intention is *not* to advocate specific options or close off discussion. Overall, the evidence identified is consistent with the findings of the Hills report, namely that "*policies that improve thermal efficiency of the housing stock tend to be the most cost-effective. They have persisting benefits in reducing fuel poverty, reduce greenhouse gases, and have very substantial net societal benefits."(7)*

Further evaluation and research priorities could include:

- Ensure interventions are targeted at people across a wider spectrum of fuel poverty (e.g. not limited to pensioners)
- Greater consistency in the working definition of fuel poverty used in research studies to enable comparison of study outcomes
- Intervention study measure outcomes using validated measures instead of self-report measures
- Studies using consistent outcome measures to enable comparison of study outcomes
- Research into how to improve energy efficiency of housing instead of increasing energy consumption

Glossary, acronyms and abbreviations

Carbon Emissions Reduction Target (CERT) – scheme that ran from April 2008 until December 2012 which placed a five year commitment on certain gas and electricity suppliers to reduce carbon emissions within domestic properties.

Community Energy Saving Programme (CESP) – obligation, that came into force on 1 September 2009 and ran until 31 December 2012, on large UK energy companies to deliver energy saving measures to low income households.

Competition and Markets Authority (CMA) - the competition regulator in United Kingdom, responsible for strengthening business competition and preventing and reducing anti-competitive activities.

Cold Weather Payment (CWP) - payment made to low-income households when outdoor temperatures are at or below zero degrees Celsius for at least seven consecutive days. CWP is a means-tested one-off payment made to receipts of certain benefits.

Energy Company Obligation (ECO) - a government energy efficiency scheme in Great Britain to help reduce carbon emissions and tackle fuel poverty. The scheme began in April 2013, and over time it has been amended.

Energy efficiency measures (EEM) – measures to improve energy efficiency

Excess Winter Mortality (EWM) – The difference between the actual number of winter deaths from December to March and the expected number of deaths.

Fuel Poverty – the condition when a household cannot afford to heat their home to an adequate temperature.

Fuel Price Support - targeted reductions in fuel tariffs aimed at particular population groups (in contrast with universal fuel price regulation which impacts on the whole population).

Home Energy Efficiency (HEE) interventions/measures – interventions or measures to improve the energy efficiency of homes

Home Energy-Efficiency Improvement – home improvements to increase energy efficiency.

Regression Continuity Design - a quasi-experimental before-after design that aims to determine the causal effects of interventions by assigning a cut off or threshold above or below which an intervention is assigned.

Residential energy efficiency interventions (REEI) – improvements in residential housing that seek to improve energy efficiency

Sustainability and Transformation Partnerships (STP) – partnerships introduced in 2016 between NHS organisations and local councils to develop shared plans to improve health and care in their local area.

Warm Home Discount (WHD) - a mandatory social price support measure that was introduced in addition to the WFP, and replaced social tariffs that were available to households vulnerable to fuel poverty.

Winter Fuel Payment (WFP) - a non-means-tested, tax-free annual cash payment made usually in December to households with someone over Pension Credit age (currently, 65 years) to help with heating costs.

References

1. Piddington J, Nicol S, Garrett H, Custard M. The housing stock of the United Kingdom. BRE Trust: Watford, UK. 2020.
2. Taylor J, Symonds P, Heaviside C, Chalabi Z, Davies M, Wilkinson P. Projecting the impacts of housing on temperature-related mortality in London during typical future years. Energy and Buildings. 2021;249:111233.
3. Ferriman A. Excess winter deaths linked to temperatures in cold homes. Bmj. 2001;323(7323):1207.
4. Armstrong B, Bonnington O, Chalabi Z, Davies M, Doyle Y, Goodwin J, et al. The impact of home energy efficiency interventions and winter fuel payments on winter- and cold-related mortality and morbidity in England: a natural equipment mixed-methods study. NIHR Journals Library. 2018;10:10.
5. Bone A, Wookey R, Austyn K. Cold Weather Plan for England. Making the case: why longterm planning for cold weather is essential to health and wellbeing. Public Health England https://www gov uk/government/uploads/system/uploads/attachment_data/file/36526. 2017;9.
6. Hinson S, Sutherland N, Bolton P. Fuel Poverty. London: House of Commons Library; 2022.
7. Hills J. Getting the measure of fuel poverty: Final Report of the Fuel Poverty Review. 2012.
8. Thomson H, Thomas S, Sellstrom E, Petticrew M. Housing improvements for health and associated socio-economic outcomes. Cochrane Database Syst Rev. 2013;2:CD008657.
9. Sunderland L, Croft D. Energy poverty–risks, conflicts and opportunities in the development of energy poverty alleviation policy under the umbrella of energy efficiency and climate change. Energy efficiency first: The foundation of a low-carbon society. 2011.
10. Poortinga W. Health and social outcomes of housing policies to alleviate fuel poverty. Urban Fuel Poverty: Elsevier; 2019. p. 239-58.
11. Green G, Gilbertson J. Warm Front Better Health: health impact evaluation of the Warm Front scheme. 2008.
12. Department of Energy and Climate Change. Evaluation of the Carbon Emissions Reduction Target and Community Energy Saving Programme: Executive Summary. London: Research undertaken for DECC by Ipsos MORI, CAG Consultants, UCL and Energy
Saving Trust; 2014.
13. Powell J, D. K, Reed M. What works in tackling fuel poverty: an evidence review of interventions to address fuel poverty. 2018.
14. Pollard A, Jones T, Sherratt S, Sharpe RA. Use of Simple Telemetry to Reduce the Health Impacts of Fuel Poverty and Living in Cold Homes. Int J Environ Res Public Health. 2019;16(16):09.
15. Pye S, Dobbins A, Baffert C, Brajković J, Deane P, De Miglio R. Addressing energy poverty and vulnerable consumers in the energy sector across the EU. L'Europe en Formation. 2015;378(4):64-89.
16. Committee On Fuel Poverty. Annual Report: 2021. London: Committee On Fuel Poverty,; 2021.
17. Iparraguirre J. Have winter fuel payments reduced excess winter mortality in England and Wales? J Public Health (Oxf). 2015;37(1):26-33.
18. Angelini V, Daly M, Moro M, Navarro Paniagua M, Sidman E, Walker I, et al. The effect of the Winter Fuel Payment on household temperature and health: a regression discontinuity design study. NIHR Journals Library. 2019;1:1.
19. Beatty TK, Blow L, Crossley TF, O'Dea C. Cash by any other name? Evidence on labeling from the UK Winter Fuel Payment. Journal of Public Economics. 2014;118:86-96.
20. Allmark P, Tod AM. Can a nudge keep you warm? Using nudges to reduce excess winter deaths: insight from the Keeping Warm in Later Life Project (KWILLT). J Public Health (Oxf). 2014;36(1):111-6.

21. Wang C, Wang J, Norbäck D. A Systematic Review of Associations between Energy Use, Fuel Poverty, Energy Efficiency Improvements and Health. Int J Environ Res Public Health. 2022;19(12).
22. Crossley TF, Zilio F. The health benefits of a targeted cash transfer: The UK winter fuel payment. Health Economics (United Kingdom). 2018;27(9):1354-65.
23. Snell C, Bevan M, Thomson H. Justice, fuel poverty and disabled people in England. Energy Research & Social Science. 2015;10:123-32.
24. Shiue I. Cold homes are associated with poor biomarkers and less blood pressure check-up: English Longitudinal Study of Ageing, 2012-2013. Environ Sci Pollut Res Int. 2016;23(7):7055-9.
25. Thomson H, Thomas S, Sellström E, Petticrew M. Housing Improvements for Health and Associated Socio-Economic Outcomes: A Systematic Review. Campbell Systematic Reviews. 2013;9(1):1-348.
26. Gough I. Climate change, social policy, and global governance. Journal of international and comparative social policy. 2013;29(3):185-203.
27. Loopstra R, McKee M, Katikireddi SV, Taylor-Robinson D, Barr B, Stuckler D. Austerity and old-age mortality in England: a longitudinal cross-local area analysis, 2007-2013. J R Soc Med. 2016;109(3):109-16.
28. Hajat S, Gasparrini A. The Excess Winter Deaths Measure: Why Its Use Is Misleading for Public Health Understanding of Cold-related Health Impacts. Epidemiology. 2016;27(4):486-91.
29. Liddell C, Morris C, Thomson H, Guiney C. Excess winter deaths in 30 European countries 1980-2013: a critical review of methods. J Public Health (Oxf). 2016;38(4):806-14.
30. Milne E. Mortality in England - erroneous attribution of excess winter deaths to underlying trend. J R Soc Med. 2017;110(7):264-6.
31. Ballesteros-Arjona V, Oliveras L, Munoz JB, Lima AOD, Carrere J, Ruiz EM, et al. What are the effects of energy poverty and interventions to ameliorate it on people's health and well-being?: A scoping review with an equity lens. Energy Research & Social Science. 2022;87.
32. Wilkinson P, Landon M, Armstrong B, Stevenson S, Pattenden S, McKee M, et al. Cold comfort: The social and environmental determinants of excess winter deaths in England, 1986-96. 2006.
33. Curl A, Kearns A. Housing improvements, fuel payment difficulties and mental health in deprived communities. International Journal of Housing Policy. 2017;17(3):417-43.
34. Poortinga W, Rodgers SE, Lyons RA, Anderson P, Tweed C, Grey C, et al. The health impacts of energy performance investments in low-income areas: a mixed-methods approach. NIHR Journals Library. 2018;3:3.
35. Sharpe RA, Machray KE, Fleming LE, Taylor T, Henley W, Chenore T, et al. Household energy efficiency and health: Area-level analysis of hospital admissions in England. Environ Int. 2019;133(Pt A):105164.
36. Sawyer A, Sherriff N, Bishop D, Darking M, Huber JW. "It's changed my life not to have the continual worry of being warm" - health and wellbeing impacts of a local fuel poverty programme: a mixed-methods evaluation. BMC Public Health. 2022;22(1):786.
37. Berretta M, Furgeson J, Wu Y, Zamawe C, Hamilton I, Eyers J. Residential energy efficiency interventions: A meta-analysis of effectiveness studies. Campbell Systematic Reviews. 2021;17(4).
38. McAndrew R, Mulcahy R, Gordon R, Russell-Bennett R. Household energy efficiency interventions: A systematic literature review. Energy Policy. 2021;150.
39. Willand N, Maller C, Ridley I. Understanding the contextual influences of the health outcomes of residential energy efficiency interventions: realist review. Housing Studies. 2020;35(1):1-28.
40. Heffernan C, Jones L, Ritchie B, Erens B, Chalabi Z, Mays N. Local health and social care responses to implementing the national cold weather plan. Journal of Public Health. 2018;40(3):461-6.

41. Murage P, Hajat S, Bone A. Variation in Cold-Related Mortality in England Since the Introduction of the Cold Weather Plan: Which Areas Have the Greatest Unmet Needs? Int J Environ Res Public Health. 2018;15(11):19.