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Housing improvements, fuel payment difficulties and mental health in deprived communities

This paper examines the effect of warmth interventions on self-reported difficulties affording fuel bills against a backdrop of rising mental health problems, using a longitudinal sample in Glasgow, UK. Following a period of rising fuel prices and stagnating wages, fuel poverty is high on the political agenda and is a particular issue for those living in deprived communities who may be most affected by rising fuel bills and reductions in employment, wages and incomes in the recent period of recession and austerity. Since 2006, the reporting of difficulties paying for fuel bills has been rising in the study population. Alongside fuel prices and income, energy efficiency is the third key driver of fuel poverty. As such the research seeks to establish whether warmth interventions, designed to improve the energy efficiency of homes can provide protection against worsening financial difficulties and lead to better mental health outcomes for residents. Results suggest that those who report greater frequency of financial difficulty also report worsening mental health. There is limited impact of energy efficiency improvements on perceived fuel affordability difficulties, and where there is an effect, central heating is related to more frequent financial hardships.

Keywords: fuel poverty; energy efficiency; mental health; regeneration;

Introduction

This paper presents the results of work exploring the relationships between housing warmth improvements (provision of central heating and insulation), fuel poverty and mental health, the latter using a measure of perceived financial difficulty. Those individuals who are in fuel poverty spend a disproportionate amount of household income on heating their homes.. In the UK, health is identified as the main beneficiary of strategies that address fuel poverty, especially for vulnerable people (Department for Business, Environment and Regulatory Reform (BERR), 2001). In

Scotland, it is deemed that ‘fuel poverty can impact negatively on quality of life and health’, with the emphasis on excess winter deaths and circulatory health conditions such as hearing problems or high blood pressure (Scottish Government 2008, p.12). Financial stress is also associated with mental health, and rising fuel costs are a particular source of stress. Energy efficiency of the home is one of three key drivers of fuel poverty and while there is an assumption that improvements in energy efficiency will reduce fuel poverty through reduced fuel bills, there is limited evidence relating to how this is experienced among those with limited budgets. The purpose of this study is to investigate the impact of energy efficient housing improvements on reported difficulties affording fuel bills and mental health in relatively deprived communities in Glasgow, UK. Deprivation in this context comprises those communities in the most 15% income deprived according to the Scottish Indices of Multiple Deprivation (SIMD) which rank areas according to household income (Walsh 2008; Scottish Government 2012). Those in the bottom 15% of household income are likely to experience deprivation across multiple domains (such as health, education etc.) and be most susceptible to the negative health and wellbeing effects of high fuel costs (Wilson et al 2012).

The paper first considers how fuel poverty is understood in academic and policy debates. This discussion is followed by the definition and extent of fuel poverty in Scotland, where this study of housing improvements, fuel poverty and mental health is conducted. Before describing the study in detail the evidence for the impacts of housing improvements upon fuel poverty and mental health is reviewed.

Fuel poverty is usually measured objectively and there is an assumption that improved energy efficiency will reduce the actual cost burden of keeping homes warm, but there is limited evidence on the occupants’ experience of paying for fuel after

energy efficiency improvements, and even evidence on the impacts of payment difficulties upon mental health.

Defining and Measuring Fuel Poverty

Researchers who have been studying the issue of fuel poverty for a long time state that “the perfect definition of fuel poverty is proving elusive” (Boardman, 2012, p.144). As has been pointed out in relation to the UK Government’s review of the definition of fuel poverty (Hills 2012), different definitions focus on different groups of fuel poor households (Moore 2012) and can make official policy to eradicate fuel poverty appear more or less successful at the same time (Boardman 2012; Liddell et.al. 2012).

Most of these debates are about different means of estimating the numbers and identity of those who are deemed to be in fuel poverty. A more fundamental issue is what is being measured in order to determine whether or not an individual or household fits into a category of being in fuel poverty. A UK think tank has said that “Put simply, fuel poverty is the inability to afford to heat your home adequately” (Howard, 2015, p.9). Yet, taking a human rights approach to fuel poverty, Boardman’s description broadens the issue to include access to energy services more generally (Boardman 2010) and encompassing aspects of money, comfort, health and psychology: “To be able to be warm, to be free from intense worry about paying the fuel bills, to be able to afford adequate hot water and light – these are part of our human rights...”; and “At heart, reducing fuel poverty is about enabling people on low incomes to be warm, comfortable and healthy” (Boardman 2012, p.147).

More fundamentally, Walker and Day (2012) see fuel poverty as an issue of distributional justice, identifying two distinct perspectives. The first views fuel poverty as an issue of inequality in the distribution of a primary good, a la Rawls (1971), in the

form of energy services or adequate warmth. The second perspective, which the authors prefer, sees fuel poverty as concerning inequality in the capability to achieve capable or valued functioning (things people want to be or do), a la Sen (1999). Allied to the latter, Sen also considers a relational perspective wherein “fuel poverty can be read as a lack of recognition of the needs of certain groups” (p.71). Most interestingly, this perspective, based on recognition theory (Fraser 1995), acknowledges that fuel poverty can have both material and psychological consequences which are not equal across social and demographic groups.

These alternative understandings of fuel poverty are reflected in the main methods of measurement used in both official policy and in research. The access to material goods perspective informs the most commonly used measurement approaches. Measurement approaches mostly examine either what proportion of people’s incomes are actually spent on fuel or what proportion would need to be spent on fuel to achieve defined standards of warmth, taking account of the energy efficiency of their homes (e.g. Department of Energy and Climate Change (DECC), 2011). Focusing on what Boardman (2012) sees as the main solution to the problem., estimates have suggested that expenditure needs are at least a fifth higher than actual expenditures, particularly in the UK’s peripheral regions (Department of Energy and Climate Change 2011; Liddell et al 2011). A minority of studies use an alternative measure of how many days occupants go without heating. As has been pointed out, the use of an absolute standard or proportion of income spent on fuel as a definition of fuel poverty presents difficulties because it is very susceptible to movements in fuel prices (Hills 2012), and it is insufficiently adjusted for regional differences in heating needs and fuel costs (Liddell et al 2012). Indeed, in his review for the UK Government, Hills (2012) suggests moving away from a single measure, and defines being in fuel poverty as

having required fuel costs which are above the median level, and , if that amount were to be spent on fuel, being left with a residual income below the official poverty line.

Alternatively, studies from the capability and recognition perspective focus on the psychological consequences of fuel poverty and either measure people's perceived thermal comfort (e.g. Hong et al 2009; Lacroix and Chaton 2015), or their perceived difficulty paying for fuel bills, or financial strain more generally (e.g. Green and Gilbertson 2008; Platt et al 2007). The measure utilised in this paper is perceived financial difficulty, in order to understand the experience of fuel poverty, rather than an absolute measure.

Fuel Poverty in Scotland

Poor housing conditions and poverty, more generally, have long been extensive problems in Scotland. Since Scotland gained additional powers from the United Kingdom government under a process of devolution in 1999, tackling these issues as part of a social justice agenda has been a political priority (Scottish Executive 2006) as part of a social justice agenda. In setting a future agenda for Scotland's housing at the commencement of devolution, it was estimated that 90 percent of Scottish dwellings did not meet the then-current building regulations for thermal energy efficiency and that 'there is a significant problem of fuel poverty among Scotland's families' (Scottish Office 1999, para. 1.18).

The Scottish Government, like other public agencies, takes a materialist perspective and defines fuel poverty as spending more than 10% of household income on fuel use, and extreme fuel poverty as spending more than 20% (Scottish Executive 2002). The Housing (Scotland) Act of 2001 states that Scotland is committed to alleviating fuel poverty 'so far as is reasonably practicable' by late 2016. There have been a series of

programmes since 2001 to provide central heating and energy efficiency measures to variously defined poor or vulnerable households in Scotland; the earliest incarnation being the Central Heating Programme (CHP) and the latest being the Home Energy Efficiency Programmes (HEEP) for Scotland. As a result, the energy efficiency of the Scottish housing stock has been gradually improving with 71% of dwellings achieving 'good' ratings by 2013 (Mueller et al 2014). Despite this, one review pointed out that even if all the housing was in the top category for energy efficiency, 14% of households would still be in fuel poverty for other reasons (Wilson et al 2012).

Despite improvements to the housing stock, the proportion of Scottish households in fuel poverty in 2013 had almost doubled since 2003 and continues to rise (Liddell, 2015). The latter is partly a function of the fact that whilst energy efficiency improvements resulted in an 8% drop in energy needs for the average household from 2010 to 2013, the cost of that energy rose by 20% in the same period (Mueller et al 2014). The UK has amongst the highest electricity prices in the world, with the third highest cost for domestic electricity out of 28 developed countries monitored by the International Energy Agency, and the eleventh lowest domestic gas prices in the same group (Department of Energy & Climate Change, 2016). Thus, fuel price movements are outstripping energy efficiency measures in tackling fuel poverty. On top of this, the financial recession from 2008 and government austerity measures since 2010 have negatively impacted household incomes in more deprived local authorities (Beatty and Fothergill 2013), with Glasgow being hardest hit by welfare reforms (Welfare Reform Committee, 2013).

In 2013, it was estimated that 39% of households in Scotland were in fuel poverty, including 10% in extreme fuel poverty (Mueller et al 2014). Within this, the highest rates were among those who owned their homes outright (56%) and among local

authority tenants, i.e. those in public housing (48%). The lowest rate was among owners with a mortgage (19%), however lower rates were also reported for private renters (36%) and tenants of housing associations, i.e. registered social landlords (38%). Whilst mortgaged owners probably have higher incomes, the rate of fuel poverty among housing association tenants has undoubtedly been aided by the provision of housing improvements to the social sector stock under a government requirement to bring the stock up to a new Scottish Housing Quality Standard (SHQS) by 2015 (Communities Scotland 2007).

Fuel poverty, health and housing improvements

A recent review of housing and thermal comfort showed that an initial focus of reducing excess winter mortality from fuel poverty was later extended to an interest in reducing the cumulative effects of cold homes upon a wider range of physical health conditions such as pneumonia, arthritis, asthma and domestic accidents (World Health Organisation (WHO) 2007). More recently this has been extended to combating other illnesses such as sore throats, headaches and gastric complaints (Ezratty et al 2009). There is also growing interest in the impacts of fuel poverty on mental health, both on its own and in combination with poor physical health. The WHO (2007) review called for more attention to be given to specific aspects of mental health such as anxiety, mood and coping, and for examination of pathways from fuel poverty to social engagement, quality of life, healthy lifespan development, and physical health (Liddell and Morris 2010). This paper focusses on the mental health impacts of fuel poverty and the role that housing warmth interventions have to play.

The main policy approach to fuel poverty assumes that energy efficiency measures to homes will reduce fuel poverty and thereby improve physical and mental

health. Indeed, the UK Government's latest research reports savings from energy efficiency measures for occupant households in England and Wales, in terms of annual gas consumption, of 2% per year for loft insulation, 9% per annum for cavity wall insulation and 10% per annum for boiler installation (Department for Energy and Climate Change 2013). But independent experts have criticised government figures as being too optimistic (Collinson 2014) and the evidence from intervention studies is not overwhelming. A recent review (Fenwick et al 2013) found only six studies of energy efficiency improvements that collected fuel cost data, all reporting a reduction after improvements (Lloyd et al 2008; Shortt and Rugkasa 2007; Caldwell et al 2001; Green and Gilbertson 1999; Ambrose 2000; and Heyman et al 2011). However, in two of these studies, occupants also experienced rent increases after improvements, so the net effect on household budgets is unknown.

With regard to mental health, a systematic review of all published studies up to 2012 found nine which examined the mental health impacts of warmth (installation, upgrade or repair of central heating) and energy efficiency improvements (roof and cavity wall insulation and double glazing) to homes, but the weight of the combined evidence is not strong (Thomson et al 2013). SF-36 is a validated scale measure of self-reported health and quality of life with separate sub-scales of physical and mental health (Ware et al 2007) commonly used to measure mental health. Of three experimental studies in Thomson et al's (2013) review, one reported significant improvements to three of the SF-36 sub-scales. The households in this study were said to be at risk, containing someone with a pre-existing respiratory condition (Howden-Chapman et al 2007). The four quasi-experimental studies reported conflicting, non-significant findings. One study found depression to be higher in the intervention group (Braubach et al 2008), whilst another, conducted in Scotland, reported both that the intervention

group were less likely to report any degree of financial difficulty than a comparison group, and to obtain small relative gains on three of the SF-36 mental health sub-scales (Platt 2007). Lastly, two small studies of adults, again with pre-existing cardiac or respiratory conditions, found significant gains to mental health following warmth and energy efficiency improvements (Allen 2005a; 2005b). A further study, not covered in Thomson et al's review, found no reductions in levels of stress and mental illness among those receiving heating and other energy efficiency measures, but when compared to a comparison group, it was argued that the intervention may have prevented a worsening of such conditions (Shortt and Rugkasa 2007).

Studies suggest a number of potential routes to mental health gains following warmth and energy efficiency improvements to homes; some of these relate to fuel bills, but not all. An evaluation of the Warm Front insulation and heating improvements programme in England reported reductions in anxiety and depression among the intervention group, attributing this to reduced 'perceived financial strain', i.e. a reduction in self-reported difficulty paying fuel bills (Green and Gilbertson 2008, p.19). An evaluation of another similar programme in England, the Foundations Independent Living Trust (FILT) Warm Homes Service (WHS), also reported a general expectation of a reduction in fuel bills, although not everyone gained in this way: participants without a prior-functioning heating system worried about increased bills; and vulnerable participants expressed anxiety due to not understanding their fuel bills (Bashir et al 2013).

The same FILT WHS evaluation was cited in an international review as demonstrating how benefits flowed from increased control (International Energy Agency (IEA), 2014). This included increased control of the home environment and, as a result, also increased ability to manage long-term poor health, for example because of

improved diet through more usable space in the home. But interestingly, the study authors argued that only in a minority of cases did the increased control result from a new boiler or the installation of thermostatic radiator valves; mostly, “benefits were accrued from the advice received...and not just from affordable warmth or heating interventions. This advice included energy coaching following installation of measures which provided clients with confidence and knowledge of how to heat their homes adequately and safely” (Bashir et al 2013, p.iii).

Increased control, and perceived greater value for money after improvements, were also put forward as explanations for mental health gains in the Warm Front evaluation, despite the fact that heating expenditures increased post-intervention (Hong et al 2006; Liddell and Morris 2010). Qualitative research with Warm Front participants has reported that “having a reliable, controllable source of heat and hot water” that produces mental health gains, including “the alleviation of anxiety and worry” (about the boiler breaking down, or the heating not working), as well as “increased feelings of contentment and relaxation in the home” or “emotional security and autonomy” (Gilbertson et al 2006, p.952 and 953).

Contrarily, in a study of people who continued to live in cold homes after warm and heating improvements, the complicated nature of programming controls was cited as a major reason for this, indicating a lack of control for some households (Critchley et al 2007). However, this was not the entire explanation. Some people had adapted to living in cold homes and considered ‘cool’ conditions to be good for health; thereafter, they were slowly adjusting to the prospect of living in warmer homes. But living in cold homes post-intervention was also associated with poor psychosocial health due to reasons of dissatisfaction, stress and lack of control over the new heating system (Critchley et al 2007). This runs slightly counter to the argument that the greater mental

health gains are derived from housing improvements where fuel poverty is combined with poor health in the prior period (Liddell and Morris 2010).

The literature highlights that both reductions in fuel poverty and mental health gains thereafter from warmth and energy efficiency improvements to homes are by no means certain and depend a lot on the prior housing conditions, life-styles and personal health and other circumstances of the occupants, as well as their ability to adapt to their new home environment after changes have been made. Given these conclusions, this paper explores the relationships between the two key outcomes of financial difficulties and mental health, and subsequently examines whether fuel affordability difficulties are alleviated by warmth improvements, using perceived financial difficulty as a measure of fuel poverty.

Research Questions

This research aims to investigate the consequences of energy efficient housing interventions for both fuel poverty and mental health, addressing the following research questions:

- (1) How have self-reported levels of fuel affordability difficulty changed over time?
- (2) Do changes in fuel affordability difficulty affect mental health?
- (3) Do warmth improvements, specifically central heating and insulation, affect the likelihood or frequency of occupants reporting difficulties affording fuel bills?

Methodology

Study site: Glasgow

The study takes place in Glasgow, where over a decade ago in 2002 it was estimated

that the mean energy efficiency rating of the city's housing stock, at 5.5, was well below the 'good' energy efficiency threshold of 7 or above on the National Home Energy Rating (NHER) scale of 0-10 (Glasgow City Council (GCC) 2006). Thereafter, the transfer of the local authority's sizeable housing stock (83,000 dwellings) to a housing association in 2003 (Gibb 2003) began a programme of housing investment to bring the stock up to and beyond the Scottish Housing Quality Standard (SHQS) as part of the tenant transfer commitment (Glasgow Housing partnership Steering Group (GHPSG), 2000). A total of £1.2bn (\$1.74bn) was to be spent on housing improvements in the city by 2013, with 40,000 new heating systems and 28,000 fabric works (insulation, over-cladding) and 26,000 re-roofings being completed by 2010 (Glasgow Housing Association (GHA), 2010). This study examines the impacts of these works.

Data

The analysis in this paper draws on three waves of household survey data from the GoWell project which is a longitudinal study of regeneration, health and well-being undertaken in Glasgow, UK. Data from 2006 (wave 1), 2008 (wave 2) and 2011 (wave 3) are analysed. The full survey design is a repeated cross sectional study with a nested longitudinal cohort. Random samples of addresses were selected across fifteen study areas in Waves 1 and 2. At Wave 3 all addresses where a survey had previously been conducted were selected for the sample. In six of the fifteen areas where extensive demolition was taking place, all occupied dwellings were selected at each wave. The surveys achieved response rates of 50.3% (n=6003), 47.5% (n=4869) and 45.4% (n=4270), respectively, which are considered respectable for surveys in deprived areas, particularly in the context of generally declining response rates to official surveys over

time (Scottish Government 2010), and lower response rates in Glasgow than in many other Scottish local authorities (Scottish Government 2013).

Figure 1. Sample Construction by Case Linkage and Data Matching

The analysis in this paper relies on longitudinal survey data, where the same householder in the same dwelling was surveyed on more than one occasion. retrospective matching of names and addresses was used to identify the longitudinal cases embedded in the surveys, This resulted in a longitudinal sample of 2,788 who were surveyed at least twice. Each 'pair' of survey waves is analysed separately given that they span the period of recession, it is likely that results will differ depending on the survey waves analysed particularly as we are focussing on issues of financial difficulties. The sample for analysis is a subset of the 2,788 longitudinal cases which were matched to Glasgow Housing Association's (GHA) database of housing improvements to give a sample size of 1,933 for this study (Figure 1).

Measures

There are three key measures of interest in this paper: housing improvements; fuel affordability; and mental health.

Data were obtained from Glasgow Housing Association (GHA) regarding improvement works to properties over the period of study. Using data-linkage those survey respondents who were also living in GHA managed properties were identified and information regarding housing improvements was attached to the survey dataset. The analysis in this paper uses data relating to two warmth interventions: central heating and fabric works. Central heating involves installing or upgrading existing central

heating systems, as well as boiler and hot water tank replacement. The type of heating system varied between property types. All properties had existing full or partial heating systems so the results in this paper relate to improvements in systems rather than provision of heating where it did not previously exist. Fabric works include a range of external improvements including insulation, wall cladding, roof renewal and, in some cases, balcony repairs. Fabric works are therefore a broad category which may be considered to be aesthetic, safety and warmth improvements. However, given that we cannot break this down into further sub-categories, in this paper fabric works are treated as a warmth intervention, whilst recognising that the relationship between fabric works and mental health may occur through mechanisms other than warmth.

In total 374 respondents had fabric works between two survey waves and 575 households had central heating between two survey waves. The control group in each case is those who have not had the improvement works in question at any point since 2003 (the date of the stock transfer and from which we have records from GHA). For fabric works this is a control group of 1090 cases and a control group of 599 for the central heating analyses. Cases where improvements had occurred prior to the first interview are excluded from the analysis: 469 cases where fabric works had taken place before the first interview and 799 who had central heating before their first interview. This limits the cases used in the analysis considerably but it is important to remove those who had work undertaken recently, but not between the two survey points.

The measure of fuel affordability comes from the household survey. Survey respondents were asked how often they have difficulty affording several essential items, including fuel bills. There were four response categories: Never; Occasionally; Quite Often; or Very Often. Changes in frequency of fuel affordability difficulties, referring to increased or decreased frequency between first (T1) and second (T2) interview are

examined for each ‘pair’ of survey waves, i.e. movement in both directions between the response categories to the affordability question. This is a repeated measure, rather than a recall measure. If respondents were asked to recall whether they had more frequent financial difficulties following housing interventions, responses might be biased by their opinion of the housing improvement. However, the question on financial difficulties was asked in the same way at two points in time and not directly in relation to housing improvements, given the broad nature of the study. The repeated and independent nature of the affordability question is a strength of the study.

Mental health is measured in the household survey, using the SF12 Mental Health Component Score (SF-12v2 -MCS). This is a shorter version of the SF-36 scale, which as previously described has been used in previous studies to evaluate the health impacts of housing improvements (Thomson et al 2013). Both the SF12 and SF36 are designed as generic health measures, are psychometrically tested and have been used to assess the impact of interventions on health outcomes¹. The SF-12v2 is a validated questionnaire for measuring health-related quality of life (Ware et al 2005); scores are computed from responses to 12 questions and range from 0 to 100, with higher scores indicating better health. The MCS is based on questions pertaining to vitality, social functioning, the impact of emotional problems, taking care in daily activities, feeling calm, and feeling ‘down’, for example:

During the past four weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling anxious or depressed) (All of the time; Most of the time; Some of the time; A little of the time; None of the time)

- a. Accomplished less than you would like*
- b. Did work or other activities less carefully than usual*

¹ <http://www.sf-36.org/tools/sf12.shtml>

Analysis

Analysis is presented in three stages, answering each of the research questions. First descriptive results showing the prevalence of fuel affordability difficulties over time in the sample are presented. Then the paper examines the relationship between changes in fuel affordability difficulties and changes in mental health. Finally, the relationship between housing improvements and changes in levels of fuel affordability difficulty is examined using binary logistic regression models. The analysis focuses both on those who report increases and those who report decreases in the frequency of affordability difficulties.

The regression analyses control for building type, using this as a proxy for house size and type of heating system, which are likely to be important for fuel bills. The model also controls for age group and change in employment status. Age affects both use of heating and access to benefits to assist with cost. Change in employment status is important for fuel affordability as employment, or income, is one of the key drivers of fuel poverty, alongside energy efficiency and fuel prices. The relationship between income and employment is not straightforward, and given the low income nature of the sample it is likely that some of those not in employment will have higher incomes than those employed. Nevertheless, changes in employment status are likely to have an impact on the ability to afford household energy bills, whether positive or negative. It is assumed that fuel price changes, the third key driver of fuel poverty, will affect everyone similarly, although the limitations of this approach are recognised (see below).

Results

Table 1 provides the descriptive statistics for the sample against the main variables of interest. The table shows the proportion of those in each group who received

improvements works and who report financial difficulty and the mean SF12-MCS for each group. Fabric works are more common than central heating works for all groups except those under 25; affordability difficulties have been rising for middle aged adults, but have reduced among other age groups; and mental health has been improving in the retired age group, but declining among young adults.

Table 1. Descriptive Statistics

Fuel affordability difficulties over time

Figure 2 shows a breakdown of the frequency of experiencing difficulty paying fuel bills by survey wave, based on the longitudinal matched sample. The majority of respondents never experience any difficulties at all survey waves. However, there has been a decline in those never reporting difficulty since wave 1 and therefore an increase in those who report some level of difficulty affording fuel bills, particularly in the 'quite often' category.

Figure 2. Fuel Affordability difficulty in longitudinal sample at each survey wave

Figure 3 shows that whilst the aggregate proportion of respondents reporting difficulties at each survey wave has remained relatively stable there has been change within this so that not the same individuals are reporting difficulties at each survey wave. 43.8% of the sample reported some level of difficulty paying fuel bills at one or more survey waves.

Figure 3. Changes in frequency of fuel affordability difficulties between survey waves

Between wave 1 and wave 2 and wave 2 and wave 3 around 40% of respondents reported either increases or decreases in frequency of fuel affordability difficulties, with a roughly equal division between the two. At wave 3 (both w1-w3 and w2-w3) more respondents report an increase than a decrease in frequency of difficulties, suggesting that over the period of recession from 2008 respondents have been more likely to struggle more often with their fuel bills.

The analyses which follow seek to understand increases and decreases in fuel affordability difficulties in the context of housing improvements.

Fuel affordability difficulties and mental health

This section focuses on the relationship between fuel affordability difficulties and mental health. The larger study of which this analysis is part has previously reported negative associations between fuel affordability difficulties and mental health (Curl & Kearns, 2015), but here results include controlling for other variables. Linear regression models (Table 2) show the relationship between changes in the frequency of fuel affordability difficulty and mental health (measured using the SF12 mental health scale).

Table 2. Linear regression results for SF12 Mental health at T2, showing the relationship with change in fuel affordability difficulties (increased/decreased frequency of difficulty) (* - $p < 0.05$, ** - $p < 0.01$)

Table 2 shows the linear associations between mental health at T2 and fuel affordability difficulties, controlling for age, employment, building type and mental

health score at T1 for three ‘pairs’ of survey waves. In both the Wave 1-3 (middle column) and Wave 2-3 (last column) samples, an increase in fuel payment difficulty is associated with a substantive reduction in mental health scores of around half a standard deviation on the scale used. Between wave 1 and wave 3 (middle column) there is also an association between reduced fuel affordability difficulties and improved mental health.

The models control for housing type, age group and employment change. Those over 65 report improvements in mental health more so than other age groups. The effect of employment on mental health is consistent with previous work (Curl & Kearns, 2015), with those remaining in employment between survey waves having improved mental health relative to those who remain in unemployment. Between waves 2 and 3 those who move out of employment and even more so those who gain employment were also more likely to experience improved mental health relative to those who remain in unemployment.

Fuel affordability difficulties and housing improvements

This section presents results examining the relationship between housing improvements and fuel payment difficulties in order to establish whether energy efficiency improvements can reduce the frequency of fuel affordability difficulties.

The results are reported in two stages, first analysing the relationship between housing improvements and the odds of reporting an increased frequency of fuel affordability difficulties and then the likelihood of reporting reduced frequency of fuel affordability difficulties.

The small number of cases in the analyses is due to excluding those who had either central heating or fabric works before their first interview. The control group is

therefore those who have had neither improvement from 2003 until the point of second interview. Each housing improvement was also modelled separately, which allowed inclusion of more cases in order to improve the power of the models, but the pattern of results was the same, so only the models containing both housing improvements simultaneously are included here for ease.

Table 3 shows the results of binary logistic regression models where the outcome is reporting an increased frequency of difficulty between survey waves. Those who had central heating between wave 1 and wave 2 were more likely to report an increased frequency of difficulty paying fuel bills than those who did not receive this housing improvement. Neither of the two housing improvements were significantly associated with increased fuel payment difficulties in any of the other wave-pair samples.

Table 3. Binary logistic regression results showing likelihood of reporting increased frequency of fuel affordability difficulty at T2 (* - $p < 0.05$, ** - $p < 0.01$)

Between Wave 1 and Wave 3 and between Wave 2 and Wave 3 those aged 65 or over were less likely to report increased frequency of affordability difficulties than those in other age groups. Those remaining in employment between waves were also less likely to report increased fuel affordability difficulties. The same is not true for those who gain employment, suggesting that it is perhaps stability of employment which is more important for protecting against increasing affordability difficulties. Alternatively it may be that gaining employment is associated with an initial period of lower income relative to state support, depending on circumstances.

There are no significant effects of housing improvements in relation to reduced frequency of fuel affordability difficulties in any of the wave-pair samples (table 4). Between Wave 2 and Wave 3 gaining employment is associated with being more likely to experience reduced frequency of fuel affordability difficulties. Those remaining in employment between Wave 1 and Wave 2 were more likely to report a reduced frequency of fuel affordability difficulties. Between Wave 2 and Wave 3 those under 25 were more likely to report a reduced frequency of fuel difficulty than other age groups.

Table 4. Binary logistic regression results showing likelihood of reporting reduced frequency of fuel affordability difficulty at T2 (* - $p < 0.05$, ** - $p < 0.01$)

It therefore seems that there is a limited relationship between housing improvements and fuel affordability difficulties, and where there is an association it is not as intuitively expected: those with central heating interventions are more likely to report an increase in frequency of fuel affordability difficulty between Wave 1 and Wave 2 than those without the intervention.

Discussion

Fuel affordability difficulties have been rising in recent years in a sample of predominantly social housing tenants living in deprived areas in Glasgow. In particular, the incidence of frequent difficulty paying for fuel increased, especially after the advent of recession in 2008. After 2008, increases in the frequency of fuel payment difficulties were associated with substantial reductions in the mental health of those who experienced them. This is an important finding since it emphasises the mental health impacts of fuel poverty rather than the physical health effects more usually

studied and estimated. However, there is no evidence to suggest that the provision of warmth-related housing improvements to dwellings affected the likelihood of experiencing either increased or reduced fuel payment difficulties. The following section considers why this might be the case, and return to the two conceptions of fuel poverty discussed earlier.

It may be that the housing improvements do not impact upon fuel poverty in the materialist sense, i.e. reducing the actual cost burden to occupants, although this is something we have not been able to measure. A lack of impact on fuel costs to the occupant may be because the energy efficiency of the property is not enhanced sufficiently, or because rising fuel prices outweigh any potential gains from the improvements; both of these factors may apply here. The average NHER rating of the improved housing stock is 7.4 (on a scale of 0-10), thus many properties may not reach the 'good' ratings of 7.0 or above necessary to reduce fuel costs sufficiently, particularly in a region where exposure to high winds and colder external temperatures increases fuel requirements (Wilson et al 2012). Evidence from the Scottish House Condition Survey shows that fuel poverty rates are much higher in properties with 'moderate' energy efficiency (NHER ratings of 3-6) at 37% than in the group of 'good' NHER properties, at 21% (Wilson et al 2012, table 44).

Alternatively, housing improvements are likely to impact upon fuel poverty in the official, materialist sense of reducing the energy use required to keep the dwelling sufficiently warm but, at the same time, over the period 2002 to 2010, which includes most of the survey period, indexed fuel prices nearly doubled (ibid., figure 5). Bearing in mind that the study focusses on a very low income group, the findings are consistent with one of the conclusions reached by the Scottish Government's 2012 fuel poverty evidence review, that "energy efficiency improvements cannot lift people out of fuel

poverty when situated within the context of rising fuel prices and stagnant income” (ibid, p.17). The importance of the materialist view on fuel poverty is also illustrated in this study by the effects of either keeping one’s job during a recession – which reduced the odds of experiencing increased fuel payment difficulties substantially; or, gaining employment during the recession – which trebled the odds of experiencing a reduction in fuel payment difficulties.

Another perspective on the findings is that, irrespective of whether housing improvements impact upon a household’s fuel cost burden, they do not affect fuel poverty in the capability sense (i.e. achieving desired functioning and psychologically), at least for low income groups. This could be due to the interaction of fuel costs with other household bills, or be the product of how new heating systems are used. In qualitative research on financial stress among the same study group, it has been found that fuel bills were considered to be the least affordable, or most expensive household item, but nonetheless the item most often prioritised over others (Trevisan et al 2014). Thus, fuel, more than anything else, carries the burden of financial difficulty during times of recession and austerity, and this may help explain why energy efficiency measures to dwellings do not appear to reduce that burden. Indeed, the Scottish Government’s independent advisor on poverty and inequality has recently recommended ‘that future [fuel poverty] programmes focus more specifically on helping those in fuel poverty who are also in income poverty’ (Eisenstadt 2016, p.17).

A second explanation for the lack of impact of housing improvements upon perceived fuel payment difficulties, or fuel poverty in the capability sense, relates to the use of heating systems by occupants. This would be consistent with the fact that the only significant effect of housing improvements on fuel affordability difficulties found

in the present study was that between 2006 and 2008 those respondents who had central heating improvements were more likely than those who did not have improvements to report an increase in the frequency of their difficulty paying for fuel. This may be because the recipients of central heating improvements used their heating differently afterwards, as explained below. .

Others have suggested there may be negative effects of new central heating systems in terms of bills as users get used to the new systems. Recent research into housing associations' experience of delivering energy efficiency measures to tenants' homes in Scotland reported 'surprising' findings of a 'need for additional, bespoke support and advice for tenants' both 'to ensure they use new technologies effectively' and 'even with more common and better understood heating systems' (Faulk 2015, pp.30-31). It is therefore important that central heating interventions in particular are supported by advice and support on usage of the new system, given the importance of user interaction. This is important not only to ensure efficient and effective use of any new heating system, but also to enhance feelings of control that are important for mental health impacts (Bashir et al 2013). Although such advice is less important for fabric works, it may also be that it takes time for households to adapt to needing less heating in a more energy efficient building. Research in the Netherlands, for example, has shown that the introduction of more advanced controls for heating does not generally lead to a reduction in energy use (Guerra Santin 2013).

A further factor may be the "rebound" effect (Hens et al 2010; Webber et al, 2015) whereby any cost savings from warmth improvements result in the system being used more and therefore have no net effect on affordability but do result in improved thermal comfort. For example, after housing improvements, occupants may choose to keep more rooms warmer and for longer, even when the rooms are not in use, or simply

to prefer higher indoor temperatures thereafter (Guerra Santin 2013), possibly expecting a neutral impact on fuel bills given the expected benefits of the improvements. While this could still be interpreted as being in fuel poverty as the occupant cannot afford their desired level of warmth, it might be seen as an improvement if there has been no change in fuel cost but an improvement in thermal warmth, and indeed would be seen as an improvement using objective measures of fuel poverty. However, it has been argued that the rebound effect should form part of any calculation of the expected energy savings from housing improvement programmes (Kane et al 2011). Moreover, research also suggests that where improvements produce dwellings of medium efficiency, as is the case with Glasgow's social housing (see above), and comfort demand increases, energy use can also increase (Love, undated).

In summary there may be a number of reasons why there are not positive effects of warmth interventions on perceived fuel affordability. The gap between the technical potential and realised effects have been studied recently by others (Webber, et al, 2015) who explain that gaps may be either due to performance gaps or rebound effects. DECC (2012) suggests that energy improvements may be as low as 50% of their potential in deprived areas, which provides some explanation for why the results may not be as strong as might be expected in this study.

The findings presented lend support to three of the policy proposals made by the main energy lobby organisations in the UK: that the proposed devolution of further powers to Scotland from the UK government should enable energy efficiency programmes provide by energy companies to be better suited to Scotland's needs; that the Scottish Government should improve the reporting of the impacts of fuel poverty and energy efficiency schemes; and that there is more scope for actions on fuel poverty

to be seen as a means for reducing health inequalities (National Energy Action and Energy Action Scotland 2015).

Limitations

Although the model included variables to control for other effects on fuel poverty, such as change in employment there are other factors which influence a household's ability to afford bills. Household composition might be important for two reasons, firstly in terms of energy demand and ability to pay. Although it is hard to determine in which direction these associations may run as whether additional household members are dependent or contributing to the family budget could be important. Furthermore, employment is not the same as income, and it may be that those in employment struggle more financially. Some evidence suggests that those in receipt of benefits had largely been protected from the effects of the recession, before the impact of austerity measures (Curl & Kearns, 2015). Rather than assume that employment is entirely beneficial for low-income groups, future research might examine how income from earnings and benefits are changed by employment for this group, as a factor that may influence fuel poverty.

Our study is limited by the measure of perceived fuel affordability difficulties. While we believe self-reported difficulty to be an important and crucial aspect of fuel poverty, a measure of actual fuel use and costs before and after interventions would be valuable in helping to explain some of our findings.

The low explanatory power of the models should also be mentioned. Although it is expected that housing improvements are important for fuel bill affordability and that affordability is important for mental health, it is clear that there are also many other factors explaining both outcomes which have not been included in these models.

Perhaps it is not reasonable to expect large effects from housing interventions in a sample population which has lots of conflicting influences both on affordability and mental health.

Related to this is the issue of timescale. Although over a long period of time more energy efficient buildings should lead to reductions in fuel poverty, over the relatively short period studied here other factors are perhaps more important for these outcomes. In other words, while long term improvement of the housing stock might be positive at the population health level, it may still be the case that the short term effects on individual experiences of fuel poverty are less evident or even negative. An alternative approach to future research could also consider any mental health and wellbeing effects due not only to the fuel poverty impacts of energy efficiency works, but also arising from increased control following energy efficiency advice and support, i.e. the missing education rather than infrastructure part of an improvement programme.

Although this study distinguishes between central heating and fabric works, which is an advance on many studies that consider undifferentiated holistic improvement packages, even these two types of improvement works vary between properties, and the study could not take that variation into account. Thus, we it is unclear whether the impacts upon the occupants vary according to the different types of heating system, or different kinds of payment methods. It is also unclear how the occupant responds to the improvement works, such as the extent and degree to which the occupant heats their home (e.g. to below or above the recommended comfort level). These things may clearly act as mediators for both affordability difficulties and mental wellbeing. Future research might also measure changes in thermal comfort following warmth and energy efficiency works, which have not been taken into account here, but which offer an alternative justification for undertaking improvements, irrespective of

their impacts upon fuel poverty.

Conclusions

Fuel poverty is a serious problem and a policy priority for The Scottish Government, with a series of policy programmes over the past decade aimed at tackling the issue. Whilst this is predominantly seen by the Scottish Government as a social justice and anti-poverty issue, the findings of this study also highlight the importance of fuel poverty for the mental health of the nation's lowest income groups, particularly where households struggling financially prioritise meeting fuel costs both for comfort reasons and for fear of being cut off by suppliers (Trevisan et al 2014). Under the devolution settlement, however, the policy options available to Scotland's administration are limited to only one of the three main drivers of fuel poverty, namely energy efficiency works to homes, rather than actions on fuel prices or on benefits or financial support to those on low incomes.

The evidence presented here, from studying a large-scale, widespread programme of warmth improvements to housing across Glasgow suggests that such energy efficiency programmes are likely to have a limited impact upon fuel poverty in the capability sense for those on very low incomes, particularly in circumstances of recession and/or austerity. Given the priority attached to tackling fuel poverty in Scotland, it seems clear that to do this effectively, the Scottish Government needs to have devolved powers to act upon the other two key factors, namely fuel prices and income- or fuel payment- support.

Further, to the knowledge of the authors, the delivery of housing improvements in Glasgow over the past decade has not been accompanied by user/occupant guidance and support which could provide assistance to deriving fuel cost savings from improved

dwellings. The argument that money spent on advice is money taken away from physical measures (Energy Action Scotland 2015) is potentially self-defeating if the ultimate aim is to achieve higher levels of wellbeing through energy efficiency measures. To this end, it is hoped that the latest incarnation of the Scottish Government's energy efficiency policy programme, to commence in September 2015, will include the personal advice and support and continued support to occupants beyond installation, which was promised at its launch (Scottish Government 2015). Alongside such policy programmes, research on fuel poverty and on the impacts of policy actions must continue. In this regard, it will be important to mount intervention studies which are capable to combining both the materialist and capability perspectives on fuel poverty.

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Table 1 – Descriptive Statistics

	n	Receipt of housing improvements		Rate of difficulty affording fuel bills			SF-12 MCS Mean Score (sd)		
		Central Heating	Fabric Works	W1 2006	W2 2008	W3 2011	W1 2006	W2 2008	W3 2011
<i>Built Form</i>									
Multi-storey flat	829	31%	39%	33%	33%	30%	48.17(10.25)	48.17(11.26)	49.12(12.45)
Other Flat	976	11%	23%	21%	23%	27%	47.6(9.65)	48.49(10.85)	49.23(11.67)
House	123	5%	22%	8%	16%	20%	49.57(8.34)	47.51(11.8)	50.93(10.77)
<i>Age Group</i>									
Under 25	72	32%	25%	45%	61%	33%	52.62(7.16)	49.4(10.16)	50.27(11.54)
	131								
25-64	8	20%	29%	29%	47%	51%	47.57(10.29)	47.01(11.26)	47.52(12.37)
65+	549	15%	33%	20%	18%	14%	48.35(8.89)	51.26(10.24)	53.53(9.45)
<i>Employment Status</i>									
Working	337	20%	29%	23%	30%	28%	51.84(7.83)	49.58(9.26)	51.96(9.78)
	156								
Not working	7	19%	30%	35%	39%	40%	47.13(9.98)	48(11.46)	48.77(12.2)

Table shows the proportion of those in each group who received improvement works or who report financial difficulties. e.g. 20% of those aged 25-64 had central heating compared to 32% of those under 25.

Table 2 - Linear regression results for SF12 Mental health at T2, showing the relationship with change in fuel affordability difficulties (increased/decreased frequency of difficulty)

	wave 1-wave 2	wave 1-wave 3	wave 2-wave 3
Constant	40.31(35.05,45.56)**	35.16(29.48,40.84)**	37.69(33.9,41.48)**
SF12 Mental Score T1	0.12(0.02,0.22)*	0.24(0.13,0.36)**	0.2(0.12,0.27)**
<i>Building Type (ref: other flat)</i>			
Multi-storey flat	-0.22(-2.33,1.88)	0.01(-2.77,2.79)	0.82(-0.76,2.39)
House	-1.28(-6.75,4.2)	1.41(-2.07,4.9)	1.08(-2.25,4.42)
<i>Change in fuel affordability difficulty (ref: no change)</i>			
Increased fuel difficulty	0.28(-2.33,2.88)	-4.67(-7.37,-1.98)**	-5.27(-7.23,-3.3)**
Reduced fuel difficulty	1.26(-1.26,3.77)	4.24(0.9,7.58)*	-0.06(-2.04,1.92)
<i>Age Group (ref:25-65)</i>			
Under 25 T1	3.22(-1.6,8.04)	-0.66(-7.43,6.11)	0.84(-3.37,5.05)
Over 65 T1	5.27(2.92,7.62)**	5.12(2.62,7.63)**	6.98(5.08,8.88)**
<i>Change in employment status (ref: remain in unemployment)</i>			
Remain in employment	3.48(0.17,6.8)*	3.24(-0.38,6.86)	6.82(4.47,9.16)**
Move out of employment	1.19(-4.23,6.6)	1.79(-2.26,5.83)	3.87(0.73,7.01)*
Gain employment	2.71(-1.38,6.81)	4.93(-0.78,10.63)	7.33(4.1,10.56)**
<i>n</i>	531	426	770
<i>Adjusted R²</i>	0.039	0.131	0.182

*Indicates statistical significance: *p<0.05, **p<0.01

Table 3 – Binary logistic regression results showing odds of reporting increased frequency of fuel affordability difficulty at T2.

	wave 1-wave 2	wave 1-wave 3	wave 2-wave 3
Central heating T1-T2	1.99 (1.02,3.89)*	1.63 (0.62,4.28)	0.67 (0.28,1.6)
Fabric Works T1-T2	0.77 (0.32,1.85)	1.79 (0.82,3.91)	1.75 (0.83,3.69)
<i>Building type (ref: multi-storey flats)</i>			
other flat	0.65 (0.32,1.33)	2.48 (0.79,7.81)	0.93 (0.39,2.2)
house	1.08 (0.2,5.88)	3.82 (0.77,18.95)	0.17 (0.02,1.63)
<i>Age Group (ref: 25-64)</i>			
under 25	1.48 (0.44,4.96)	1.49 (0.11,20.92)	0.7 (0.14,3.5)
65+	0.46 (0.21,1.01)	0.18 (0.07,0.42)**	0.27 (0.12,0.63)**
<i>Change in employment status (ref: remain in unemployment)</i>			
remain in employment	0.27 (0.08,0.96)*	0.19 (0.05,0.69)*	0.2 (0.06,0.61)**
move out of employment	1.51 (0.48,4.72)	0.35 (0.07,1.75)	0.29 (0.06,1.4)
gain employment	0.97 (0.29,3.27)	0.9 (0.19,4.16)	0.57 (0.17,1.88)
<i>Constant</i>	0.26	0.18	0.49
<i>n</i>	307	205	256
<i>Nagelkerke R2</i>	0.122	0.184	0.124

*Indicates statistical significance: *p<0.05, **p<0.01

Table 4 – Binary logistic regression results showing odds of reporting reduced frequency of fuel affordability difficulty at T2

	wave 1-wave 2	wave 1-wave 3	wave 2-wave 3
Central heating T1-T2	1.58 (0.85,2.91)	1.46 (0.43,4.99)	1.74 (0.75,4.05)
Fabric Works T1-T2	0.55 (0.24,1.24)	0.42 (0.14,1.2)	0.65 (0.29,1.43)
<i>Building type (ref: multi-storey flats)</i>			
other flat	1.65 (0.86,3.15)	0.43 (0.11,1.72)	1.42 (0.58,3.51)
house	1.05 (0.2,5.49)	0.45 (0.06,3.54)	0 (0,0)
<i>Age Group (ref: 25-64)</i>			
under 25	0.5 (0.1,2.44)	2.58 (0.2,33.55)	4.19 (1.27,13.84)*
65+	0.66 (0.34,1.27)	0.9 (0.31,2.59)	0.65 (0.29,1.49)
<i>Change in employment status (ref: remain in unemployment)</i>			
remain in employment	0.28 (0.09,0.86)*	0.94 (0.23,3.82)	0.8 (0.32,1.97)
move out of employment	0.97 (0.29,3.31)	0.54 (0.06,4.54)	0.92 (0.23,3.67)
gain employment	0.35 (0.07,1.61)	4.59 (0.89,23.75)	3.14 (1.11,8.91)*
<i>Constant</i>	0.28	0.32	0.19
<i>n</i>	307	205	247
<i>Nagelkerke R2</i>	0.04	0.048	0.088

*Indicates statistical significance: *p<0.05, **p<0.01