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THE HEALTH EFFECTS OF IMPROVED HEATING IN DOMESTIC DWELLINGS: A LONGITUDINAL STUDY

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The Health Effects of Improved Heating in Domestic Dwellings: A Longitudinal Study

Two features of the immediate housing environment, damp and cold, have received increasing attention in recent years.

Damp housing is particularly prevalent in the North of England and in Scotland. In Glasgow, for example, about 70% of homes are known to suffer some degree of dampness (Glasgow District Council, 1989). A study in the North of England by Keithley et al. (1984) reported that 42% of households said they were unable to keep warm in the previous winter because of inadequate heating systems, fuel bills or poor structure. Investigations by Hunt et al. (1988) and Hopton & Hunt (1990) in Scotland revealed that over 70% of respondents from deprived areas reported that their dwelling was "too cold". A recent survey of almost 1000 young, working class mothers in the Midlands, showed that 20% said that their home was cold and almost as many that the dwelling was damp.

Cold and damp in dwellings are, of course, closely related. The ability to maintain adequate indoor temperatures depends upon the climate, the expectations and the disposable income of the occupants, the available heating system and its cost, how quickly heat is lost to the outside and the position and structure of the building.

Most Scottish housing stock is constructed of fairly dense materials which are good conductors and, thus, quickly lose heat to the outside. In addition, much of the housing is draughty and, on exposed sites, there is considerable air infiltration. Much of the pre-war and inter-war housing has relatively poor thermal insulation and post-war local authority housing was characterised by massive precast concrete construction with a high thermal mass and a serious incidence of condensation. Where a dwelling is particularly cold, as will be the case where there is inadequate heat and poor wall insulation, condensation is likely to be excessive and persistent. Since the water in condensation is relatively pure, that is, not contaminated by chemicals in soil, it provides, together with organic material on the walls, ceiling

and floors, an ideal medium for mould growth. In a study by Hunt et al. (1987) of a random sample of dwellings in a Scottish community, the findings showed that dampness and mould were significantly more likely to be found in older, upgraded tenement buildings where coal fires had been taken out and expensive heating systems installed. The combination of cold walls, poor insulation and inadequate ventilation ensured a high level of condensation.

Inadequate heating is compounded by inadequate finances. The lowest income groups tend to live in hard-to-heat houses. It has been calculated that in Glasgow typical weekly energy costs in January 1990 exceeded £50 per week (Porteus & Markus, 1990). In deprived areas with high unemployment this figure is not affordable by most people.

Housing and Health

Damp conditions in a dwelling harbour several agents which may be damaging to health. Viruses which give rise to infection are more common in damp houses (Hatch et al. 1976; Buckland & Tyrell, 1962). Bacteria too thrive in moist conditions (Morris, 1988; Kingdom, 1960) and dampness also encourages the proliferation of the house dust mite (Voorhorst et al. 1969). Surveys in Holland, South Wales and London have established links between house mites, dampness and symptoms of ill health (Burr et al. 1988: Maunsell et al. 1970).

Damp conditions, particularly condensation, encourage the growth of mould. The health consequences of long term exposure to mould in the home have not been precisely established in uncontrolled environments. Nevertheless, the repeated findings of associations between the presence of mould and symptoms of ill health, together with evidence from clinical assays, leaves little reason to doubt that exposure to some fungi can constitute a significant health hazard by creating toxic reactions, allergies and infections.

Moulds have long been known to be a source of respiratory allergens (Solomon, 1974; Kozak et al, 1980; Burr et al, 1988) and some can produce severe symptoms caused by direct infection

of the lungs (Tobin et al. 1987). At certain times, particular fungi can become toxic. These mycotoxins are readily absorbed into the bloodstream and can cause damage to the lungs and other organs (Smith & Moss, 1985; Northup & Kilburn, 1978).

The full implications of constant exposure to moulds in houses are not yet known, but there have been several epidemiological investigations of significance.

A double blind study carried out in Edinburgh (Hunt et al. 1986; Martin et al. 1987) found significant links between aches and pains, diarrhoea, headaches and respiratory complaints in children and the presence of visible mould in the house. A much larger, double blind, study by the same team (Hunt et al. 1988; Platt et al. 1989; Hunt & Lewis, 1989) carried out in three cities, showed significant and severe effects of mould on children, including symptoms of allergy and infection such as fever, sore throat, headache and respiratory complaints. Adults were more likely to report aching joints, nausea, blocked nose and breathlessness in the presence of mould. There was a dose response relationship between mould and symptoms; that is the greater the extent of mould on the walls and the higher the air spore count, the more symptoms were reported for both adults and children. These results were independent of income, smoking, unemployment, cooking and washing facilities and the presence of pets. The authors were also able to rule out investigator, respondent and selection bias in the explanation of the findings.

A study by Hyndman (1990) of dwellings in Tower Hamlets, which utilised subjective and objective measures of both health status and housing conditions also found strong associations between dampness/mould and respiratory symptoms, diarrhoea, vomiting, depression and general health.

It is feasible that some of these findings were a consequence of a combination of damp, mould and cold. There is both epidemiological and experimental evidence to indicate a relationship between exposure to cold and physiological changes which may be implicated in both respiratory disorders and in heart disease. Within a week of temperatures falling below 0 C hospital admissions in Glasgow go up by 105% for acute

respiratory disorders and by 58% for bronchitis. Hospitalisation for heart disorders rises by almost 30%. (SHHD, 1988).

Cold air can act as a direct trigger of bronchospasm (Strachan & Sanders, 1989) and Rasmussen et al. (1978) found cold to be linked with impaired lung function in men as measured by forced expiratory volume and the findings were independent of smoking. A rapid change produces greater respiratory effects than a gradual one. Thus, moving between warm and cold rooms, e.g. as at bedtime, is particularly stressful. A strong association between wheezing in children and cool bedrooms has been reported by Ross et al. (1990).

A Report of the World Health Organisation indicated that chilling of the body was associated with increased risk of upper respiratory tract infections and that the breathing of cold air increases the risk of respiratory problems in babies (W.H.O. 1982). Collins (1986) estimated that diminished resistance to respiratory infections occurred at indoor temperatures below 16^0C and in addition, hypothermia in the elderly has been linked to indoor temperatures below this figure (Fox et al. 1986)

A study by Blackman et al. (1989) in Belfast linked recurrent illness to reports that the respondent had been unable to keep warm the previous winter. Hyndman (1990) in her study of Bengalis in East London showed that both measured and reported low temperatures in the home were closely associated with symptoms of "hidden asthma" and that people in cold homes were twice as likely to suffer from poor chest health. It has also been suggested that cold affects the prevalence of viruses, since influenza epidemics often occur after a particularly cold spell (MacFarlane, 1977).

Data from studies in Finland have suggested that the decline in heart disease in that country is closely associated with improvements made to the housing stock, such as adequate affordable heating, increased insulation and appropriate ventilation (Salonen et al. 1983; Tuomilheto et al. 1986).

Although there appears to be increasing acceptance of the links between adverse housing conditions and symptoms of ill health,

particularly in respect of dampness/mould, there have been very few studies which have attempted to test the hypothesis that an improvement in housing conditions is followed by an improvement in health.

An early study by Robinson (1955) in New Jersey suggested that moving people out of slum dwellings into more spacious and sanitary accommodation led to a fall in the incidence of tuberculosis and other diseases of childhood. Wilner et al (1962) found that families who had been rehoused into better homes showed a decline in infectious and parasitic diseases, digestive disorders and accidents, although these effects were only significant at ages under 35 years.

In Britain, an investigation by Hopper (1962) in Rotherham indicated that the residents of a new housing estate had less tuberculosis, bronchitis and accidents in comparison with individuals living in the area they had come from. Better health was strongly associated with housing improvements made on an estate in Liverpool and was particularly the case with respect to mental health, respiratory symptoms and sleep (McKenna & Hunt, 1990).

However, it is notoriously difficult to draw conclusions from such studies due to the significant number of confounding variables. For example, selection of particular people into particular dwellings, family size, the effects of decanting itself, attrition and non-comparability of groups. Factors such as income, gender, age, unemployment and other problems may have an effect on health and be difficult to control for in longitudinal studies. The complexity of interacting variables and their mode of interaction make the links between intervention and outcome hard to interpret unequivocally. Nevertheless, longitudinal studies constitute a powerful means of testing hypotheses about causal relationships between housing conditions and health outcomes. However, the ability to carry out such studies normally requires the close cooperation of those bodies charged with carrying out changes to the housing stock.

The Study

In 1988 an opportunity arose to carry out a longitudinal study on the effects of the installation of improved heating in domestic dwellings, when the South of Scotland Electricity Board (as it then was) and Glasgow District Council joined forces to install a "Heat with Rent" scheme in dwellings on selected estates.

The "Heat with Rent" scheme involves the installation of a controlled heating system which responds to external temperature. Tenants pay a fixed sum which is incorporated into their council rent. The rationale for this scheme is that it addresses both dampness and cold in dwellings and problems associated with fuel poverty and budgeting. The scheme has not been universally popular, especially with people on low incomes, since it limits the discretionary use of income. The installation of the scheme is voluntary, although if a tenant moves out the scheme is installed before a new tenant moves in. The installation procedure does not involve any major disruption and does not require people to move out.

Since the installation of the scheme operated on a rolling basis, it provided an ideal opportunity to conduct a "natural experiment".

Aims

1. To evaluate the effect of the scheme on tenants' assessment of their housing conditions.
2. To assess the effects of the scheme on indicators of health status, with emphasis on the health status of children under 16 years of age.

METHOD

Choice of site

One of the places targeted for the "Heat with Rent" scheme was a relatively isolated estate to the south of Glasgow, where a previous survey had established that almost 50% of homes suffered

from dampness and a further 30% were hard to heat. Temperatures in all rooms had been found to be considerably below those which are recommended by the Building Research Establishment as the minimum necessary for comfort. (Glasgow District Council, 1986). The estate is located on land which is exposed to the prevailing wind. At the time the study began the original heating system was an electric fan ducted system which ran on off peak meters, separate from the domestic meter. Outlets were in the hall, kitchen and living room. Bedrooms were not supplied with heat. The system cannot be partially used, it is either on or off and it was notoriously expensive as well as largely ineffective. This estate was the first in Scotland to be designated hard to heat and residents were, therefore, entitled to an extra heating allowance. This site was chosen for the study because of its discrete boundaries and the high percentage of dwellings with problems associated with inadequate heating.

The building of the estate began in 1972 and was completed in 1979. There are only three types of construction, all of which contain flats, most having deck assess.

Sample

The estate contained 1338 households. Blocks had been targeted for being offered installation of the scheme in sequential order until all households had had the opportunity to have it. Those blocks scheduled for the installation of the scheme in the first year of operation were to form the focus of the study. When as many of the dwellings as possible had been sampled, other blocks in the estate were chosen at random to be included.

This design was intended to pick up three types of group:

a) the "experimental" group who would experience the new heating scheme during the period of the study

b) a group, living in the same blocks who had been offered the scheme but who had opted not to have it installed

c) a group who would not have the scheme installed during the period of the study.

An interview schedule which had been used in previous studies and found to be both valid and reliable (Hunt et al, 1986; Hunt et al. 1988; Martin et al, 1987; Platt et al, 1989) was amended slightly to incorporate extra questions pertinent to the local circumstances. The following topics were covered:

- composition of the household
- length of time in the flat
- reason for moving to the flat
- number of occupants
- symptoms, reported health status and use of health services over the previous two weeks for children and adults
- chronic illness in the household
- smoking in the household
- perceived dampness, cold, noise, lack of security, state of repair, play space
- other problems with the house and the area
- employment status of occupants
- patterns of income and expenditure
- type of heating available and patterns of use
- perceived financial situation

The schedule was administered by trained interviewers in the respondents' homes, on three occasions; prior to the start of work on the Heat with Rent scheme, approximately 6 months later and again 12 months later. Thus data would be available on all three groups at three points in time.

Procedure

The interviewers first visited all those households who were due to get the Scheme within the coming year. Where there were children in the home, the respondent of choice was the mother. Where the mother was not available information was obtained from the father or other guardian. For the first and second round of interviews three call backs were made where no contact could be made. On the final occasion as many as ten call backs were made in order to maximise the sample.

RESULTS

(Data reported here are based on interviews at times 1 and 3 only. These rounds of interviews were concluded in February 1988 and February 1989 respectively. The health data will be confined to the children).

997 households were visited during the winter months of 1988. Table 1 shows the response rates.

Table 1: Response rates of households at time 1

Completed interviews	532
Unoccupied	135
Refusals	109
No contact	221
Total	997

The rate of unoccupied dwellings was higher than recorded in the housing department and the large number of no contacts can be accounted for in several ways. The study was carried out just prior to the implementation of the poll tax in Scotland, the area has a high number of transients, some people are fearful of answering their door because of a high rate of vandalism and burglaries and because they do not welcome visits from officials in general.

The results showed housing conditions to be very poor with over 54% of households reporting dampness. Almost a quarter of respondents had a room they either did not use or would have preferred not to use because of dampness and/or cold. In addition, there were high rates of reporting of other problems, especially poor repair, lack of security and noise.

Table 2 indicates the unpopularity of the existing heating system and the use of alternative heating. The table refers to percentage of households.

Table 2: Type of heating available and its use in the two weeks prior to interview

Type of heating	Available	Used
Vented central heating	83%	32%
Electric bar fires	80%	69%
Fan heaters	30%	25%
Calor Gas	21%	15%
Paraffin heaters	4%	2%
Storage heaters	2%	1%

Almost 40% of households contained someone who was unemployed and 70% reported a total income of less than £100 per week, 81% were receiving housing benefit.

47% of the households had at least one child and the interviews at time 1 yielded data on 475 children. 36.4% were in the age range one month to four years, 43.7% were aged 5 to 11 years and the remainder were in the age range 12 to 15 years. Only 63% of children were said to be in excellent or good health. Thus almost 40% were reported to have only fair, poor or very poor health. A third of children under 5 years and a fifth of those aged 5 to 11 years had consulted a general practitioner in the two weeks prior to the interview. This compares with 21% and 10% respectively for children in the General Household Survey (OPCS, 1985). 31% had had a restricting illness and 28% were reported to have a longstanding health condition compared with the 12% and 16% respectively found by the GHS.

Over two-thirds of households with children had at least one child with respiratory symptoms - wheezing, sore throat, persistent cough or runny nose. These symptoms were significantly related to reported dampness ($p<0.01$).

Thus, interviews at time 1 yielded a picture of a severely disadvantaged area with a much higher than expected sickness rate for children.

Time 2

The 532 dwellings sampled at time 1 were revisited in October and November of the same year. Table 3 shows the outcome of these visits.

Table 3: Response rates at time 2

Completed interviews	303
Unoccupied	37
Refused	59
No contact	73
Changed tenancy	45
Interview not completed	15
Total	532

Of the 303 completed interviews, there was some doubt in 20 cases as to whether or not occupancy had changed since time 1, as no names had been recorded. These twenty were, therefore, omitted, leaving 283 households from the original sample. Of these 77 had had the Heat with Rent scheme installed.

Time 3

In January and February of 1989, these 283 households were visited again. Table 4 shows the outcome.

Table 4: Response rates at time 3

Completed interviews	215
Unoccupied	10
No contact	37
Refused	21
Total	283

In addition, 43 households who were in the sample at time 1 but who had not been contacted at time 2 were successfully interviewed. The total sample size at time 3 was, therefore, 258. At this time only 90 households had had the Heat with Rent scheme

installed. This was far fewer than had been scheduled.

Table 5 compares the characteristics of respondents with and without Heat with Rent (HWR, NoHWR).

Table 5: Characteristics of respondents with and without Heat with Rent

	HWR (n= 90) %	NoHWR (n=168) %
Married/Living together	56.2	46.7
Male respondent	17.8	25.7
Children under 16 years	61.1	46.7
Someone unemployed	23.3	33.5
Income < £80 per week	47.8	59.3
Getting financially worse off	39.8	46.3
Respondent looking for work	8.9	14.4

The Table indicates that there were considerable differences between those households where the Scheme had been installed and those where it had not. Respondents without Heat with Rent were more likely to be male, unmarried, without children, with an income less than £80 per week, to have someone unemployed in the home and to be looking for work. None of these differences reached statistical significance, but they do draw attention to the problems inherent in the study, when there is no control over the major independent variable.

Table 6 shows the percentage of respondents in each of the groups reporting housing problems at time 1 and time 3.

It will be noted that those respondents with Heat with Rent report significantly fewer problems with cold and damp, although other problems remain virtually unchanged from time 1 to time 3. The data show a remarkable consistency and add weight to the accuracy of respondents' reports. The high percentage of households having several types of housing problem is noteworthy.

Table 6: Respondents in HWR and NoHWR reporting housing problems at time 1 and time 3

	HWR		NoHWR	
	1988	1989	1988	1989
	%	%	%	%
Any damp	62.2	31.1	48.5	46.1
Cold only	16.7	5.6	16.2	12.6
Cold and Damp	41.1	6.7	31.7	29.9
Lack of security	61.1	61.1	60.1	66.1
Noisy	40.0	32.2	33.5	34.7
Poor repair	48.9	52.2	57.1	58.9

Children's Health

132 of the households where interviews had been carried out at time 1 and time 2 had at least one child under 16 years. 55 of these households were in the HWR group. Table 7 compares the characteristics of households in the HWR and the NoHWR groups.

Table 7: Characteristics of households with children: HWR and NoHWR at time 3

	HWR (n=55)	NoHWR (n=77)	
Someone unemployed	26%	38%	
Income >£80 per week	29%	44%	
Getting financially worse off	45%	39%	
Receiving housing benefit	55%	67%	
Other housing problems	84%	94%	
Mean number of children	1.9	1.7	
Children under 4 years	44%	52%	
Male respondent	7%	7%	
Mean Age of respondents	34 yrs	30 yrs	*

* $p<0.05$

As the Table shows there were some small differences between the households, although the only one reaching statistical significance was age of respondents. In particular, it is noteworthy that the number of children in the household and the

number of children under 4 years of age did not differ between the groups, since these factors separately and together are known to be associated with increased illness rates.

For the overall sample there were indications that symptom experience had increased from time 1 to time 3, as had the number of children reported to be suffering long term illnesses. In HWR households four symptoms showed a large increase - these were aches and pains, irritability, tiredness and high temperature. Two remained the same. These were sore throat and wheezing. There was a decrease in the reporting of seven symptoms; headaches, poor appetite, diarrhoea, feeling down, earache, persistent cough and runny nose. In the NoHWR group seven symptoms showed a large increase. These were aches and pains, sore throat, persistent cough, tiredness, headaches, poor appetite and temper tantrums. Reports of vomiting and wheezing, irritability and runny nose also increased, but earache, feeling down and fever went down. A McNemar test for the significance of changes from time 1 to time 3 between the groups yielded a p value of 0.05.

Thus of those symptoms which had previously been associated with dampness/ mould, reports of wheezing, runny nose, sore throat, headaches and persistent cough declined or stayed the same in HWR households, whilst they showed a marked increase in NoHWR households. These findings are detailed in Table 8.

An important feature of the reporting of the symptoms is the remarkable consistency which most of them show from one year to the other, suggesting that parents and guardians are reliable sources of this kind of information.

Although the pattern of changes suggests differences between the two sets of households, these differences are not as marked as might be expected if housing alone had a major effect on health status. It was clear that any effects of improved heating might have been attenuated by other influences on children's health, in particular other aspects of disadvantage. Accordingly a crude index of disadvantage was constructed consisting of housing problems other than cold, damp and mould; that is, fear of burglars, vandalism, poor repair, overcrowding, noisy, nowhere for children to play indoors, nowhere safe for children to play

outdoors and financial problems such as, in arrears with rent and/or rates, getting financially worse off, receiving housing benefit, someone unemployed in the household.

Table 8: Percentage of households reporting children with symptoms in 1988 and 1989 by Heat with Rent

	HWR		NOHWR	
	1988	1989	1988	1989
	%	%	%	%
Aches and Pains	9.1	25.5	9.1	18.2
Diarrhoea	12.7	10.9	14.3	14.3
Vomiting	14.5	16.4	14.5	16.4
Wheezing	20.0	20.0	14.3	18.2
Sore throat	43.6	43.6	24.7	36.4
Persistent cough	29.1	25.5	16.9	26.0
Runny nose	41.8	32.7	40.3	45.5
Irritability	7.3	16.4	9.1	11.7
Tiredness	10.9	23.6	9.1	16.9
Headaches	20.0	12.7	5.2	11.7
Earache	14.5	12.7	11.7	10.4
Fever/high temperature	9.1	18.7	20.8	22.1
Temper tantrums	20.0	25.2	16.9	26.0
Poor appetite	25.5	16.4	28.6	36.4

Since almost all the respondents had at least two of these problems, a dividing line was set at 4 such problems or fewer and more than 4, which created groups of almost equal size. Comparisons were then made within the Heat with Rent group only, in relation to the overall percentage of respondents reporting a change in children's symptoms. This analysis is summarised in Table 9.

Table 9: Number of indicators of disadvantage reported by household and changes in children's symptoms from time 1 to time 3: HWR only

Number of indicators of disadvantage	4 or less (n=26) %	More than 4 (n=29) %
Children's symptoms		
Increased	30	42
Decreased/Same	70	58

Although there are differences which suggest that the extent of disadvantage may have had an effect on symptoms, the differences were not statistically significant.

Discussion

This study illustrates some of the methodological issues associated with the conduct of longitudinal studies in disadvantaged communities. First, there were a number of difficulties in contacting people. Some addresses were used only as gyro drops, the area suffers a high incidence of crime which makes people reluctant to answer their doors and also renders interviewing problematic, especially where night work may be necessary in order to contact those households where people are out all day. Since the study was carried out in the winter, darkness descended by 3.30p.m. and interviewer motivation began to wane. The study area is one which residents are eager to leave, making attrition over time a considerable problem. Although the study was conducted with the close collaboration of the Housing Department, information about whether or not a dwelling was occupied was frequently inaccurate.

Second, because of delays in the installation of the scheme, the number of children in the sample was much lower than expected, raising problems for statistic analysis. For example, multivariate analysis which would take into account such variables as number of children in the household, unemployment,

changes in financial situation, length of time since the installatien of the Scheme, ages of the children and other housing problems was rendered impossible by the small numbers.

The results are most clear cut in relation to changes in housing conditions and do demonstrate that the improved heating made a considerable difference to the warmth and dryness of the dwellings. More rooms were in use and were being heated at time 3 . A small proportion of the HWR homes still had some signs of dampness and mould and were felt to be still cold. There are several explanations for this. The scheme had been installed for varying lengths of time in different dwellings and the full effects may not have been felt at the time of the last interview. Moreover, some of the dwellings may have lacked the adequate insulation and ventilation needed for the elimination of dampness.

The results do suggest that the partial elimination of damp, mould and cold had some positive effect on the children in the HWR households, particularly with respect to respiratory symptoms. In an area where general health seemed to be declining, one tentative interpretation is that the improved heating had a protective effect. That is, it was not so much that the installation of the heating system led to improvements in health, but rather that it prevented a further decline in the relevant symptoms.

Some of the symptoms, for example, high temperature, irritability and tiredness did show marked increases in the Heat with Rent households. A possible explanation for this is that the children were having problems adapting to the unaccustomed warmth, behaved more lethargically and complained of being "too hot". The reported increase in aches and pains is hard to explain, but since it occurred in both groups it might have been a general indicator of worsening health.

The contribution of other housing problems and financial difficulties to children's health indicates that improvements in housing alone are insufficient to ameliorate symptoms in areas of socio-economic disadvantage. Inadequate housing is just once of a number of interacting conditions which adversely affect the

health experience of children.

As far as can be ascertained this is the first longitudinal study of its kind ever carried out in Britain and although the results are not as conclusive as might have bben hoped, several lessons have been learned from the experience. First, targeting families with young children would have been preferable to taking the whole sample, which included elderly people, young men living alone and childless couples. Maximising the number of children in the sample would enable more complex statistical analyses to be used in order to estimate the contribution of other important variables to health outcomes.

Second, prior to the start of the study, it would have been more efficient to have surveyed the area with respect to unoccupied houses personally and with the assistance of the Community Council whose information was usually more up to date than that of the official housing records.

Third, the study was underfunded because of the failure to anticipate some of the problems which arose. For example, some of the interviewers were quite nervous about being in the area after dark, especially if they had to use public transport. It would have helped to have been able to provide transport and a driver who could have given reassurance and a feeling of protection. Only one incident did occur when the car of an interviewer was broken into and her handbag stolen, but the perceptions of the interviewers, like those of the residents were an important determinant of behaviour and motivation. In addition, more interviewers should have been employed because of the high number of call backs required.

Some factors in a "natural" experiment such as this were, of course, outwith the control of the research team. In particular the installation of the heating scheme proceeded much slower than the schedule had indicated.

Conducting the investigation in an area of high economic and material disadvantage meant that effects on health due to housing inevitably interacted with the many other adverse circumstances with which residents of the area had to contend.

Finally, it is clear that although improving heating probably has some beneficial effects on the health of children, the continuing existence of other housing and environmental problems are likely to attenuate these beneficial effects. It would be more efficient and more efficacious to address housing conditions by a whole package, rather than attempting piecemeal renovations.

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