Cold Homes and Health

A report to the Eaga Charitable Trust

Roger Critchley
Health & Housing Group
1997

Eaga Charitable Trust

The Eaga Charitable Trust (Eaga-CT) was established by Eaga Partnership Ltd in February 1993. Eaga is the Trust's sole funder.

The objectives of the Trust are *"the relief of fuel poverty and the preservation and protection of health by the promotion of the efficient use of energy."*

Applications for funding by the Trust should:
i. assist to clarify the nature, extent and consequences of fuel poverty; and
ii. offer insights into opportunities for the energy efficient and cost-effective relief of fuel poverty in any part of the United Kingdom.

Eaga Charitable Trust Publications

Other reports published by the Eaga Charitable Trust include:

Making cold homes warmer: the effect of energy efficiency improvements in low income households (1997)
by Geoffrey Milne and Brenda Boardman
Environmental Change Unit, University of Oxford

The housing and heating of low-income households (1997)
by Sandra Hutton
Social Policy Research Unit, The University of York

Fuel Poverty, Energy Efficiency & Health (1997)
by Melanie Henwood
Health & Social Policy Analyst

Rural Fuel Poverty - A Project in the Wiltshire Rural Development Area to Study Rural Fuel Poverty and Suggest Practical Solutions (1998)
by Alastair Gill, with assistance from Juliet Davenport and John Lancaster
Energy for Sustainable Development

Advice into Action - An Evaluation of the Effectiveness of Energy Advice to Low Income Households (1998)
by Energy Inform Ltd, in association with Catrin Maby and the Environmental Change Unit, University of Oxford

Developing a methodology to evaluate the outcome of investment in affordable warmth (2001)

by Janet Rudge, Low Energy Architecture Research Unit (LEARN), School of Architecture and Interior Design, University of North London.

Further information

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BACKGROUND TO THIS REPORT

The Eaga Charitable Trust asked me to act as a referee on the first draft of the report *Fuel Poverty, Energy Efficiency and Health* by Melanie Henwood. Some, but not all, of my comments and ideas have been incorporated within the final text of Melanie Henwood's report. Subsequently it was decided that my contribution be made more widely available, as part of the Trust's research initiative on fuel poverty and health.

My own report contains all the original comments and the only additions are a number of sub-headings and a contents page. Since the comments were written in response to specific paragraphs of Melanie Henwood's draft report, they appear somewhat disparate and disjointed. Moreover, at times the text may appear unpolished. Apologies for these shortcomings and any errors committed in haste - a seamless report would have been impossible without a major re-write and complete restructuring. However, I hope that the information and ideas contained within this report will stimulate the debate on the EAGA Charitable Trust's funding relating to fuel poverty and health.

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CONTENTS

THE NEED TO LOOK AT MORE THAN HEATING

Whilst the main area for improving thermal efficiency involves providing more efficient heating systems and improving the thermal efficiency of the home, if the key issue is considered to be fuel poverty, it is also necessary to look at the efficiency of the appliances within any home together with the hot water system. Marcus Newborough calculates that the economically active spend £195.00 per annum on electrical appliances, whilst the average family spends £213.00 and the professional family £229.00 (all prices based on unit prices 0.8p per kWh and exclude all standing charges). He argues that significant savings can be made, firstly, by replacing low efficiency appliances with high efficiency appliances and, secondly, by using existing or new appliances in energy efficient ways. (1)

At the same time, the consideration of methods of providing hot water can be very fruitful in terms of reducing overall fuel expenditure and thus increasing the household income available for space heating. For instance, the replacement of a poorly insulated hot water cylinder with a combination boiler, which provides hot water as and when it is needed, offers substantial savings.

THE LAW AND COLD HOMES

The law does set heating standards, albeit in an obscure way. The fitness standard for housing does take account of heating, although in a very unsatisfactory form. Section 604 of The Housing Act 1985 states that a dwelling should meet certain criteria, one of which is that it should have "adequate provision for heating". If it fails to meet that criteria then the dwelling can be considered to be unfit and as a result of that failure, the Local Authority may consider the dwelling is not fit for human habitation.

Current advice on the interpretation of the fitness standard in relation to space heating has been set out in two circulars with identical text. (2) Whilst the text of the circular clearly acknowledges the relationship between low temperatures and ill-health, it draws upon the research by Collins (see paragraph 2.29), the Circulars recommend the provision for "fixed heating of sufficient capacity to maintain ..... most of the rooms at a temperature of 18°C or more when the outside temperature is -1°C" and "for heating each other habitable room there should be provision for heating sufficient capacity to maintain most of the room at a temperature of 16°C or more when the outside temperature is -1°C. This should normally comprise a fixed heating source or a gas point with working flue or a safe electrical installation suitable for a fixed portable electrical heating appliance. For the latter, there should be a 13 amp minimum outlet available.....".

Local authorities throughout the country have used this circular to approve single power socket outlets in bedrooms and a gas supply with a flue in the main living room as sufficient for the purposes of this fitness standard. However, this Circular is not a definitive interpretation of the law and challenges are being considered. One case is currently due to undergo judicial review in 1997 but this will not necessarily set any precedent. The whole fitness standard is under review and a consultation document is expected this autumn which many propose an improved heating/thermal standard.

At the same time, the law of Statutory Nuisance[3] implies that no home should be prejudicial to health. A cold home environment clearly can be prejudicial to health[4] and some specialist housing solicitors have engaged experts to prepare cases for the Magistrates' court. In all cases, known to date, tenants have either been rehoused or won additional heating systems without going to court. Consequently, no precedent has been set. These particular cases have been based simply around the fact that a particular home was hard to heat and hence cold. However, where there is mould growth in homes the law of Statutory Nuisance has been used successfully for many years by tenants to gain not only additional heating systems but improved insulation and other works in order to make their homes warm, dry and easier to keep warm with the prime aim being that no condensation should reoccur. Increasingly, in Environmental Protection Act 1990 cases, there is more specific evidence given in relation to the affordibility of the space heating system. On occasions energy audits showing very high heating costs are persuasive in convincing the Magistrates that a key factor which is contributing to the fact that the premises are prejudicial to health are the high heating costs. [5]

The 1965 Building Regulations give the minimum insulation values for roofs, walls and exposed floors.[6]

EHCS 1991 – COLD AS A HEALTH RISK AND THE USE OF SAPS

The most damning quotation from EHCS 1981 : Energy Report is considered to be "cold homes represent the primary health risk in buildings, contributing to the proportion of some 20,000 excess winter deaths each year". This is believed to be the most explicit acknowledgement of the health risks of cold in any government publication to date.

The EHCS 1991 : Energy Report relies on SAP Ratings which is understandable, taking into account the levels of data involved. However, it should be recognised that SAP Ratings are not as sophisticated as other energy auditing programmes currently used, e.g. the National Home Energy Rating Scheme. For instance, SAPs do not take into account lights and appliances, location, stairs entering into living rooms, various combinations of heating systems etc. A SAP Rating would not normally be used to calculate the running costs of any particular dwelling in detail. However, the Department of the Environment and the Building Research Establishment have modelled, as best as they could, running costs using these SAP Ratings.

DEFINING AFFORDABLE WARMTH

Understanding the concept of affordable warmth appears relatively easy. Instinctively it could be considered to mean that any household should be able to heat their home to adequate temperatures for a reasonable time at costs that they can afford. However, where any local authority considers an estate refurbishment, when any magistrate considers whether a heating system is adequate in a court case, or any person looks critically at standards of affordable warmth, they will want a more explicit definition which can be used to reach an informed judgement. Without a tightly worded definition it is impossible to judge whether any particular home and its heating system can, in fact, provide affordable warmth. This problem will be discussed in the following few paragraphs since it raises a number of critical issues.

In order to define affordable warmth it is necessary to ask five key questions:

- What temperature should be achieved?
- For what length of time?
- Should all fuel costs be included or just heating costs?
- Should the definition relate to the property size?
- To what income levels, if any, should the definition relate?

The most comprehensive definition which addresses most of these questions has been devised by Brenda Boardman and Sonja Hunt.[7] Their definition is that any household, for a maximum of 10% of expenditure, should be able to achieve the following temperatures for the relevant periods :

- Living rooms - 21°C for 13 hours a day
- Bedrooms - 18°C for 13 hours a day (including 8 hours at night)
- Other spaces - 18°C for 13 hours a day
- All spaces - 14.5°C at all other times

A fuller discussion of target temperatures is set out in paragraph 2.29 below. The authors of the above definition state that the temperatures chosen "represent conditions of comfort, for health and for the avoidance of condensation."

A number of assumptions have been made which are that these temperatures are satisfactory and that the "walls, floors and windows are no more than a few degrees below air temperature, e.g. a condition not difficult to attain with reasonable insulation and double glazing." And "that the relative humidity is below 70%." Both of these assumptions are open to question in relation to many low income families.

The choice of 13 hours is largely based on past work by Brenda Boardman, showing that the home for many low-income families is effectively essential to their lives. A housewife in the publicly rented sector typically spends 1.7 hours a day out of the home, compared to the full-time employed person in the same tenure, spending some 10.8 hours outside the home. Moreover, most unemployed, except housewives with children spend some 7 hours a day at seated tasks.[8]

The 13 hour period could be viewed as excessive but there are other authorities using longer periods. For instance, the Building Research Establishment when developing their energy audit programmes developed three typical patterns, one of which was heating for 16 hours between 7.00 and 23.00. In that case, they chose 21°C for the living room and 19°C for the rest of the home.[9]

The Brenda Boardman and Sonja Hunt definition relates to total fuel costs, as does the EHCS 1991 data. However, some definitions of affordable warmth do not. For instance, in 1992 the Department of the Environment Energy Efficiency Office issued guidance to local authorities on affordable warmth policies.[10] They recommended space heating costs of £2.50 per week for a one bedroom dwelling, to £4.50 per week for a three bedroom dwelling. Such targets contain a number of problems including those already addressed under 1.3 above. They assume certain boiler efficiencies that may not exist, do not include standing charges which for low-income families with token meters can exceed £100 a year. They do not address the problem of how

long a property should be heated for. A point of interest though, is that these particular publications posed four key factors for an affordable warmth scheme which included:

- "A good level of insulation
- An efficient heating system
- Ventilation control measures
- Energy advice for tenants"

The latter two factors are not normally considered as part of an affordable warmth definition but can make an important difference to expenditure, indoor climate and health.

The Sonja Hunt and Brenda Boardman definition does not explicitly address the issue of property size. Recently, affordable warmth targets have been set in terms of National Home Energy Ratings, e.g. of 7 or 8 or SAP Ratings of 70 - 80. The problem of ignoring property size was recently highlighted in a publication by the Building Research Establishment.[11] Whilst stating that "the most widely accepted target for affordable warmth is that a households total fuel costs should not exceed 10% of disposable income", they compiled a matrix of total fuel costs based on different floor areas and different SAP Ratings. This illustrates that at 1995 prices a SAP Rating of 70 in a 40 m^2 dwelling would result in a total fuel cost of £6 per week, whilst the same SAP Rating in a 100 m^2 dwelling would result in a fuel cost of £11.60 per week. The prices are more striking at lower SAP Ratings. For instance, in the 40 m^2 dwelling at a SAP Rating of 30 the total fuel costs are £9.40 and with 100 m^2 floor area the total fuel costs are £20.10 per week.

These figures illustrate two problems. Firstly, if a NHER or SAP Rating is used as a target, a small family in a dwelling with a relatively large floor area can still be subject to relatively high fuel costs. Secondly, if a maximum of 10% of disposable income is set and the family lives in a dwelling with a large floor area, it may be hard even with reasonable energy efficient measures to achieve the 10% target. It therefore seems reasonable that any affordable warmth targets be qualified by a statement that indicates that the property size should be reasonably suitable for the number of persons in the household.

Brenda Boardman's original definition of 10% of net income[12] has been widely accepted in literature referring to affordable warmth in the 1990's. However, whilst the majority of references refer to it as a maximum for income, other publications discuss 10% as a target. The EHCS 1991 Energy Report widened the definition even further stating that "10% and 15% may be considered as target and maximum fuel expenditures for the purposes of assessing affordable warmth."

EHCS 1991 – HEATING PATTERNS DO NOT PROVIDE SUFFICIENT HEAT

The EHCS report chooses inadequate heating patterns. This brief discussion of how long homes should be heated for is relevant to any interpretation of EHCS data regarding fuel expenditure as set out in Table 2 of the Report to EAGA Charitable Trust. The heating regime defined as a "minimum heating regime" is in fact an 18°C/16°C all day regime (which is defined as 16 hours in paragraph 9.10) to only half the house. In other words, the target temperatures are below comfort temperatures when only half the house is heated up to a 16 hour period. The standard heating regime is in fact the 21°C/18°C comfort temperatures to the full house but the heating period is only for the morning and evening which is considered to be typically two hours in the

morning and six hours in the evening. Such a heating pattern may be totally inadequate for many low-income families who spend much of their time at home. The minimum and standard heating periods presented in Table 2, therefore, should be recognised as failing to meet the needs of many low-income families and if the 21°C/18°C 16 hour full house standard had been set then the figures for the percent of income needed to achieve the targets would have been significantly increased.

EHCS 1991 – TEMPERATURES TAKEN IN WARM WEATHER

The fact that the external temperature was 11°C needs highlighting in order to keep the EHCS temperature monitoring results in perspective. An average winter day's temperature used for condensation calculations and other calculations would usually be 5°C and design temperatures of 0°C or -1°C. Therefore, the mean external temperatures in the EHCS were noticeably warm and consequently the internal air temperatures taken tell us relatively little about internal temperature in English homes during normal winter temperatures. They are more relevant in helping to distinguish households or types of homes more susceptible to colder temperatures. The methodological problems of surveying homes for internal temperatures are clearly problematic for the EHCS survey managers. However, the present system including temperature monitoring as a standard part of the interview survey is considered to be inadequate and a system whereby home temperatures could be taken during cold spells would provide far more useful data, albeit at a higher survey cost.

When the external temperature is 16°C it would be hoped that the internal temperature throughout most of the dwelling was also 16°C or thereabouts. At such temperatures, a space heating system is not normally in operation, therefore, the fact that 45% of the poorest households were able to reach the minimum heating standards reflected in the EHCS data but does not really tell us anything useful.

THE ROLE OF ADVICE

Direct capital expenditure is certainly the main area that needs investment. However, the role of advice and assistance must not be forgotten. Heating and hot water systems and new appliances become increasing sophisticated and often intimidating. "The installation of a modern and efficient heating system is often not enough. Many tenants are afraid to use central heating systems or do not understand how to use heating controls such as programmers and thermostats and so use the system manually or not at all. Others regard central heating as a luxury but is inherently expensive to run and so are afraid to use it."[10]

The quotation from the EHCS Survey as to whether or not fuel expenditure is adequate is again open to question since it is based on the minimum heating regime (see paragraph 1.14).

GERMAN USE OF BUILDINGS IS DIFFERENT

Countries such as Germany tend to make better use of the land and build more flats as well as dry and warm basements. The phrasing of the question in the European household panel survey leaves it open to UK respondents to state "yes, I have a damp basement" even if it is a non-habitable unusable space. [13]

DAMPNESS AND DISREPAIR INCREASE FUEL COSTS

A list of variables which may contribute should include dampness and disrepair. Rising dampness, for instance, will contribute additional moisture into any home and cause the wall surfaces to become cold and the salts within the wall surface will hold continuing water from the air. Disrepair of the heating and hot water system, water penetrating into walls, loft insulation that has been disturbed, heating control systems that have broken, windows that are in disrepair are some of the many factors found in low-income homes which contribute to additional fuel expenditure and/or colder internal environments.

CONDENSATION CONTROL PUT BEFORE THERMAL EFFICIENCY

It is interesting to note that the 1974 Building Regulations changes were not due to the government's desire for any increased thermal efficiency but specifically to deal with the condensation problems.[14] In order to achieve energy efficiency, it was not until the 1991 Building Regulations that the poor thermal insulation of homes was addressed through an improved thermal insulation requirement.

LINKS BETWEEN DAMP/COLD HOMES AND ILL HEALTH -CAN THEY BE PROVED?

It is agreed that the precise causal relationship between cold and damp in homes and the health conditions of any particular household is difficult to determine. However there **is** relevant literature which draws clear links between both damp homes and ill-health and cold homes and ill-health. Disentangling the variables is certainly a major problem. It is considered that firm conclusions relating to the UK population can be drawn taking an overview of the available literature.

HEALTH EFFECTS ON THE ELDERLY

Malcolm Wickes' comments which interpret the fact that the elderly often do not report cold conditions, or say that they do not want to become warmer, are summarised by Dr Hamdy[15] who states that:

a) the cutaneous cold receptors are often less sensitive in the old therefore warning signals to the hypothalamic and cortical centres may be delayed

b) the temperature regulating centres become less sensitive as age advances

c) the afferent and efferent nervous pathways linking cutaneous cold receptors, temperature regulating centre and other key parts of the body may be disrupted or less efficient

d) the endoctrinal system may be less sensitive

e) disease of the locomotor system may make shivering impossible

At the same time, Dr Hamdy points out that:

i) sedatives, narcotics, tranquillisers and other drugs may tend to depress consciousness and slow the mental processes

ii) the tendency to fall can be a major precipitating factor in hypothermia

iii) diseases of the locomotor system interfere with active movements reducing the mobility of the patient thus decreasing the metabolic rate

iv) major illness can upset the temperature regulating centre including strokes, pulmonary embolism, congestive heart failure and myocardioinfarcts

iv) incontinence can precipitate hypothermia by not only losing heat from the body but cooling the body when urine is left in contact with it.

v) there are social factors in relation to the ease of using any heating system, fear as to its costs, lack of knowledge and access to the insulation which will improve thermal efficiency

vi) some patients are very likely to develop hypothermia if left on their own. Depression, post bereavement depression and mental disabilities can lead to lowered core temperatures Based on his research as a Registrar in Geriatric Medicine, Dr Handy underlines the central issue with his article entitled: "Why do you want to see me? I don't feel the cold".

Work by Fanger suggest the elderly have a very different sensitivity to temperatures felt by touching heated metal plates. Whilst the young perceive temperature difference of 0.9 °C +/- 0.2 °C, the elderly perceive differences of 2.5 °C +/- 0.8 °C. [16]

In the Age Concern study of minimum bedroom temperatures, it was found that in 1972 81% of the sample had minimum bedroom temperatures below 16°C, whilst in 1991 the figure had fallen to 63%. Ann Savage, the author of the Age Concern report draws out the significance of this in that individuals would be likely to be vulnerable to respiratory disease at air temperatures of this level. The fact that in a 19 year period between the two surveys, during which the presence of central heating had increased from approximately a quarter of the sample to almost three quarters, there had only been a 5% increase in the number of living rooms where the temperature exceeded 20°C need emphasising.

The time in which the urine temperature was taken was between 8.00 - 10.00 am. It is noted that the body temperature varies throughout the day with fluctuations between usually 0.5 - 0.7°C with the lowest temperature usually being around 4.00 am.[15] This may lead to the temperatures quoted slightly underestimating those at risk of hypothermia. The Age Concern study provides detailed discussion on the problems facing the elderly, together with a thorough review of past main literature relating to this subject. The answers to two further questions particularly relevant to in terms of comfort and health discussion in paragraphs 2.29. Respondents were asked "Would you say you ever felt cold indoors?" The responses were then compared to the living room and bedroom temperatures.

Ever feel cold at home, by morning living room temperature

Feel Cold	Morning Living Room Temperature °C	
	0-13.9 %	18+ %
Very often	14	5
Fairly often	7	5
Sometimes	28	25
Rarely	26	23
Never	25	41

Ever feel cold at home, by minimum bedroom temperature

Feel Cold	Minimum Bedroom Temperature °C	
	<8 %	16+ %
Very often	19	6
Fairly often	4	5
Sometimes	32	27
Rarely	21	23
Never	23	40

These tables illustrates the complex responses to cold and warmth, showing that a significant number of pensioners feel cold at temperatures above those recommended by the government and a significant number rarely or never fell cold at temperatures which are likley to adversely affect their health. A fifth of the sample said that they were not warm in the kitchen and a similar proportion said they were not always warm enough in the bathroom.

The quotation from Collins does not fully represent his findings and no information regarding Collins' research is outlined in paragraph 2.29.

MORE HEALTH EFFECTS OF COLD

Within the excess mortality figures there are patterns relating to social class. For instance, social class 5 babies are near five times more likely to die from bronchitis or pneumonia than babies of class 1 when they are less than one year old. These diseases may be triggered by breathing cold air. (17)

A further study of mortality from ischemic heart disease found that it was highly correlated with temperature, rainfall and the socio-economic index. A clear divide was found between higher excess mortality rates and excess death rates in the north and west and the death rates in the south and east. (18)

A further study which confirms the relationship between the internal temperature shows a close association of internal temperatures and deaths from most diseases other than cancers. Whilst respiratory diseases such as bronchitis and pneumonia and cardio-vascular diseases such as strokes are strongly related to the fall in temperatures. Deaths from duodenal ulcers and genitory-urinary diseases were also found to increase during periods of colder weather.[19]

PROFESSOR KEATINGE AND THE ROLE OF EXTERNAL TEMPERATURES

Professor Keatinge's views on cold have been controversial. A lack of empirical evidence and the use of anecdotal asides together with a lack of consideration of all variables, has been found in his work. For instance, in a seminar sponsored by The EAGA Charitable Trust in January 1995 : Beating the Cold and Ill-health - Why warmth matters. The Neighbourhood Energy Action and Policy Studies Institute Series : Energy Savings and Social Policy. He asserts inter alia:

a) the increase in mortality was at least as large in warm Mediterranean countries such as Greece and Portugal as in Britain without mentioning the general lack of heating systems and sharp drop in night-time temperatures in some of these countries. For instance in Javea, which the WHO considers to be the healthiest climate in Europe, there are steep drops in night-time temperature whilst in Israel condensation problems due to reduced temperatures are an acknowledged problem.

b) that mould growing in damp houses leading to respiratory illness has not been confirmed, yet he does not address any of the considerable research evidence to the contrary (see paragraphs 4.1 – 4.6 below).

c) there is no sign of an effect from central heating in preventing deaths. He uses detailed figures based on 15,000 units of sheltered accommodation but only looks in detail at the use of 14 units, where 13 of the households said they switched off all the heating and opened the windows at night

The key claim from Professor Keatinge that the external cold environment in winter is likely to be a major factor in poor health is not challenged, but some of his views and his conclusions drawn from particular data need to be viewed critically.

The BRE's view is that winter mortality has decreased as central heating has increased and that many winter deaths are among those who do not go outdoors. [33A]

NEED FOR A DEFINITION OF HEALTH

Before discussing links with temperature and ill-health, it is essential to have a definition of health. In the UK health is often regarded as the absence of disease or infirmity. This definition of health is often implicit in discussions of health and housing. However, at the same time, there is an alternative and wider definition of health provided by the WHO who define it as "a state of complete, physical mental and social well-being and not merely the absence of disease or infirmity."[21]

The Environmental Protection Act 1990, which has already been discussed (see paragraph 1.3), requires any person considering a prosecution for unhealthy housing in a Magistrates' court under the Environmental Protection Act to prove that the dwelling is prejudicial to health which is further defined as "injurious or likely to cause injury to health". Mould growth and dampness are well established in the courts as being prejudicial to health and so are other physical defects such as faulty electrical wiring, dangerous stairs, holed floorboards, presence of asbestos. Of particular relevance to cold homes are the successful prosecutions taken by occupants under this Act in relation to noise nuisance. In such cases there is no danger or likely defect likely to cause a physical health risk, however, people suffering noise nuisance will suffer mental stress and anxiety including sleepless nights and disturbed living patterns. Such affects have been found to be prejudicial to health and are relevant to any discussion of temperatures within homes.

COMFORT TEMPERATURES AND TEMPERATURES WHICH MAY LEAD TO PHYSICAL ILLNESS

"Low temperatures" can be considered to fall into two categories:

a) those that can cause discomfort, worry, anxiety, mental distress

b) those that can lead to illness or disease or exacerbate other medical conditions

The following paragraphs look in detail at the difference between comfort temperatures and these two categories of "low temperatures".

For many years buildings have been designed with heating systems which have been designed to provide adequate thermal comfort, which has been described by Fanger as "that condition of mind which expresses satisfaction with a thermal environment".[22]

The Chartered Institute of Building Service Engineers leads up to its definition of thermal comfort by stating that "the indoor environment should be safe, appropriate for its purpose and pleasant to inhabit. There should be little to cause annoyance or distraction and work or pleasure activities should be unhindered physically or mentally. A suitable environment can contribute towards a person's health, well-being and productivity."[23]

Various comfort scales have been produced with descriptions of slightly cool, neutral/comfortable and slightly warm.[24] [25] The Bedford Scale has been used in the EHCS 1991 survey.

Thermal comfort is affected by a variety of factors. The six main ones have been defined by Fanger [22] as:

- Activity level
- Thermal resistance to clothing (clo value)
- Air temperature
- Mean radiant temperature
- Relative air velocity
- Water vapour pressure and ambient air

He carried out a number of experiments where all these variables were carefully controlled. He was thus able to produce detailed tables relating comfort to different air temperatures, relative air velocities, clothing values etc.

It is not necessary to understand all the complexities of these variables but it is important to appreciate a few key factors: firstly, the active person, e.g. carrying out housework will not need as high a temperature as a sedentary person.

Secondly, the level of clothing may affect the need for internal temperatures. Edwina Curry and other politicians have encouraged the population to wear woolly hats and other clothing. However, putting on extra clothes can make you feel bulky and stiff and prevent you from easily carrying out everyday household tasks and leads to many people being ashamed to invite others into their homes if they and their guests have to keep wrapped up. At the same time, controlling comfort levels through additional clothes, does not address the problem of breathing in cold air. For the purposes of this discussion the level of clothing equal to one clo is considered to be reasonable. (For example men's clothing which will provide 1 clo unit would be pants, light vest, light long sleeved shirt, light sweater, light trousers, light jacket, ankle length socks and shoes). The example of the effect of additional clothing to provide thermal comfort is illustrated in the table on the next page. [26]

Thermal comfort relating to clothing and activity levels

ACTIVITY	18 ^{o}C	16 ^{o}C	14 ^{o}C	12 ^{o}C	10 ^{o}C
Sitting	1.8	2.2	2.5	2.8	3.2
Daily mean	1.2	1.5	1.8	2.1	2.4
Light housework	0.9	1.2	1.4	1.6	1.9

This table illustrates how carrying out light housework at Clo level 0.9 would result in thermal comfort at a temperature of 18°C. However, sitting down at a temperature of 10°C would necessitate long underwear, heavy shirt, two thick sweaters, knee length woollen socks, heavy trousers, shoes, a thick overcoat and a hat in order to maintain thermal comfort.

Thirdly, the mean radiant temperature takes into account the surface temperature of the surrounding walls. In low-income households this can have a noticeable affect particularly with large areas of single glazing and solid concrete walls which are slow to react to the heating source. Usually, within most dwellings the relative air velocity is low but sometimes draughts can be felt and can cause some additional discomfort. The relative humidity of a home has relatively little affect upon comfort levels except at much higher temperatures which are outside the scope of this report.

DESIRABLE COMFORT TEMPERATURES

Taking into account these qualifications, Fanger has produced tables of temperature which American students found to be thermally comfortable having been seated in a strictly controlled experimental procedure. With the air still and the subjects sedentary, with a clothing value of 1.0 and no significant air movement, with a relative humidity of 60% which is largely typical for a low-income family home, the thermal comfort temperature would be 23°C. However, under the same conditions, with medium activity the thermal comfort temperature would be 15°C. In fact, comfort temperatures recommended in most present UK design guides are 21°C in the living

room and 18°C in the remainder of the rooms in any home. The table below illustrates various recommendations relating to the temperature standards.

All temperatures in °C	1944 Post war Building Studies	Parker Morris Report 1961	British Standard for Energy Efficiency in Housing 1988 and 1995	Chartered Institute of Building Services	Department of Environment Unfitness Circular 1990 and 1996	Homes for the Future 1983 Institute of Housing and RIBA	British standard for gas space heating systems 1977 and 1990
Living rooms	17 - 19	18	21	21	18	21	21
Bedrooms	10 - 13		18	18	16	18	18
Kitchen	16	13	18	16		16	18
Bathroom	10 – 13		22	22		21	22
WC	10 - 13		18	18			18
Circulation areas	10 - 13	13	16	16		16	18

Fanger's work developed an equation which enables the predicted mean vote (PMV) to be used as a comfort index. He also produced figures for a predicted percentage dissatisfied (PPD). Since he found that in a thermally neutral environment there was, in a large population, a base level of dissatisfaction of around 5%.

Spaces which were reported to be cool or warm are likely to have 80% satisfaction levels. CIBS is currently considering recommending temperatures which have an equivalent PPD of 10% [27]

Such experimental work recognises that you cannot satisfy all of the people all of the time and any discussion of thermal comfort, the majority of people may find a particular temperature satisfactory whilst the minority may disagree.

Whilst Fanger's work is the basis of many national and international codes, there is also research which challenges his models to some degree. Research at the University of Surrey found that there was an average difference of 4.8°C between the comfort temperature predicted by Fanger and that actually regarded as satisfactory as thermally neutral by people living in solar homes. [28]

The research also suggested that there are other environmental factors which inter-relate with thermal comfort which are not normally taken into account including seating, lack of draughts, quality of daylight.

Further work by the Building Research Establishment on starter homes, which took care to take into account levels of clothing and other key variables, found that the mean living temperature of 19.2°C found during the survey was very similar to the preferred temperature of 19.4°C which was below the normal comfort temperature for living rooms of 21°C, and those proposed by Fanger. A full literature review is beyond the scope of this short report. There appear to be important questions relating to comfort, temperature and health and higher ranges of temperatures and such questions include:

- Are the present comfort temperatures too high? If so, could this lead to substantial savings in national energy usage?

- In what way do people feel discomfort, anxiety, stress or have their living patterns limited or disturbed by failure to reach comfort temperatures?

- Should the thermal efficiency of any home be designed to meet the minority of people who require higher temperatures or for the majority?

TEMPERATURES LEADING TO ILL-HEALTH

The question of which temperatures are likely to directly lead to ill-health arise through the work of Dr Collins.

The work of Dr Collins, Department of Geriatric medicine at St Pancras hospital, has been crucial in establishing temperatures below which ill-health may occur. Manton and Muir drew on his work for their study of Building Regulations in 1985 and Raw and Hamilton rely on his work for their equivalent publication in 1995. His benchmark temperatures are widely quoted throughout the literature on cold homes.

Below 16°C he points out that a cold environment may impair the function of the ciliated, goblet and mast cells in the bronchial epithelium and reduce the resistance of the body to infection secondary to colds and influenza. Below 12 °C there are changes in blood viscosity and rises in blood pressure have been observed in older men after 1 hour at 12°C and increasing after 2 hours. Raised blood pressures in cold indoor temperatures affects both the old and the young.

Raw and Hamilton also point out that emerging from a cold home into cold outdoor conditions can produce a greater cardio-vascular strain than emerging from a warm home. A number of studies have shown that cold air can cause a narrowing of the bronchi which may particularly affect those with asthma or bronchitis. Cold air, in many cases, reduces the effective working pattern of the lungs. The temperature change involved in moving to a colder room, e.g. from a heated living room to a colder bedroom can affect the persons respiration and circulation. Rapid changes have been found to have most effect. [29] [30]

"Acute respiratory infections in Europe have taken the lead among all communicable diseases... each year 30% of the population in the United Kingdom have a recorded acute respiratory disease". [31]

Dr Evan Lloyd has argued that "in a house in which only one room is heated, especially overheated, the person will suffer acute cold stress every time s/he leaves the room". [33] He recommends central heating with relatively small temperature differences between rooms. He also states "the fact that bedrooms and bathrooms often remain totally unheated, with a window open even at night in winter, may result in repeated exposures to severe cold stress especially if only room in the house is heated". Furthermore, "the bathroom is another danger room for cold. It is a room which is seldom heated and after a bath, the person is totally naked, vaso-dilated and wet". [34]

ACCIDENT RISK AND TEMPERATURE

Cold also affects a persons mobility and agility. It leads to an increase in the rate of accidents in the home and government statistics have shown that deaths from such accidents increase by 35% in the December-April period.[35]

Allison & Barstow found that fractures of the thigh bone increased by three and a half times within a few days of a drop in outside temperatures. [36]

Lloyd identified the everyday problems related to cold and our general ability of perform everyday tasks. "The effects of cold on nerves, joints and muscles are liable to cause clumsiness, loss of manual dexterity and impairment of co-ordination and therefore increase the risk of accidents". [34]

PAIN AND DISCOMFORT

Although cold does not increase the risk of contracting rheumatoid arthritis, a cold or damp environment worsens the pain and suffering from this disease. [37]

Smaller sub-groups of the population have especially sensitive blood vessels in the skin. They may suffer from a range of conditions which are called perniosis. These include: chilblain (a red, round itchy swelling usually on toes or fingers) and Reynaud's disease (pallor, numbness and discomfort in the fingers).

CARBON MONOXIDE POISONING

Recent research indicates that carbon monoxide poisoning is far more widespread than has been realised to date and tentative conclusions can be drawn that it is the fuel poor who are most likely to suffer ill-health from this cause.

The Health and Housing's Group survey of 213 homes concluded that 5% of households had definitely suffered from CO poisoning and 20% of households had probably suffered during their existing tenancy. [38]

The Building Research Establishment estimates that over 100,000 people suffer from CO poisoning each year in the UK[20]

The last two studies probably provide the most accurate current picture. No source of data presently provides a complete picture and many sources provide a very significant underestimate. For instance, only officially reported incidents are recorded by the HSE; only people in a very poor condition are likely to present themselves at hospital and emergency departments; only a proportion of deaths and illness will be reported by the media.

Moreover, there is clear evidence that GP's frequently fail to recognise the symptoms of carbon monoxide poisoning and therefore the true cause of death may not be recorded, in addition the risk of heart attack and sudden death from existing cardiovascular problems appears to increased by carbon monoxide but this is likely to be overlooked. Examples of frequent misdiagnosis of

CO poisoning are psychiatric illness, migraine headaches, stroke, acute alcohol intoxication and delirium tremens, heart disease and food poisoning.[39]

A MORI survey of 200 GPs overseen by Dr Henry, Consultant Physician at the National Poisons Unit involved sending them the symptoms of CO poisoning such as headaches, drowsiness, dizziness, vomiting and pains in the chest. They were asked for a possible diagnosis. Not one doctor suggested CO poisoning. [40]

Recent research and personal experience indicate that:

- the private rented sector contains a high proportion of older appliances and/or unserviced appliances or flues and defective ventilation.
- households renting from council or housing association landlords are not free from illness or death despite such landlords annual maintenance programmes [38]
- CO incidents are more frequent where households rely on a single space heater eg a gas radiant fire or a coal fire in the living room rather than a full space heating system.
- there are many low income owner occupiers who cannot afford the annual cost of servicing
- there are families whose English is poor and who have little or no realisation of the possible dangers of CO [38]
- households on low income are more likely to suffer from pervasive dampness in their home or from long term disabilities or illness which result in some household members sleeping in a downstairs room with a single space heater eg gas radiant fire or coal fire in the living room
- households on low income are more likely to try and heat one room as much as possible thus making them more susceptible to faulty appliances, flues or ventilation
- there is still insufficient general awareness of the dangers of CO (eg only 17% of tenants in the Health and Housing Group survey were aware that CO is odourless [38]))
- faulty appliances are by definition inefficient appliances and thus more expensive

FUTURE DANGERS FROM ENERGY EFFICIENCY MEASURES

During the past 20 years there has been growing awareness of indoor air pollution as a result of reduced ventilation rates, warmer and more humid atmospheres and a greater use of building materials, furnishings and consumer products. As a result recent research has been exploring the effects of such pollutants such as formaldehyde, volatile organic compounds, nitrogen oxides, airborne bacteria, airborne fungi and house dust mites. [41] Whilst the fuel poor are largely excluded from the new generation of more air tight homes, there is evidence that the benefits of additional insulation and control of draughts is bringing with it new problems.

For instance, Jens Korsgaard monitored homes where leaky single glazing had been replaced with well sealed double glazing. Whilst internal temperatures were raised 1.5°C to 2°C and energy consumption decreased, the water vapour increased by 30% and the house dust mite population increased. [42]

As energy efficiency measures are implemented and as there is increased use of mechanical ventilation with heat recovery systems, the problems of radon and higher levels of pollutants can be expected to increase. A detailed analysis of this is beyond the scope of this report but it is

a factor that needs to be taken into account immediately since there are already cases of homes becoming unfit due to energy efficient improvements [43]

COLD, DAMP AND MOULD

Ill-health due to dampness is not always linked to cold buildings. It is important to distinguish between certain types of dampness. Condensation dampness is caused by a lack of balance between heating, ventilation, insulation and moisture production. This type of dampness is usually associated with inadequate heating systems, inadequate insulation and fuel poverty. However, condensation dampness can be caused by building defects and there are documented cases of severe illness relating to water penetration causing moulds on carpets within the dwelling.

The updated version of Building Regulation and Health [20] states that "mould growth is capable of causing Type 1 and Type 3 allergy, infections, toxic reactions, cancer and psychological symptoms." This report states that there is strong evidence that at least 100,000 people in the UK are affected each year with a Class 4 reaction (a Class 4 reaction is classified as a moderate outcome, e.g. similar to occasional severe discomfort, chronic/regular/moderate skin irritation, of benign tumours, occasional viral pneumonia and regular serious coughs and colds).

The humidities quoted here are very misleading. It is true that the optimum conditions relative to house dust mite growth is 75-80%, unlike moulds house dust mite colonies will increase at much lower humidities. The accepted ranges of temperature for their population to survive is 17-32°C and 55-80% Relative humidity. [44]

The WHO suggests a maximum of 7g/kg of moisture in the air which equates to a relative humidity of 50% at 19°C or 60% relative humidity at 16.5°C. [33A]

The levels of bacteria, viruses, fungi, mites, respiratory infections, allergic rhinitis, asthma, chemical reactions and ozone production are all related to relative humidities. A review of the literature [45] recommended an optimum band of 40-60% relative humidity and the key target being 50%. **Aiming for a relative humidity of 50% or thereabouts is critical in its health and expenditure implications for low-income households**. Traditionally, relative humidities have been discussed in relation to condensation moulds with a maximum of 70%, but there now is a growing realisation in the technical literature that relative humidities must be lowered in order to deal with house dust mites. Increasing internal air temperatures is one crucial part of any strategy to lower humidities but other measures are usually necessary at the same time. One study looked at 14 different factors which might affect the growth in house dust mite numbers, relative humidity was found to be the most significant factor. [46]

Very little work has been done on the effect of reducing humidity in the home environment in order to the control house dust mites but the work with mechanical ventilation and heat recovery systems appears promising. [47] House dust mites have been associated with a range of illnesses from asthma to prolonged colds. [48]

Whilst mould growth is certainly less prevalent in better insulated, heated and ventilated homes, the problem is by no means automatically solved in homes built to current Building Regulation standards. In a study of one bedroom and bedsit homes built in the 1980's, nearly two thirds of

the homes had condensation, at least enough to cause pools of water on the window sill, and one in six homes had signs of damage caused by condensation. [37]

Often homes continue to be built, certainly up to the 1994 Building Regulation changes, which fail to incorporate design codes on condensation control, which are satisfactory from a building control point of view and yet suffer from condensation mould and are therefore likely to suffer from proliferation of house dust mites. The 1994 amendments to the ventilation requirement were based partly on private builders' anecdotal accounts of condensation in homes that they had built to Building Regulations standards. [50] This situation points to the future dangers of increased air-tightness and inadequate ventilation.

MOULD AND ILL HEALTH LINK PROVEN

Whilst the exact number and type of spores which lead to a specific level of ill-health is not known, the research to date from various epidemiological studies have led Sonja Hunt to conclude that: "the observed relationships between mould and ill-health meet the criteria for the acceptance of the causal link as laid down by the epidemiologist Bradford Hill." That is:

- "The data indicate a very strong relationship after accounting for other relevant variables, such as income and smoking
- The findings are consistent across studies and, indeed, countries
- The associations are quite specific
- The adverse housing conditions can be observed prior to the developments of the health problem
- Dose response relationships have been observed between dampness/mould and the relevant symptoms, that is the greater the area of visible mould and the higher the air spore count the greater the prevalence of symptoms
- The findings are biologically plausible in that it is well established that mould can be a cause of infection, allergy and toxicosis
- Removal of an individual from a mouldy house has been shown to lead to a decline in symptoms" [51]

There is certainly a complex relationship between housing circumstances and health effects and often it is difficult to determine any link. There is no research known to this author that has investigated on a large scale all the possible health effects from a range of low-income dwellings. Such a study would have to include the possibilities of carbon monoxide poisoning, house dust mites, moulds, nitrogen oxides, volatiles, dampness, temperature, humidity etc. The evidence already presented on carbon monoxide poisoning highlights the prevalence of patients reporting to doctors with illness related to housing problems which is unlikely to go undiagnosed for years.

EMOTIONAL STRESS, HECA, ENVIRONMENTAL HEALTH OFFICERS, BRECSU AND THE GOVERNMENT

Dampness and mould have been associated with emotional distress in women. [52] One study claims strong evidence for escalating distress in both adults and children as adverse conditions (such as dampness, mould, cold, noise, poor repair, overcrowding) multiplied. [53]

Whilst no complete list of HECA, bids and schemes is available at this time, personal contact with two leading authorities who have been successful in obtaining HECA grants show that the overall HECA budget is extremely limited and cannot satisfactorily addresses fuel poverty. At the same time, there are a number of innovative schemes and ideas that are likely to be funded through the scheme. Some local authorities demonstrate an excellent understanding of fuel poverty and energy efficiency. Croydon, for instance, clearly understands the broad relationship between ill-health for fuel poverty and affordable warmth and have already undertaken such schemes as training home-helps to deliver energy audits, thus maximising HEES take up amongst the elderly, education within schools, re-designing council repair systems to maximise energy efficiency opportunities at all stages, training tenant heating advisors, mass distribution of low energy bulbs in schools, training staff and local retailers and additional training to energy installers to improve quality and a whole range of further initiatives. [54]

Whilst many British cities have adopted the aims of UK Health For All and do discuss the objective of health for all, there is a structural weakness in this process in relation to fuel poverty, energy efficiency and health. Environmental Health Officers will often play a major role in any such discussions and they themselves rely on the government's circular already discussed (see paragraph 1.3) which advises that a single power socket outlet offers a satisfactory means of heating in much of the dwelling. I have seen many Environmental Health Officer's reports in the past ten years, and note that in those working for local authorities, there has been only one instance where an officer recommended an affordable heating system. Ironically, this was within weeks of the Local Authority losing an important court case in relation to cold and mould. Some of the Professional Practice Notes for the Institute of Environmental Health Officers are currently being revised and it is hoped that when these are published there will be a stronger emphasis on affordable heating.

Brenda Boardman's figures are understood to be drawn from an unpublished report by the Government.[55] Little work has been carried out into this area.

A third area could also be argued, namely the work of BRESCU. Their work, in more recent years, has consistently discussed targets for affordable warmth whilst politicians have not used the term.

Tessa Jowell recently announced the Government's intention to produce a coherent public health strategy guide for action at the local level, embracing health and local authorities, the voluntary and the private sectors. The Green Paper has been promised for the autumn of 1997. She announced that there is to be "a million pound research programme into the effects of air pollutants in the home. We want to look at issues like damp and its effects on asthma and the effects of environmental tobacco smoke." [56]

THE PURPOSE OF RESEARCH

Before establishing any research agenda, it is important to define what the aim of that research might be. For instance:

- Is it to gather data on particular problems?
- Is it to draw together and evaluate past research which is generally inaccessible?
- Is it to undertake original research programmes and test hypotheses or fill gaps in the knowledge?
- Is it to form policies or to devise practical solutions?

The preferences for any research agenda often implicitly reflect the author's concerns or interests. The interest of this author includes disseminating existing academic and research information to a wider audience, changing policies of institutions and governments in relation to healthy housing targets, providing practical research data which informs any decision makers in relation to the provision of improved housing which prevents ill-health.

In the light of the above, the following comments are offered on the suggested research agenda:

- The EHCS 1991 Energy Report does contain a vast amount of information and presents some of the key findings in a more accessible form is considered to be useful but the limitations of the EHCS survey raises question marks as to the usefulness of some of the data
- The usefulness of European fuel poverty data is questionable in terms of what positive effect, if any, such research would have for the fuel poor and/or those suffering ill-health in the UK
- The conclusion that the research into the effects of damp and house dust mites is perhaps less well developed and more speculative, is not agreed. There is a wealth of research but much of it has not been reported in this research. Sonja Hunt's conclusions quoted in paragraph 2.34 summarise the current position. Strachan tends to be more cautious in drawing conclusions in relation to dampness in mould growth [(57)] Sonja Hunt regards the causal link now well proven. There continues to be large scale epidemiological research which find strong relationships between damp, mould and respiratory disease and also detects nonspecific symptoms such as fever, chills, headaches, myalgias, nausea, vomiting and diarrhoea [(58)]
- The Institute of Environmental Health Officer's Practice Notes state that moulds are a clear cause of ill-health in housing [(47)]
- A Canadian working party summed up the effects of inhaling mould spores as follows: "responses to inhalation of fungi may be mild and unobservable, may be acute and severe with flu-like symptoms, may cause irreversible change in lung function after continuous chronic exposure or may cause death." [(60)]

- It is important to disseminate research information. A well researched publication should be accessible listing the presently known health effects of a cold environment. Such a document would certainly be useful. A system of evaluating and disseminating good practice from the many initiatives that are currently underway, (which directly or indirectly may impinge upon fuel poverty and ill-health) is needed. BRESCU publications are a good example of how good practice in relation to energy efficiency is disseminated within the building industry and housing authorities. An equivalent mechanism for taking in a wider medical, social, environmental health research field is worth considering.

SUGGESTED RESEARCH PROJECTS

Taking into account the issues raised in this paper, an alternative research agenda is proposed:

1) A detailed literature review encompassing building, medical, environmental health and social science material of the possible health effects of temperatures in the 16-21 degree range in terms of discomfort, stress, anxiety, limited use of the home, mould and mite proliferation and other relevant factors. This research would include a review of the present problems of defining comfort. The aim would be to review and clarify existing knowledge in relation to higher temperatures and possible effects mainly on mental health.

2) An original research project to determine the effect on mental health of cold homes. The aim would be to explore the nature and scale of the effect of cold on mental health in order to determine whether the present government recommended temperatures should be reviewed

3) A numerical analysis of the size of the different population groups amongst those subject to fuel poverty who also are likely to be particularly susceptible to physiological effects e.g. elderly, asthmatics, those with heart conditions, rheumatoid arthritis sufferers etc. The aim would be to raise general awareness and awareness amongst policy makers of the size of sub-groups within the fuel poor who are particularly susceptible to ill health due to low internal temperatures.

4) A longitudinal research study focusing on a block of flats or other similar cold environment but where mould growth is generally not a problem. Such a study would look at the health and well being of occupants before and after rehousing or a major refurbishment. The aim would be to try and remove dampness and mould from a before and after study and examine the effects of an improved thermal environment on the fuel poor.

5) A large scale study to determine the exact extent of CO poisoning within fuel poor households, its causes and possible cures. The aim would be to provide national data on the frequency of CO poisoning and to recommend appropriate

legal, enforcement and administrative measures which would radically reduce its incidence.

6) A small research project limited to a few houses and/or flats together with a control group of identical dwellings where the occupants suffer from asthma and are allergic to house dust mites. A range of dwelling types would be chosen and practical measures applied in order to reduce the relative humidity and house dust mite population. The aim would be to set up a demonstration project that would be designed to show appropriate strategies to landlords and building professionals as how a healthier environment in low income households could be achieved whilst being mindful of capital costs.

7) A feasibility study into the most effective methods of disseminating the lessons of an ever increasing range of innovative measures which would assist the fuel poor and improve their health. Such measures range from appliance replacement and advice on controls, through training of community health staff in energy audits, through legal action. This study would examine how the lessons can be passed on to the most relevant policy makers, to environmental health, community health and building professionals, the voluntary sector and other agencies. Costings and possible sources of funding for different approaches would be provided. The aim would be to publicise the many initiatives from local authorities and the voluntary sector which are extremely innovative and yet rarely heard of. The study would devise the most effective model for disseminating the lessons from local initiatives on a national scale.

8) A research study investigating the possible health effects of energy efficiency measures carried out in the households subject to fuel poverty. The aim would be to identify potentially hazardous practices and environments and to provide warnings to all those executing or planning such work.

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