Housing Improvements and Health: The results of a randomised trial – the Watcombe Housing Study

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Background.

Following concerns of a local GP, at the high use of services and prescription costs in one area of Torquay, the (then) South and West Devon Health Authority funded a community health development project in three adjoining areas, which at that time had a Jarman Index for the area of 22.7 compared with the Devon average of 12.75 and the out of hours visiting rate was the highest in Torquay, 15% above the average for the town [1]. The community development worker funded by the project became aware of residents' concerns, in social housing in one of the areas, Watcombe, about their damp housing and reported incidence of respiratory illness in children. Supported by the worker, local people used a questionnaire survey to interview 96 household's residents, using a pictorial guide of damp/condensation and mould drawn by one of the tenants. Of the households who reported dampness and/or condensation 60% also reported asthma or respiratory problems. [2]

An interagency partnership steering group was formed (Torbay Healthy Housing Group) to put forward a research proposal to address the above problems. The Council agreed to use £600.000 of their maintenance budget to improve the houses in Watcombe and the expanded group was eventually successful in obtaining funding from the regional NHS R & D Committee to evaluate the improvement. The projects early stages are reported in more detail elsewhere [3,4] but this paper briefly reports on the design of the evaluation, the outcome measures for the environment and health of occupants, the economic costs and selected final results.

Introduction.

The association between poor health, particularly respiratory health and adverse housing conditions has been recognised for many years, but a causal relationship is difficult to establish due to the many confounders e.g. poor diet and/or smoking. To our knowledge

only one study to date has randomly allocated housing [5] and this is the first study to upgrade current accommodation at random. Poor housing conditions have been linked to various aspects of poor health [6,7]. Cold houses, expensive to heat, have been blamed for contributing to the excess winter deaths in the elderly, largely from cardiovascular and respiratory illness, seen more markedly in this country than elsewhere in Europe [8]. The association between housing conditions and asthma has been reported in several studies, particularly between damp, mouldy housing and respiratory symptoms in adults [6] and children.[9, 10,11]

Despite the latter few intervention studies have been undertaken. A recent systematic review [12] reported that although several studies demonstrated health gain from housing improvements, methodological problems, such as small study size and lack of control groups, meant that the results were not generalizable.

Participants and Methods

All occupants of houses (c580) eligible for improvements were asked to take part in the evaluation study. Following consultation with the local residents and the housing department, houses were randomised to receive their improvements either in the first or second year of the project. The randomisation was unusual in that it took place at a public meeting with the local councillor pulling house numbers from a bucket. The study design is thus one of randomisation to waiting list. Of 119 houses eligible for the study, fifty were chosen at random and improved in year 1, the remainder being improved the following year.

The following is a summary of the data collected annually, for three years beginning 1999:

- Jan/Feb. Postal questionnaires including health of the occupants, number of people in the house, smokers and pets.
- Jan/Feb. Baseline surveys of the indoor environment using 30 parameters were carried out.
- May/June. Health surveys by community nurses visiting residents in their homes.
- The first phase of housing improvements began in autumn 1999 and were completed by the following January. The second phase began in Autumn 2000, and completed by January 2001
- The final surveys were conducted after all the improvements had been completed in autumn/winter 2001.

Outcome measures

(a) Health

Chosen to reflect the commonest disease complaints identified in the residents' original survey. Change in general health was measured using the SF36 [13] and GHQ [14] questionnaires and respiratory health was measured using a symptom-based outcome measure, [15] lung function tests and symptom diaries for children. The presence of ischaemic heart disease was assessed using the Rose Angina Questionnaire[16] and change in morbidity from arthritis/rheumatism assessed using the AIMS/Rand questionnaire [17]. Use of prescribed and over the counter medication for the three specific disease categories was collected and used to estimate severity of disease.

(b) Environmental

The environmental parameters were chosen both to give an overall picture of the indoor environment of each house and to assess the levels of specific parameters known to affect the chosen diseases. Changes to the following parameters were assessed: temperature, humidity, damp, course (3-7 mcm) and fine (0.3-3 mcm) particles, house dust mite in mattresses, moulds and $CO^{2.}$

(c) Economic

The effect of the housing improvements were summarised by measuring the change in energy efficiency of the houses, using the SAP[18], a widely used energy rating. The change in heating costs for occupants, and the change in costs for the NHS were assessed through change in use of prescribed drugs and primary and secondary care contacts.

Organisation and process

The Torbay Healthy Housing Group, had representation from the Health Authority, Torbay Primary Care Group, the Research and Development Support Unit for South and West Devon, Torbay Voluntary Council, local general practices, South Devon Healthcare Trust, Watcombe residents and Torbay Council and was chaired by the Head of Housing for Torbay Council. The community development worker from the Barton, Watcombe and Hele Health Gain Initiative was appointed as the researcher for the evaluation study. The steering group met regularly and established a sub-group structure to oversee the various aspects of the project.

The researcher produced regular newsletters for the local residents to keep them up-to-date and was available to discuss progress with all those involved in the study at regular times in the local housing office. The latter being part of a group of shops on the edge of the estate. Exhibitions, frequent public meetings and Christmas parties, organised with residents were held, and helped to maintain the good response rate throughout the project.

Intervention

All properties lacked cavity wall insulation and the roof space insulation varied, leading to cold bridging at the first floor ceiling level, promoting the formation of condensation mould growth. Some of the properties had partial central heating some had none. Bathrooms and kitchens had virtually no ventilation, making it difficult to remove excessive moist air. Electrical upgrading was also required, although it was recognised that this work did not affect the energy efficiency of the house. All households were brought to a similar standard of improvement in insulation, full central heating, double glazed doors, re roofing and electrical upgrade.

All occupants of improved houses received a leaflet, from Torbay council, explaining the correct use of the new heating and ventilation systems installed in their home, in order to help them make the most efficient use of the equipment.

At the end of the project an open afternoon was held at the local school and included, health displays of healthy eating, smoking cessation, asthma management, local conservation trust, information and advice on energy efficiency and local housing services. Demonstrations of safety in the home, on the beach, and in the environment were given to pupils and to the general public. Participants in the study were given individual assessments of the environment of their homes including the known contributing factors to particulate and humidity levels. The results of the project were given in a continuous visual projection.

Results

Randomisation has produced a reasonably balanced distribution of relevant characteristics between the two phases of the study, which the graphs below highlight.
Other variables such as type of house and heating and SAP ratings (Standard Assessment Procedure) the Government's standard method for home energy efficiency rating were very similar.

Fig 1: Comparison between Phase 1 and Phase II households (119 houses randomised) by age group and gender.

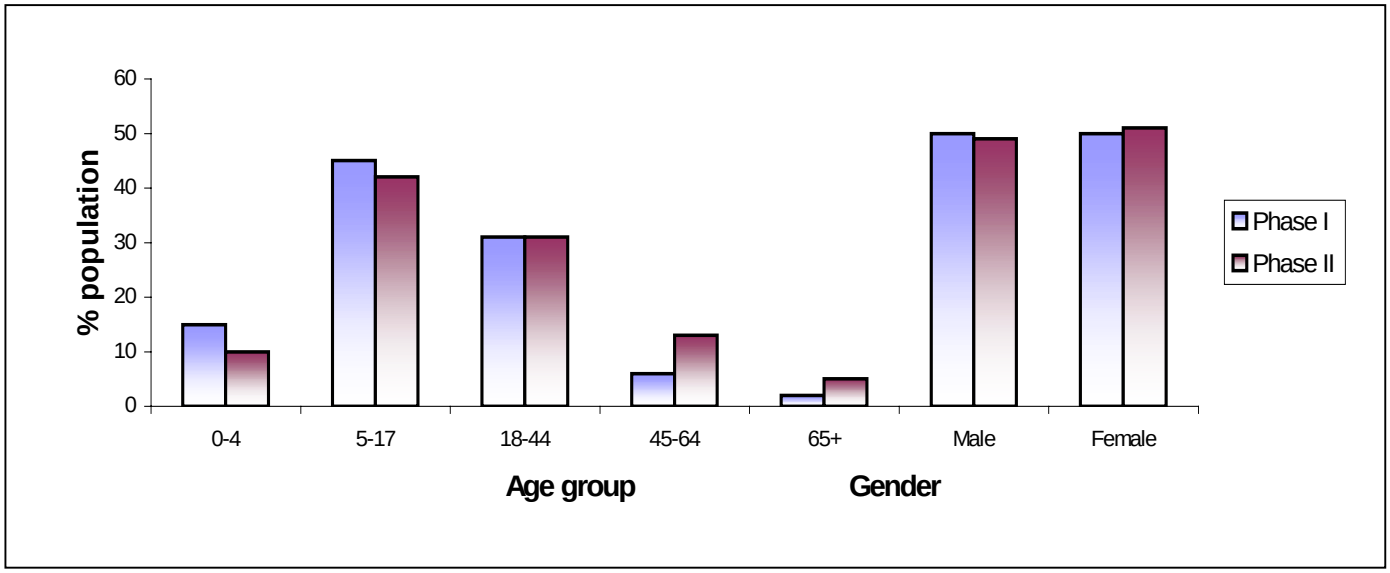
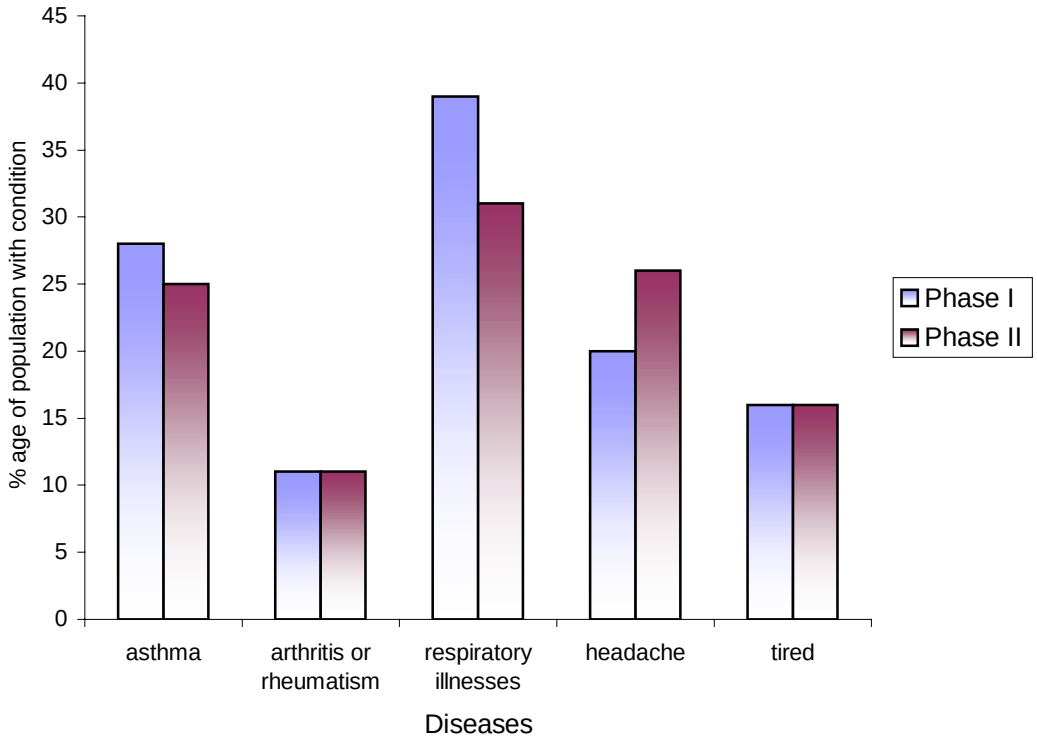


Figure 2: The table below gives a comparison between the two phases of the self-reported incidence of asthma, arthritis or rheumatism, respiratory illness, headache and tiredness, showing similarities.



The percentage of children exposed to animals and Environmental Tobacco Smoke at the start of the study is shown in Fig. 3. (NI=124, NII=141)

Fig.3. Percent of children exposed to animals and ETS by phase at the start of the study

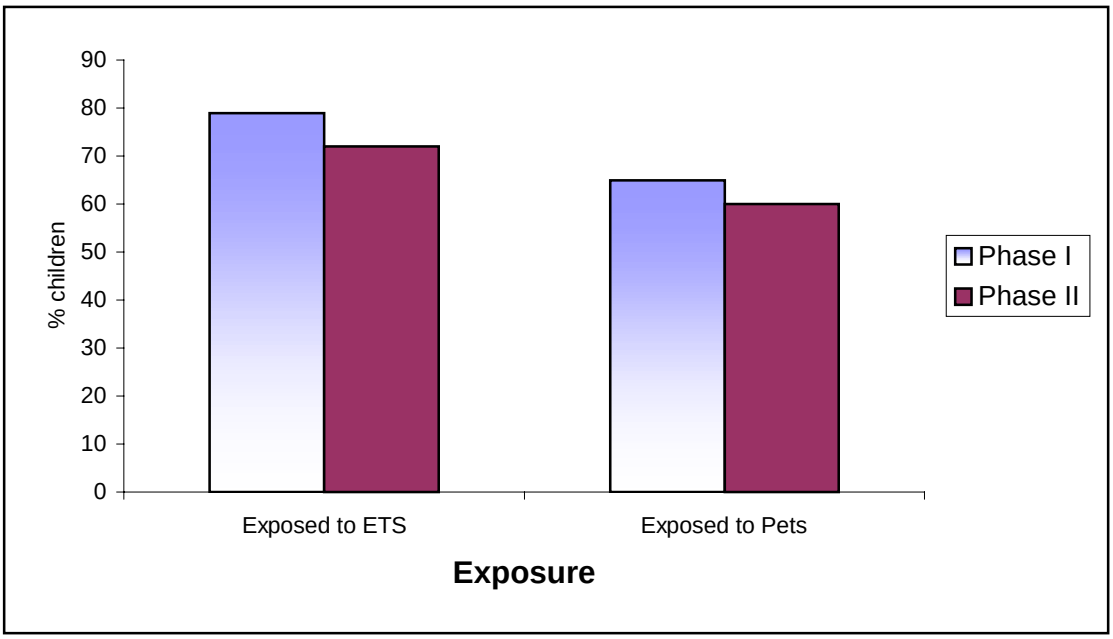


Table 1: Comparison between Phase I and Phase II households (119 houses were randomised)

Houses	Phase I (N=49) **%**	Phase II (N=63) **%**
Number of bedrooms		
2	2	1.6
3	81	73
More	16	25
Gas cooker	69	64
No pets	31	32
Number of smokers in house	22	33
Residents Unemployed	22 (N = 20)	21(N = 237)
In “good health”	47 (N = 206)	52 (N = 246)
Have asthma	27 (N =214)	25 (N = 247)

In conclusion the balance between the two phases is good on key prognostic variables.

Table 2. Response rates over the three years of the project

	Year 1	Year 2	Year 3
Postal Questionnaire	N=119	N=116	N=111
	RR=93%	RR=94%	RR=93%
Environment tests	N=116	N=116	NN=108
	RR=91%	RR=93%	RR=90%
Health Interviews	N=102	N=103	N=82
	RR=80%	RR=85%	RR=73%

Cost of the intervention

49 houses were upgraded in 1999 and 63 houses in 2000. The cost per house in Phase I was £7760 and £4819 in Phase II based on the figures given by Torbay Council.

SAP rating results shown in Table 3 below

Table 3. Figures taken from commissioned report by Alba Energy Services showing the level of improvement in rating for each house type.

House Type	Heating Type	No. of houses in cat.	Original SAP	Revised SAP	Change in SAP
A	GW50FF	14	28	80	52
A	GW50FF	1	No central heating installed		
A(n)	PHS1	4	51	74	23
A(s)	PHS1	2	51	74	23
B	Gw50ff	2	32	80	49
B	PHS1	6	51	71	20
C	GW50FF	9	34	80	46
C	PHS1	3	42	70	28
C	Not imp.				
D	GW50FF	4	36	80	45
D	PHS1	9	44	69	25
D	Not imp.	2			
E	GW50FF	12	36	81	45
E	PHS1	14	41	64	23
F	GW50FF	1	28	80	52
F	PHS1	10	44	70	26
G	PHS1	9	49	69	29
H	PHS1	2	51	71	20
J(s)	PHS1	1	44	72	28
K(n)	PHS1	3	47	71	24
L	PHS1	8	41	71	30
L	PHS1	1	No heating installed upstairs		

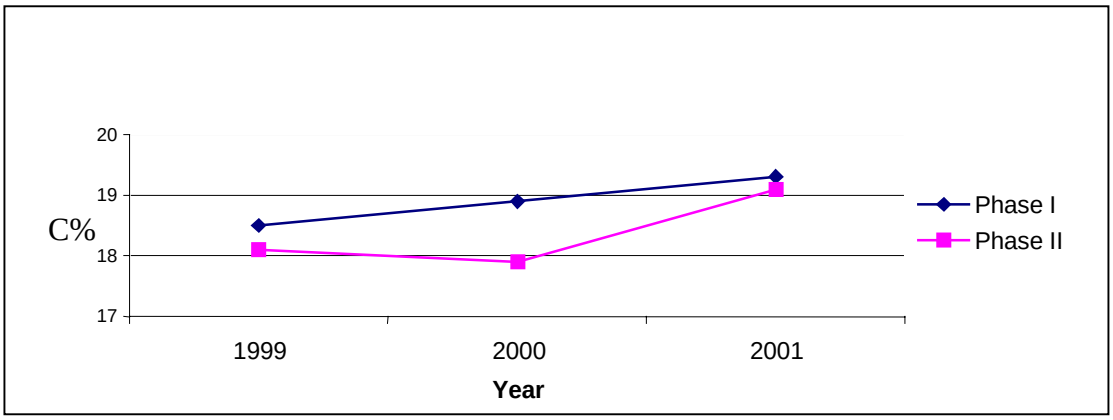
It can be seen that houses with minimal heating of a coal or gas fire at the start of the project showed the most improvement by 52 points. The average SAP increased by 33 points with a resulting average annual saving of £250 per property and a reduction of CO^2 of over 2 tonnes per property.

Environmental outcomes

The one hour tests in each house took place in the main living room and a selected bedroom. The latter was the bedroom in which any resident with a respiratory problem slept or, failing that, the main bedroom of adult residents. The analysis is restricted to houses where we have three complete years of environmental data.

Temperature, living room. Government recommendations 'standard' temperatures are 21 °C in the living room and 18°in the bedroom. Fig. 4 shows the changes in living room temperatures for the two phases, which is not statistically different but shows an improvement in both phases overall.

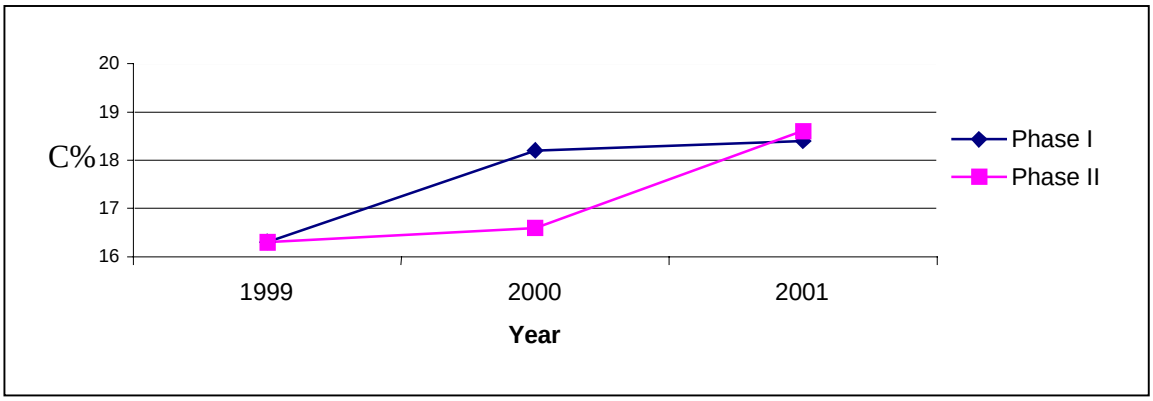
Fig. 4 Temperature, Living room (°C)



Between phase difference 1999 – 2000: p=0.14
Between phase difference 1999 – 2001: p=0.67

Temperature, bedroom. Temperature in the selected bedroom shows a differential and highly statistically significant difference between the two phases at the end of the first year. Temperatures increased in upgraded houses and Phase II 'catch up' at the end of the third year.

Fig. 5 Bedroom temperature (°C)



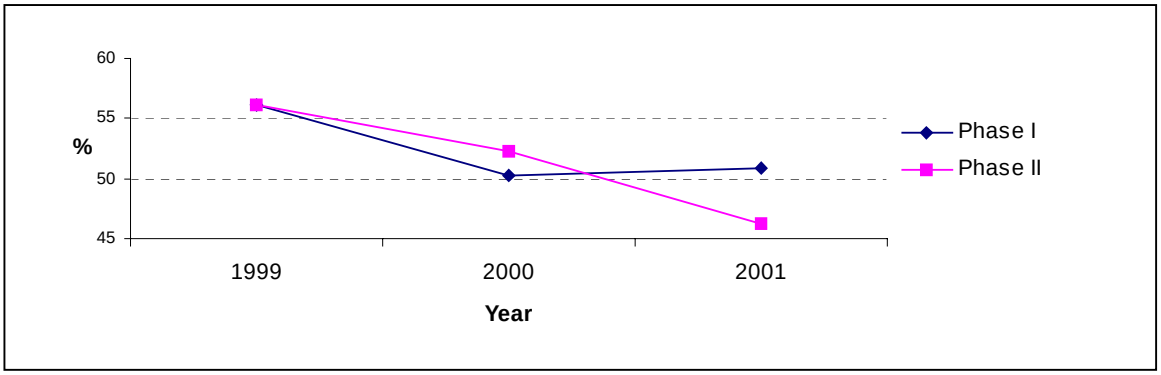
Between phase difference 1999 – 2000: p=0.002
Between phase difference 1999 – 2001: p=0.89

Humidity. Relative humidity in the living room shows a decrease coincidental with housing upgrades. Neither comparison achieves statistical significance

Between phase difference 1999 – 2000: p=0.22
Between phase difference 1999 – 2001: p=0.13

However, in the selected bedroom humidity reduces significantly in the final year in Phase II houses shown in the figure below.

Fig. 6 Bedroom relative humidity (%)



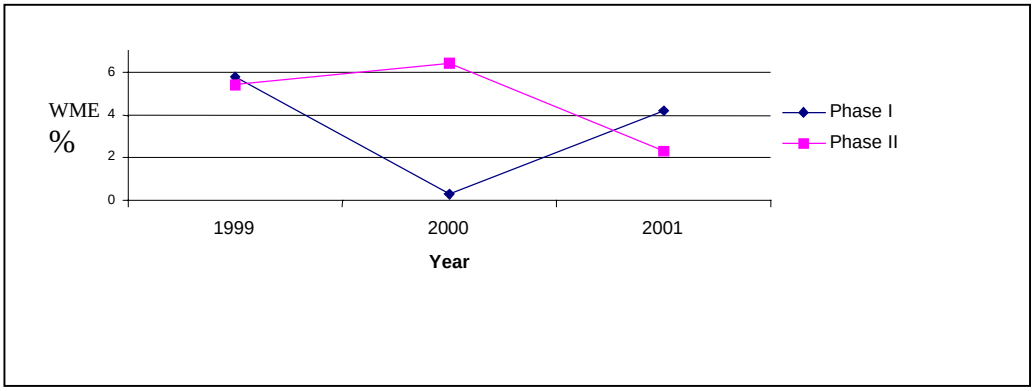
Between phase difference 1999 – 2000: p=0.28
Between phase difference 1999 – 2001: p=0.03

Wall surface dampness in the selected bedroom

There is a distinct reduction in wall surface dampness following improvements although the graph below shows there is an increase between year 2000 and 2001, the difference between ~6% and ~2% is negligible. An improvement in the wall surface dampness is a reduction in the % recorded.

There is an improvement in wall dampness following upgrading, which is statistically, significant at the end of the first year but surprisingly, the wall dampness percentage increases in Phase 1 houses during the second year. However, the wall surface and wall dampness data are highly variable with many zeros.

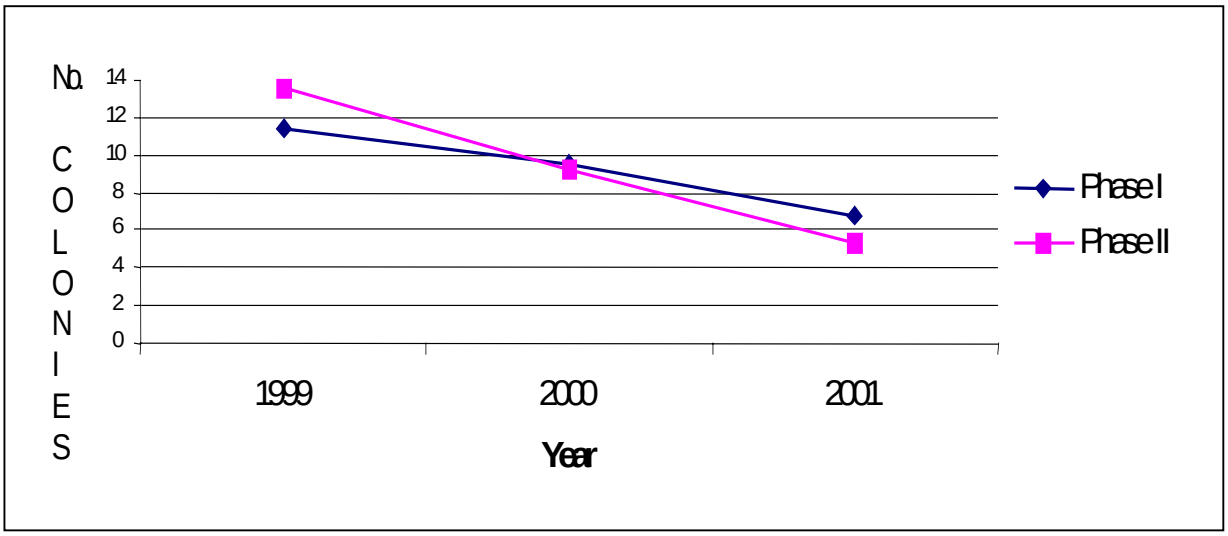
Fig. 7 Wall surface dampness (WME%)



Between phase difference 1999 – 2000: p=0.001
Between phase difference 1999 – 2001: p=0.51

Mould There is a reduction in mould in both study phases, across all years. Phase 1 houses show a faster decline in the first year but also during the second. These improvements do not appear to be related to upgrading

Fig. 8 Mould Count (Number of colonies)



Between phase difference 1999 – 2000: p=0.60
Between phase difference 1999 – 2001: p=0.35

***Coarse particles*.** These are due to human or animal activities causing the shedding of dander, kicking up of dirt etc. There is no discernable pattern commensurate with house improvements in the coarse particles in the living room or bedroom.

Between phase difference 1999 – 2000: p=0.19
Between phase difference 1999 – 2001: p=0.11

***Fine particles*.** These are caused by such things as smoking and discharge from cooking. There is no detectable difference in the number of fine particles in the living room or bedroom following house improvements.

Between phase difference 1999 – 2000: p=0.43
Between phase difference 1999 – 2001: p=0.40

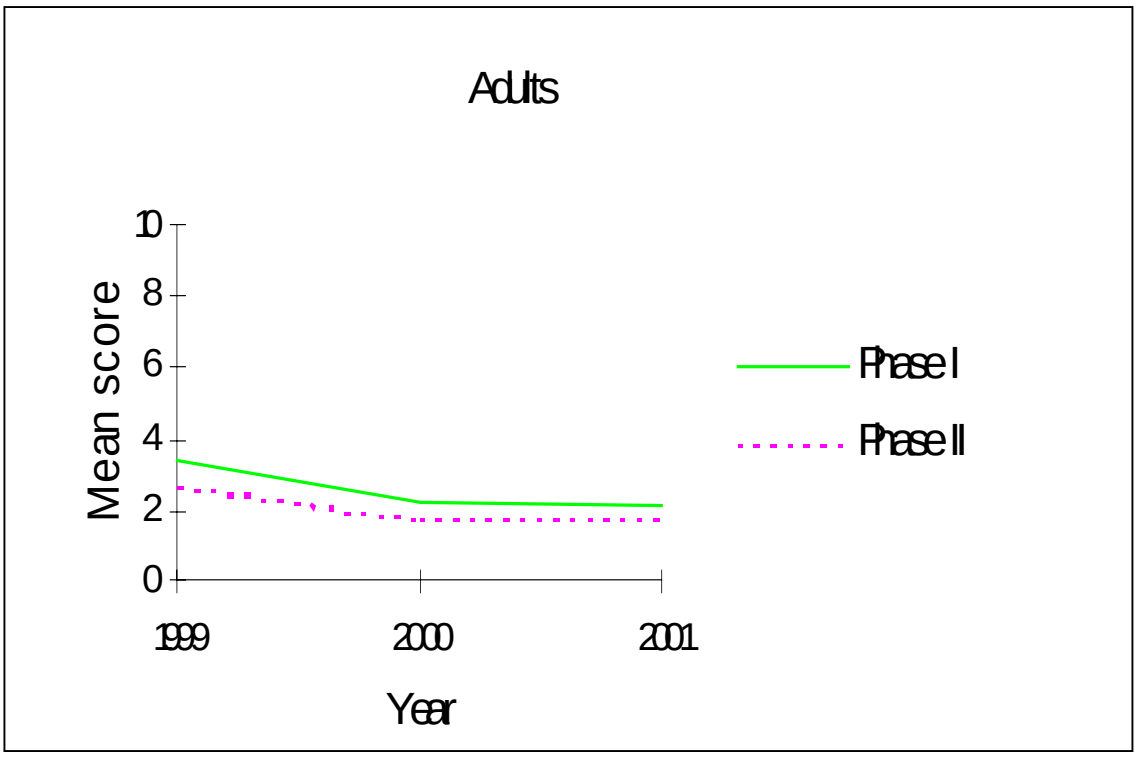
House Dust Mites (HDM). The number of HDM was collected at each environmental survey by filtered vacuuming $1m^2$ of the mattress in the main bedroom. Because of technical problems with the storage of samples at the analysis site in Cardiff there are substantial omissions from the data set and we are therefore unable to report with confidence.

Health Outcomes

The SF36 There is no difference in any of the SF36 dimension scores between phases over the course of the study. Physical functioning, physical role, bodily pain, general health, vitality, social functioning, emotional role and mental health.

GHQ12 is a 12-item tool commonly used to detect short-term psychiatric disturbance. A score of 4 is commonly regarded as needing review whereas a score of 10 calls for active surveillance. The mean scores for the two phases are displayed in Fig. 9 and as can be seen show no difference between phases but a general improvement at the end of year three in both phases.

Fig. 9 Mean GHQ -12 scores by year and phase



Respiratory Health Respondents who had reported chest trouble in the self-completed questionnaire were asked a series of six questions about their respiratory health over the

preceding month: breathlessness on exercise, breathlessness not on exercise, wheeziness during the day, wheeziness during the night, cough during the day and cough during the night. These symptoms were each rated on a five point scale: never, on one or a few days, several days, most days, every day These have been analysed for both children and adults, as individual items and as a summed score. For none of these comparisons is there a statistically significant difference between the phases.

Through the self reported symptoms we had noticed a secular downward trend in reported asthma on the estate during the course of the study. The first year this was expected as the question asked for previous respiratory illness, and may have been influence by people's desire to have their houses improved first. Further investigation was required. Two possible explanations were plausible: that respondents simply reported less asthma to avoid being asked more questions during the interviews, particularly following the first year, (although these were not many in terms of the whole questionnaire) or, alternatively, a greater awareness of asthma and its management as a result of the Study. These possible explanations were testable by reference to the symptoms reported at interview and the BTS asthma step derived from the prescribed medications. If there were no reduction in symptoms of respondents who were interviewed or, if the reduction was a result of increased awareness brought about by the Study and increased medication, there should be an increase in the BTS asthma step.

Table 4 All respondents: Symptom score 6+ (with or without BTS)

	Total (%)	Phase I (%)	Phase II (%)
1999	125/479 (26.1%)	26.3%	25.9%
2000	92/453 (20.8%)	23.1%	19.0%
2001	84/430 (19.6%)	16.6%	21.8%

X^2 for trend = 5.82, df=1, p=0.016

Table 5 All respondents: BTS 1+ (with or without symptoms)

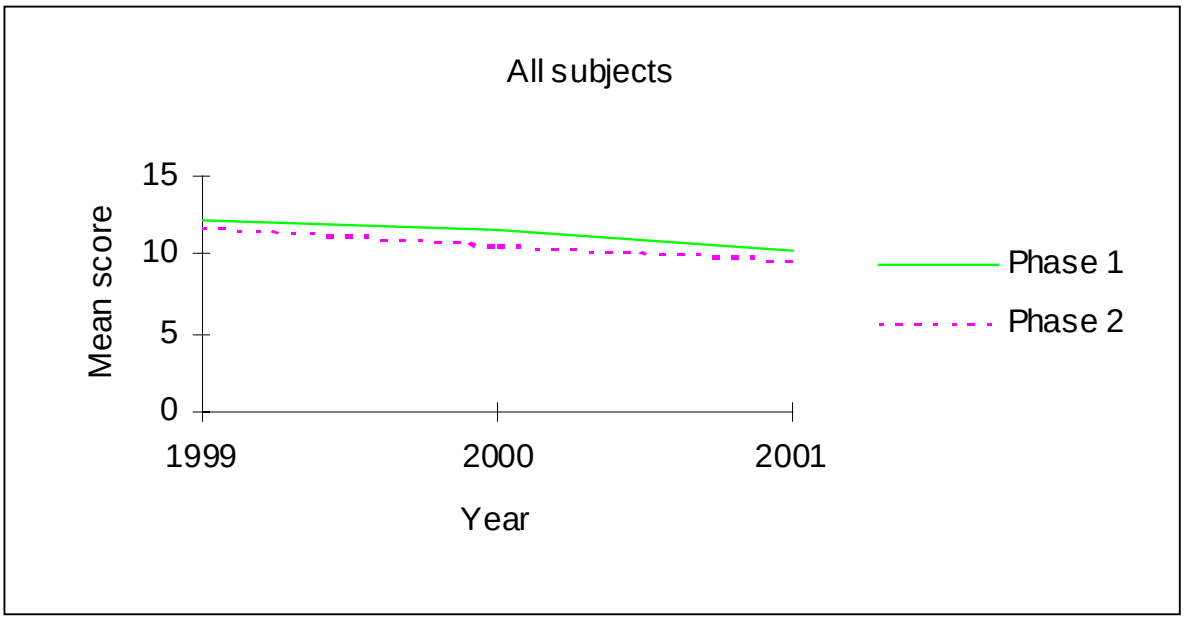
	Total (%)	Phase I (%)	Phase II (%)
1999	83/479 (26.1%)	16.7%	17.8%
2000	53/453 (20.8%)	11.3%	12.0%
2001	39/430 (19.6%)	7.0%	9.1%

χ^2 for trend = 14, df = 1, p = <0.001

Taking the adults and children together we see a significant downward trend in the symptoms of those interviewed. We therefore infer a true reduction in symptoms. The second half of Table 5 demonstrates that the BTS step also reduces showing that this reduction in symptom reporting is not a result of better management and increased medication: it is a result of less need for medication. We have repeated the analysis (not reported here) for adults and children separately in case one group was responsible for this finding. The trend remains the same, is statistically significant in each group separately, but is stronger in children. This finding therefore seems robust although the reason for it at present is unclear.

Arthritis and Rheumatism. Respondents who indicated that they suffered from arthritis or rheumatism in the self-completed survey were given an arthritis impact schedule on interview. The severity of arthritis with this scale is divined by a combination of symptoms: severity of arthritic pain, frequency of arthritic pain, multiple joint arthritic pain, morning stiffness from arthritis, and sleep disturbance from arthritis. These may be summed to provide an overall severity score for the disease. There are no significant differences at any time between phases although there is a downward trend in total symptom score as shown overall in Fig. 10

Fig. 10 Arthritis total symptom score



Economic data

Analysis of the data is incomplete at this stage but indicate that overall there is a reduction in some health service costs but not in association with either study phase in particular. The theoretical reduction in costs of energy use of householders has already been reported under SAP results

Discussion

Because of the community survey background, the project has met with excellent co-operation from local people. We are aware that even though collection of data was extensive we have still not captured some aspects of health gain or other benefit (or harm) of the housing improvements. However a qualitative study undertaken by the researcher using taped in depth interviews has provided data, which indicates that following installation of central heating and the increased warmth the entire house is now being utilised. Because of the additional usable space in the house, reported changes are improved relationships between members of the household, less stress, indications of better health and opportunities to study.

Thomson et al [12] in a systematic review of housing interventions found a lack of robust research and recommended use of qualitative and quantitative measures to capture all dimensions. Data from the former can be used to identify other methods of positive or negative impact on health and inform future research. A subsequent paper [19] looking at the health impact assessment of housing improvements found that some studies indicated improvement, whilst others found no difference in some measures and some found mixed effects. The latter paper concludes that further research is needed to improve the predictive value of health impact, as there is little evidence of the health effects of improved

housing. it does however go on to state that although there is a lack of evidence at the present time that it does not mean that there will be no evidence found in the future. Continued research therefore is important to identify those most vulnerable to poor housing and the type of house improvements needed to have a positive benefit on health in order to prioritise resources.

Key points from the project.

This study has provided evidence from a randomised controlled trial, which achieved a high response rate and was completed to schedule except for delays in the schedule of some house improvements

Although results from the analysis have not shown any statistically relevant improvements between phases from the health data, overall there has been an improvement in costs to the NHS and a reduction in the prevalence of asthma. The qualitative study indicated that wider benefits have been achieved in the quality of life of residents, in self-esteem, stress levels, improved relationships and increased leisure and study opportunities. The indoor environment has improved with the results that the entire house is now warmer and being utilised. The increased energy efficiency measures introduced should theoretically result in less costs for households but the knowledge of how to use the new equipment, the individual comfort levels and household income could all have an impact on whether this outcome is achieved.

As a result of lessons learned the Housing Stock Managers have introduced a more consultative approach to tenants, and have surveyed, by street area, the type of house improvements tenants think are a priority and the type of improvements installed.

The study has also gained national recognition for its involvement of the community in the research design and process.

Both qualitative and quantitative research is continuing to develop tools, which could be used to facilitate the process of prioritisation and use of resources.

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