



Is housing improvement a potential health improvement strategy?

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ABSTRACT

This is a Health Evidence Network (HEN) synthesis report on housing improvements and health. The reduction of exposure to specific hazards may lead to health improvements for current residents and prevent harmful exposure by future generations.

Improvements in mental health are reported consistently following housing improvements, and the degree of mental health improvement may be linked to the extent of the housing improvements. General housing improvements may also result in improvements in physical health and general well-being.

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Summary

The issue

The well-established links between poor health, poor housing and poverty suggest that housing improvements in disadvantaged areas or social housing may provide a population-based strategy to improve health and reduce health inequalities. Housing improvements that reduce exposure to specific hazards may lead to health improvements for current residents and prevent harmful exposure by future generations.

Findings

In countries where the hazards of carbon monoxide, lead, poor sanitation and unsafe access have been minimized through the enforcement of strict building regulations, the most serious hazards linked to adverse health are poor air quality, inadequate heat, dampness, radon, trips and falls, noise, house dust mites, tobacco smoke and fires. Few studies have actually evaluated the health impact of interventions to reduce exposure to these hazards, or the health impact of general housing improvement. However, available research suggests that general housing improvement appears to have the potential to improve health, especially mental health.

Housing improvements that ensure the provision of affordable warmth may have the greatest potential to reduce the adverse effects of poor housing. Optimal temperature is an essential component of domestic heating provision and may also affect levels of dampness and allergen growth. Energy efficiency improvements have led to improvements in general health and respiratory health among asthmatic children. The elderly and very young are particularly at risk from both low and high indoor temperatures. Sudden increases in air pollutants are also most detrimental to the health of the elderly and asthmatics.

The most common sources of domestic infestation that pose potential health hazards are lice, bedbugs, fleas, cockroaches, mites, rats and mice. Such infestations can be prevented through careful food and waste storage and good hygiene. Faecal pellets from house dust mites and mould spores are the most common domestic allergens. Well-ventilated, damp-free housing and household dust control are recommended to minimize growth of domestic allergens.

Poisoning, falls and fires in the home are preventable causes of death and injury, particularly among children and the elderly. Effective prevention measures for elderly people at risk include customized safety devices, exercise, balance training and hazard removal. Educational outreach and home visits are also essential if the potential for injury reduction is to be fully realized.

Policy considerations

Improvements in mental health are reported consistently following housing improvements, and the degree of mental health improvement may be linked to the extent of the housing improvements. Increased housing satisfaction following housing improvements has been strongly linked to improvements in mental health. General housing improvements may also result in improvements in physical health and general well-being.

However, the potential that housing improvement has to generate health improvement cannot be considered separately from other changes that residents may experience as part of housing improvement, such as increased housing costs, relocation and more general neighbourhood changes. Some of these may have additional health impacts, either negative or positive.

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Introduction

This comprehensive review aims to answer the question *Is housing improvement a potentially effective health improvement strategy?* From this question there follow a number of other questions that this review also tries to shed light on.

- Which housing characteristics pose the greatest health risks?
- Which available interventions are effective in minimizing the adverse health effects of housing hazards?
- Can better housing improve health?
- What sorts of housing improvements are most likely to improve health?
- What kind of health effects have been reported following housing improvements?
- Are there other factors associated with housing improvement programmes that might also affect the health of those who receive new or improved housing?

The link between poor housing and poor health is well established. Many, possibly hundreds, of cross-sectional studies have reported consistent and statistically significant associations between poor housing conditions and poor health. Many countries utilize strict building regulations to control exposure to identified housing hazards, particularly carbon monoxide, lead, poor construction and poor sanitation. In countries that enforce such regulations, the hazards believed to have the most significant adverse health effects have been ranked, with the most important being poor air quality; inadequate warmth or excessive humidity (poor hygrothermal conditions); radon; slips, trips and falls; noise; house dust mites; tobacco smoke; and fires (1). Many less wealthy countries do not have or do not enforce strict building regulations; as a result, the adverse effects of specific housing hazards may be more pronounced in these countries, especially among vulnerable groups.

The identification of individual housing hazards and efforts to limit exposure to them has led to some reductions in the mortality and morbidity associated with housing hazards. Nevertheless, the relationship between poor housing and poor health persists, and the independent effect of poor housing on health remains unknown due to the many confounding factors that are inextricably linked to poor housing. Major confounding factors include the degree of individual and neighbourhood deprivation, the presence of multiple domestic hazards and the amount of time spent in the home. More general

factors in the local social context and the national political and cultural context may also influence housing conditions and housing-related factors. An ecological approach to housing and health research – one that acknowledges the many factors that affect health in addition to concrete physical housing conditions – has been recommended (2,3). Such an approach is also essential for those attempting to describe and predict the potential health effects, whether mental or physical, positive or negative, of housing improvement. (See Annex 1 for more information on and examples of social, economic and cultural factors that increase the complexity of the relationship between housing and health.)

Sources for this review

This review has drawn on a range of research sources, including both cross-sectional studies and, where available, evaluative studies of housing improvement. Systematic or comprehensive expert reviews of the research have also been identified and included at appropriate points. A description of the sources of evidence and their role in this synthesis is provided in Annex 2. All of the work used for this review comes from countries in the developed world; housing conditions peculiar to the developing world are beyond its scope. The literature on the health effects of radon and carbon monoxide in the home was not included in this synthesis.

Findings

Housing-related health determinants and available interventions for limiting exposure

This section reviews specific housing characteristics that have been linked to poor health and includes a review of health links to housing tenure, housing design and housing satisfaction, in addition to identified physical biohazards. In many instances, there exist housing improvements that target the specific hazards, such as house dust mites; these are identified, and any research on the health effects of such improvements is, when available, reviewed. It should be noted, however, that these studies generally do not detail how much an individual intervention reduces exposure to the relevant hazard.

Indoor air quality

Over half of the airborne particles indoors arise from outdoor sources, while their most common indoor sources are ambient tobacco smoke, house dust mites, cooking, certain heating appliances and other human activity (4,5). Allergenic biological indoor air pollutants arise most commonly from house dust mites, cockroaches and pets such as cats and dogs (4). (See below for more information on house dust mite allergens.)

Short-term elevations in ambient particle levels are strongly associated with increased mortality and morbidity, with acute cardiopulmonary impairment being the predominant health impact, and vulnerable groups such as the elderly and asthmatics being the groups most at risk (4). Increased levels of domestic allergens have been linked to an increased risk of asthma among children (6), and exposure to domestic allergens has been established as a secondary cause of asthma, triggering attacks among asthmatics (7,8). However, there is insufficient research evidence to suggest that allergen exposure is a primary cause or major risk factor in the development of asthma (9).

Overall assessment: indoor air quality
<ul style="list-style-type: none">• Indoor air quality is determined by levels of both outdoor and indoor pollutants.• Sudden increases in air pollutants are most detrimental to the elderly and asthmatics.• Optimal levels of ventilation, allowing air replacement while minimizing heat loss, are recommended.• The health impact of improved indoor air quality has not been fully assessed.

Dampness and hygrothermal conditions

Dampness and hygrothermal conditions are of particular concern in European countries with a temperate, damp climate. The number of people and animals; activities such as cooking, laundering and bathing; the use of certain fuels for heating and cooking; the indoor temperature; and ventilation also affect the amount of water vapour in indoor air. Water leakage due to structural damage may contribute to dampness too. An optimal level of ventilation will reduce internal water vapour, as well as expel noxious odours and gases. However, if too much warm indoor air is exchanged for cooler outdoor air, the lost heat increases the likelihood of condensation (10).

The health risks of dampness are due to the fact that damp, warm conditions are ideal for the proliferation of allergens (especially moulds and house dust mites) and viruses, as well as to the cooling effect of damp air. While condensation is an indication of a damp environment, condensation on windows is unlikely to be harmful to health, since glass surfaces cannot support mould growth, and condensation itself is pure water (10). Condensation on walls is more likely to encourage mould growth than structural dampness is, as the salts that emerge with penetrating or rising damp tend to inhibit moulds (2).

Overall assessment: dampness and hygrothermal conditions

- A warm, damp indoor environment encourages the growth of allergens and microbes that may be harmful to the health.
- Levels of ventilation that allow air replacement while minimizing heat loss are recommended.
- The health impact of reducing dampness in the home has not been assessed.

Mould and house dust mite allergens

The pores released by moulds and the faecal pellets of house dust mites are the most common domestic allergens (11). Although the symptoms of exposure to house dust mites are poorly defined, reductions in levels of house dust mites are recommended (5). Methods of reducing house dust mites include vacuuming and chemical measures, which are used in the management of asthma. However, achieving significant reductions in allergens is difficult, requiring a high level of commitment from residents, and current measures are ineffective in managing asthma. This may be partly because asthma sufferers are often sensitive to allergens other than house dust mites, but it may also be due to the failure of vacuuming and chemical measures to achieve significant reductions in house dust mite levels when used in domestic settings (12).

Moulds thrive on the organic material of plaster and wallpaper and, once established, spread easily to furnishings and clothing. Exposure to mould spores can have toxic effects and cause infections or allergies. An association between mould growth and health status has been reported frequently, though there is debate about the strength of the relationship owing to the wide variety of moulds, differences in hazardous exposure levels and measurement difficulties, as well as the perennial problem of multiple confounding factors (11). In reviewing studies of the associations between damp, mould and respiratory health, the authors concluded that a damp or mouldy home carries a small increased risk of respiratory symptoms. It is recommended that new housing be designed to prevent the proliferation of indoor allergens (13).

Overall assessment: mould and house dust mite allergens

- Mould spores and the faecal pellets from house dust mites are the most common domestic allergens.
- Although the health effects of mould and house dust mites are poorly defined, limiting exposure to and proliferation of these allergens is recommended.
- Current methods to reduce house dust mites are not effective in the management of asthma.
- No studies have been identified on the health impact of reduced exposure to mould.

Temperature and warmth

Damp cold air and penetrating damp in the structure of a house will contribute to interior cooling. Thermal comfort is determined by a number of environmental, physiological and psychological factors, as well as by personal taste. Although minimum and maximum indoor temperatures have been recommended, it is not possible to predict which temperature limits are hazardous to one's health (14).

Central heating does not automatically result in warmer homes, and health problems associated with cold housing may be more strongly linked to fuel efficiency and affordability (15). Affordability is an essential consideration when installing new heating systems, especially for those with low incomes.

Excess winter deaths have been observed across Europe and are linked to a fall in outdoor temperatures. Those at the extremes of life are particularly vulnerable, i.e. the newborn and the elderly. Influenza epidemics, respiratory illnesses, heart disease and cerebrovascular disease contribute to the seasonal variation in deaths, while deaths from hypothermia account for only a small part of the increase. In countries such as Scotland, Portugal and Spain, the levels of excess winter deaths are higher than in Scandinavia, where winters are more severe (16,17). Recent analyses suggest that seasonal variations are related to indoor rather than outdoor temperatures. Although deprivation is a predictive factor for excess winter deaths, housing conditions and ability to heat one's home may be equally or more important; affluent people living in housing which is difficult to heat are also at an increased risk of winter death (17–19). It may be possible to reduce the annual increase in winter deaths by helping residents protect themselves from cold weather conditions (19–21).

High temperatures during heat-waves may also cause and contribute to deaths, especially among the elderly in urban areas. In a study of mortality rates during the Chicago heat-waves of 1995 and 1999, it was concluded that working air conditioners were the strongest protective factor against heat-related deaths (22).

Energy efficiency measures (e.g. central heating and double glazing) are the main housing improvements that directly affect temperature and dampness, and they may also have a subsequent impact on allergen growth. Four studies of the health impact of energy efficiency have been identified. Actual changes in levels of warmth or dampness were not always assessed, but small improvements in general health and respiratory health among asthmatic children were reported.

Overall assessment: temperature and warmth

- The elderly and the very young are particularly at risk from both low and high indoor temperatures.
- Excess winter deaths may be prevented by providing affordable domestic heating.
- Affordability is an essential component of domestic heating provision and may also affect levels of dampness and allergen growth.
- Energy efficiency improvements have led to small improvements in general health and respiratory health among asthmatic children.

Lead poisoning

Domestic exposure to lead is commonly from lead-based paints and drinking water supplied through lead pipes. Many countries have heavily (and successfully) invested in lead reduction (3,23), while in other countries, lead remains a common domestic hazard in the homes of poor people (24–26).

Adverse physical, mental, intellectual and developmental effects have been associated with lead exposure, especially in children. Evaluations of interventions to reduce lead exposure have therefore focused most often on outcomes among children.

Widespread public awareness, governmental initiatives and private action to reduce childhood exposure to lead have led to sharp declines in blood lead concentrations in children (27). There is also increasing evidence of the growing breadth of effective prevention and treatment (28). For example, controlling dust within contaminated homes can significantly reduce blood lead concentrations in children (29). Such measures to reduce or eliminate lead exposure and lead poisoning have excellent cost–benefit ratios. Strict enforcement can result in actual cost savings through reduced medical and educational costs and increased productivity for protected children (30). However, residential lead hazards remains difficult to control in older, poorly maintained rental housing, which is found most often in deprived neighbourhoods (31).

Overall assessment: control of lead exposure in children
<ul style="list-style-type: none">• Lead exposure in children leads to physical, mental and intellectual problems.• Lead exposure among children may stem from lead-based paint, which is found mainly in older, poorer housing, and mainly among poor families.• Numerous efforts to control childhood exposure have been successful in reducing blood lead concentrations and the adverse health effects of lead hazards.• While some treatments of lead poisoning exist, prevention remains the best and most cost-effective alternative.

Unintentional injuries, including falls and fires

The home is a major site of unintentional injuries and deaths, which result most commonly from falls, poisoning and fires; children and the elderly are particularly at risk (32). Targeted interventions to help prevent domestic accidents do exist, but poorly designed architectural features and overcrowding are believed to contribute to over 11% of such injuries among children (33). The use of safety devices and features in the home, particularly child-resistant packaging on poisonous products, can reduce the risk of unintentional injury. Targeted programmes to distribute such devices freely, together with educational outreach and home visits, are recommended in order to achieve the most impact. In the case of smoke alarms, proper installation and maintenance are essential if fire-related injuries are to be prevented (34). The smoke alarms that are most likely to be functioning one year after installation are those that use an ionization sensor and are powered by a 10-year battery (35).

Effective interventions to reduce the risk of falling among the elderly include exercise, balance training and individually tailored interventions for those who take sedative/hypnotic drugs or suffer from postural hypotension (36). Environmental modifications to the home, e.g. removing clutter and electrical cords, securing rugs and installing hand rails, can also help reduce falls in the elderly by up to 60% (37). Programmes to make such environmental modifications or distribute free safety appliances should be accompanied by educational efforts and home visits if injury levels are to be reduced (37,38). In addition, devices that are affordable and easy to use may be likelier to be used and can therefore increase effectiveness (3).

Overall assessment: unintentional injuries at home, including falls and fires

- Poisoning, falls and fires in the home are preventable causes of death and injury, particularly among children and the elderly.
- Effective prevention measures include individually tailored safety devices.
- Exercise, balance training and hazard removal help prevent falls among elderly people at risk.
- Educational outreach and home visits are essential if prevention programmes are to result in injury reduction.
- Smoke alarms need to be properly installed and maintained in order to prevent fire-related injury and death.

Domestic noise

There is little solid evidence linking environmental noise in residential areas with subsequent health problems (39–41). It is unlikely that outdoor sources of noise, or noise from neighbours in adjoining or nearby buildings, would be capable of causing physical damage to one's hearing (39). Community health surveys have found no direct effect of noise on the prevalence of psychiatric disorders (42–44). Residents exposed to high noise levels from aircraft are more likely to be admitted to psychiatric hospitals (45) and to receive medical treatment for heart trouble and hypertension (46). However, these studies have been challenged on methodological grounds (40,41,47). More commonly, neighbourhood noise is associated with stress, annoyance and sleep disturbance (48–50).

A maximum noise level of 30 dB(A) has been recommended for bedrooms to prevent sleep disturbance, and of 35 dB(A) for indoor dwellings more generally (51,52). Ways to reduce noise include instituting building regulations to ensure more soundproofing, and installing acoustic double-glazed windows and mechanical ventilation in homes subject to high outside noise. Disturbance from traffic noise can also be managed at the local planning level, while statutory controls and public education may help change the behaviour of noisy neighbours (39). No studies have been identified that evaluate the health effects of interventions to reduce domestic noise (39).

Overall assessment: domestic noise

- Domestic noise may result in sleep disturbance and stress but is unlikely to result in psychiatric or physical illness.
- Noise insulation, local planning and promotional work are all recommended to manage noise levels.
- The health impact of noise reduction has not been assessed.

Housing tenure

Home ownership has been independently linked to improved health among residents. Home ownership may generate a degree of security and control (53), but home ownership could also be linked to improved housing and neighbourhood quality (54). Implicit links between material factors and tenure will vary by country, depending on the rates of home ownership and the meaning attached to it. However, home ownership might not always promote health; for instance, people living on the margins of home ownership and those at risk for mortgage arrears may suffer increased insecurity and poorer mental health (55).

Overall assessment: housing tenure

- The financially secure home ownership has been linked to improved health, which may be due to better housing quality and feelings of security.
- This link may vary from country to country according to the rates of home ownership and the meaning attached to it.
- No studies have been identified that link changes in housing tenure to health.

Housing design

Living in a flat, particularly a high-rise flat, has been linked to living conditions regarded as stressful, such as increased social isolation, crime, reduced privacy and fewer opportunities for children to play safely (56). A recent review of epidemiological surveys (57) showed a consistent pattern of poor mental health associated with high and multi-unit dwellings, although the quality of research reviewed was poor. There are many factors related to flat dwelling that may confound survey findings, and there are no conclusive data demonstrating that the height of a home from ground level is associated with reduced health or housing satisfaction (58–60).

Specially designed houses are required for those with impaired physical mobility. In some countries, residents with particular medical needs are re-housed when their mobility levels limit their use of their house. Improvements in self-reported physical and mental health have been reported following such “medical priority rehousing” (61–65). However, there has been no research assessing the health effects of changes in housing design that are not specifically aimed at those with identified medical needs.

Overall assessment: housing design

- Housing design features may affect mental health, accessibility and risk of domestic injury.
- Rehousing individuals on health grounds is linked to improvements in both physical and mental health.
- No studies have been identified that describe the health effects of changes in housing design for the general population.

Housing satisfaction

Poor quality housing, flat housing and overcrowded housing are all linked to poor mental health, particularly among women and children (56,66–72). However, the direction of causality remains unknown. Neighbourhood satisfaction is most strongly influenced by satisfaction with housing and private space (73–77) and has been used as a proxy for life satisfaction (75) and one's general affect influencing mental health (77). Increased satisfaction with housing following housing improvement is strongly linked to improvements in mental health (78).

Overall assessment: housing satisfaction

- Housing satisfaction may be linked to life satisfaction and mental health.
- Increased housing satisfaction following housing improvement is strongly linked to improvements in mental health.

Infestation

There are many sources of domestic pest infestation. The most common sources that may pose a health hazard inside the home are lice, bedbugs, fleas, cockroaches, mites (scabies and house dust mites), rats and mice. The health hazard of a pest infestation may arise through it being a direct parasite (e.g. bedbugs feeding on human blood), a disease vector (e.g. the large number of diseases transmitted by rats), a hygiene hazard (e.g. cockroaches and houseflies that carry harmful micro-organisms quickly among food sources) or the source of an allergen (e.g. house dust mite droppings). Control of these hazards is best achieved by prevention and includes careful food and waste storage and good hygiene to reduce the home's attractiveness to pests. In the event of an infestation, a series of measures may be required, including chemical treatments (79).

Overall assessment: infestation

- The most common sources of infestation that pose a health hazard inside the home are lice, bedbugs, fleas, cockroaches, mites, rats and mice.
- Infestation can be prevented through careful food and waste storage and good hygiene, which reduce the home's attractiveness to pests.

The effectiveness of housing improvements in improving health

This section presents a systematic review of all the available evaluative and intervention studies that have monitored health changes following housing improvement. The evaluative studies identified covered three main types of housing improvement: medical priority rehousing, general rehousing or refurbishment, and energy efficiency measures (e.g. installation of central heating or insulation).

Housing improvement programmes, especially those featuring rehousing or major refurbishment, may involve a variety of housing improvements that change residents' exposure to some of the hazards and characteristics associated with poor health that were described in section 1. In slum clearance programmes, it may be assumed that all or most of the hazards described in section 1 will improve. However, very few studies of housing improvement and health have been carried out; despite extensive searching, only 19 studies were identified which had assessed the health impacts following housing improvement (80) (see Annex 2 for full details of the review methods and the studies included). Only a few of these studies reported on actual changes in the specific housing hazards, i.e. dampness reduction or temperature increase, subsequent to the improvements. It is impossible, therefore, to know whether health impacts reported were due to reductions in exposure to specific housing hazards. In addition, because of the lack of evaluative studies of housing improvement, there are insufficient data to attribute specific health impacts to a particular type of housing improvement. The review below is therefore presented according to type of health impact, with some more detail about types of housing improvement where appropriate.

General well-being, physical health and episodes of illness

The impacts on physical health and illness following housing improvement vary from study to study, making it difficult to draw a clear conclusion about whether the general trend is positive, negative or equivocal. It appears that small improvements in general health and illness will be observed following housing improvement, but such results cannot always be assumed.

Three studies of rehousing and community regeneration reported adverse effects on general health (81–83). One study found increases in reported illness episodes (+56%) (82), though this was attributed in part to a flu epidemic. In a further study, age-standardized mortality rates increased for all age groups except infants five years after rehousing from a slum area (81).

Mental health

Improvements to mental health have been consistently reported following housing improvements, regardless of whether they involved medical priority rehousing, energy efficiency improvements, refurbishment, or rehousing and area regeneration (63,65,82–90). In addition, the degree of mental health improvement was directly related to the extent of the housing improvement and was sustained for up to five years (87).

Respiratory health

Improvements in children's respiratory symptoms and reductions in days lost from school due to asthma have been observed three months after installation of central heating (91), suggesting that energy efficiency measures may have a positive impact on respiratory health. However, the impact of more general housing improvement and neighbourhood regeneration on respiratory health is not clear. In one study, chronic respiratory conditions increased by 12% among adults five years after the move to better neighbourhoods (83), while in another study, bronchial and asthmatic symptoms fell by 11% when measured one to four years after housing and neighbourhood improvements (82). A third study that reported on the rates of respiratory prescriptions in the local area found no significant changes after a regeneration programme that focused on housing.

Unintentional injuries, including falls and fires

The incidence of unintentional injuries was not reported in any evaluative studies of general housing improvement. See Findings “*Housing-related health determinants and available interventions for limiting exposure, Unintentional injuries, including falls and fires*” on page 9 for a review of targeted interventions to reduce injuries in the home caused by poisoning, falls and fires.

Overall assessment: the health effects of housing improvement
<ul style="list-style-type: none">• It is unclear whether reducing specific housing hazards leads to health improvements.• The small number of evaluative studies of housing improvement makes it difficult to know which types of housing improvement are most likely to improve health.• General housing improvements may result in small improvements in physical health and general well-being.• Improvements in mental health are consistently reported following housing improvements. The degree of mental health improvement may be linked to the extent of the housing improvement.• Improved energy efficiency may alleviate respiratory symptoms.• Housing improvements may also result in adverse health impacts; for example, rent increases that follow housing improvements have been linked to poorer diet, reduced employment opportunities and increased mortality rates.

Effects of housing improvement and regeneration that may have an indirect impact on health

Housing improvement rarely occurs in isolation. This section presents a literature review of other important changes that are often integral to housing improvement programmes. As mentioned at the beginning of this synthesis, it is essential to recognize interactions among such changes in the socioeconomic context in order to help explain both the negative and positive health consequences of housing improvements.

Increased rents

Housing improvement is often accompanied by rent increases that may increase the financial strain on the householder. For example, one study has reported increases in standardized mortality rates of rehoused residents. The increases were attributed to a doubling in rents, which in turn affected the

households' ability to provide themselves with an adequate diet (81). With welfare, it is unlikely that such dramatic rises in rent would be passed on to tenants these days. However, recent work in the United Kingdom reported that rents in new houses increased by an average of 14.8%. The increased rents necessitated economizing on food purchases and resulted in a welfare benefit trap and a barrier to employment opportunities, since the higher wages needed to meet the increased rent result in withdrawal of welfare benefits and a subsequent reduction in household income (82).

Effects on the social context and local area

Housing improvement may lead to other changes in the local area, including a reduced sense of isolation, reduced fear of actual or perceived crime, an increased sense of belonging and feeling of security, increased involvement in community affairs, greater interaction with neighbours and an improved attitude toward the area as a place to live (82,83,88,92). These changes may also affect residents' satisfaction with their homes, though it is not known if they translate into health improvements.

Neighbourhood effects: relocating to a new area

The socioeconomic characteristics of a neighbourhood can affect health (93). Residents relocated from deprived areas to improved housing in middle-income areas have reported sustained increases in employment opportunities, improved educational possibilities and better social integration (94,95), as well as some health improvements (96).

Relocation and the process of moving

Although moving to an improved house may be a positive experience in the long term, the process of moving house may be a stressful, health-damaging life event (97–99), sometimes due to a lack of opportunity to negotiate with the housing authority regarding the move (100). Housing relocation has also been associated with loss of community, uprooting of social networks (101) and unsatisfied social aspirations (102). It is important to consult with residents involved in proposed housing changes and general regeneration projects.

Displacement

Some area and housing regeneration projects can lead to the displacement of the original residents (84). That may in turn result in shifts in routine social and health statistics that obscure any impacts on the original residents. It is necessary to identify the reasons and potential for displacement in advance. If the health impact of housing improvement is to be predicted, it must be clear who the recipients of the improved housing will be and where existing residents will be relocated.

Social exclusion and community division

A review of regeneration and health has highlighted the potential for regeneration to increase exclusion and divisions within an area. For those living on the margins of a regenerated area, feelings of exclusion can exacerbate levels of stress and depression (82, 98). Some studies have reported that regeneration can create divisions within local areas (98), though the subsequent impacts on health are unclear.

Gentrification

Neighbourhoods undergoing regeneration may also undergo gentrification, in which traditionally working-class areas are transformed into middle-class areas (103). A systematic review of the benefits and harms associated with this process reported a range of conflicting findings that involved changes in housing demand, housing prices, social mix, crime, occupancy rates, private and local investment, and the population of other areas (104). Few studies have followed the impact of gentrification on an area's original residents, and fewer still have followed the health impact.

Overall assessment: the social impact of housing improvement and area regeneration

- Housing improvements are often accompanied by changes in neighbourhood and social context, as well as changes in housing costs.
- The positive impacts reported include improved perceptions of safety, greater community involvement and more area satisfaction.
- The negative impacts include increased housing costs, the displacement of original residents, social exclusion and community division (for those in neighbouring areas not benefiting from the improvements), disruption, uncertainty and lack of control with respect to moving.
- Only some of these impacts have been linked to subsequent health impacts. Most notably, the negative impact of increased housing costs can lead to poorer diets and reduced employment opportunities.

Conclusions

This review seeks to answer the question, “Is housing improvement a potential health improvement strategy?” Housing improvement may indeed result in improved health, particularly mental health. However, adverse health impacts can also arise. The positive health impacts of housing improvement are likely to be minor, and the potential for health gains may vary depending on individual vulnerability to the harmful effects of poor housing. The greatest potential for health gain will be among those with poor health, the elderly and the very young. There is not enough evidence about which types of housing improvement are likely to generate the greatest health gains, nor about which offer the most health improvement for the money. In addition, priorities for specific improvements will depend on local factors such as climate and the quality of existing housing stock.

The impact of housing on health is also influenced by the socioeconomic circumstances of residents and the surrounding neighbourhoods, circumstances that also may change during a housing improvement programme. In particular, increased housing costs can add financial strain and indirectly affect health by reducing the money available to spend on adequate heat, food and other necessities (81,105). Identifying potential changes associated with housing improvement (e.g. rent increases, relocation and the disruption of social connections) and their potential to affect health, whether positively or negatively, may help minimize some adverse effects while maximizing health gains.

A further unanswered question of interest to policy-makers is whether health improvement can be achieved more rapidly by centralized policy, i.e. government intervention to upgrade housing and neighbourhood conditions for low-income people, or by raising incomes of poor people and thus enabling them access to better housing. Unfortunately, research evidence on increasing access to affordable housing and improved neighbourhoods is also lacking. A systematic review of United States housing initiatives that provide rental vouchers to low-income families and promote moving to less deprived neighbourhoods suggests that such initiatives may improve household safety, but a lack of evidence prevents conclusions from being drawn on other possible health impacts (106).

Critique: using research to inform housing investment as a health improvement strategy¹

It is clear that existing research is limited in its ability to answer the question of whether housing investment is an effective health improvement strategy. The lack of research evidence is disappointing, and it raises the question of how much health improvement can be assumed to follow housing improvement. However, it must be remembered that a lack of evidence points to a knowledge gap and must not be interpreted as contrary evidence – i.e. it does not mean that the housing improvements have no effect on health, nor that housing investments are not worth making. Other grounds for housing improvement include social justice, improved access, global energy conservation and general comfort. Besides, the links between poor housing and poor health are sufficiently well established to argue for housing improvements on health grounds. (See Boxes 1 and 2 in Annex 1 for a ranking of health hazards that suggest priority areas.) However, such improvements need to be carefully evaluated if the potential for health gain is to be realized more fully.

The lack of conclusive research evidence in this field is partly explained by the difficulties in eliciting a clear relationship between poor housing and poor health that is independent of individual, local and societal factors. At the beginning of this review, it was mentioned that not only was attributing health effects to specific physical housing characteristics difficult, but that such an approach also ignored the importance of socioeconomic context, which is inextricably linked to housing conditions and health status. To address this oversight, it has been suggested that an ecological approach be adopted that incorporates assessments of the broader relationship between social circumstances and housing. Such an approach would help explain why some people are more adversely affected by poor housing than others (2), and help identify which circumstances are needed to maximize the positive health impact of housing improvement. Pathways that set out how improved housing might lead to health gains could be mapped and then incorporated and tested in future evaluations. Studies of housing improvement that have taken a broader ecological approach are now underway. It is our hope that these studies will enable a more comprehensive understanding of the potential for housing investment to generate health gains.

¹ The findings of this systematic review were originally compiled as a resource for health impact assessment and a source of accessible research evidence for use in policy and practice [see Thomson et al., 2003 (107) and Douglas et al., 2003 (108)].

Annex 1: Identifying links between housing hazards and health

Ranking of housing hazards

The ranking in Box 1 is based on a comprehensive review by both medical experts and health and safety experts, who assessed the relative risk of housing biohazards according to the strength of evidence, the number of people affected or exposed, and the seriousness of harm, ranging from death through mild heart attack, chronic severe stress, regular serious coughs and colds, and occasional severe discomfort. The identified biohazards listed in Box 1 have often been targeted as part of housing improvement programmes. Other housing characteristics, such as tenure, design and location, can also influence health. The most commonly reported ill health effects linked to housing are listed in Box 2.

Box 1. The most significant housing hazards associated with health effects (1)*

Poor air quality (particles and fibres that can cause death among the very ill)
Poor hygrothermal conditions (excessive heat, cold and/or humidity)
Radon
Slips, trips and falls
Noise
House dust mites
Ambient tobacco smoke
Fires

**The seriousness of the hazards has been ranked according to the number of people affected, the seriousness of the effects and the strength of evidence.*

Box 2. Types of health effects commonly linked to poor housing

Respiratory symptoms, asthma, lung cancer
Depression and anxiety
Injury/death from accidents and fires
Hypothermia
Skin and eye irritation
General physical symptoms

Housing and health: single hazards and the importance of sociocultural context

This section presents more details and examples of social, cultural, political, economic and climatic factors that can also influence the relationship between housing and health.

As mentioned in the introduction, the identification of single hazards is important, and subsequent development and enforcement of building regulations to limit exposure to single hazards has limited the adverse effects of poor housing in many countries. However, many less wealthy countries do not have or do not enforce strict building regulations; as a result, the adverse effects of specific housing hazards may be more pronounced in these countries, especially among vulnerable groups. Indeed, while certain housing features are considered low or negligible health risks in some countries, due to the enforcement of building controls and other contextual factors, in other countries the same housing features may be considered high health risks. For example, in Turkey the second most common cause of accidental death is falling from a flat roof. Falls are most common there in summer, when people often sleep on their roofs to keep cool (109).

Substandard housing often includes multiple hazards, so that exposure to just a single hazard is rare. Housing exists in a social context, and poor housing is often situated in deprived neighbourhoods, where people are needy and at increased risk for poor health. The unemployed, the sick and the elderly may spend longer periods in the home, resulting in longer exposures to hazards there. Such tendencies can increase individual vulnerability and thus compound the effect of poor housing on residents (2,110).

More general factors in the local social context and the national political and cultural context can also influence housing and housing-related conditions, such as the prevalence of renters or owner-occupiers. For example, there have been significant social, political and economic changes in both eastern and western Europe that have influenced housing environments. The changes may have been the starkest in post-Communist countries, but ageing housing stock, decentralization of government responsibility, pressures on energy reserves and lifestyle shifts have had implications for housing needs across Europe and the rest of the industrialized world (111). Sociopolitical and cultural context can also influence the meaning and value attached to housing conditions, size, design and ownership. Culture and climate can also affect how much time is spent in the home and thus exposed to potential hazards. An ecological approach to housing and health research – one that acknowledges the many influences on health in addition to physical housing conditions – has been recommended (2,3). Such an approach is also essential for those attempting to describe and predict the potential health effects, whether mental or physical, positive or negative, of housing improvement.

Research evidence linking health and housing and housing improvement

As well as the problems of confounding factors outlined above, there are problems in sampling and measuring housing-related health hazards. For example, temperature may vary widely from room to room and day to day. Such issues make it difficult to identify a causal link between poor housing and poor health. Nevertheless, the reports from cross-sectional studies are consistent, and the link between poor housing and poor health is generally accepted (112). The reported links to specific hazards (see Box 1) may suggest what types of housing investment are warranted on health grounds. It seems feasible that targeted housing improvements that reduce exposure to known hazards will be followed by health improvements, and that harm to future generations will be prevented; however, it cannot be assumed. Evidence of association does not confirm, or show the direction of, cause and effect. Evidence from studies that have evaluated the actual health effects of housing improvement is required to shed light on the nature, size and mechanisms of health effects and whether, however counterintuitively, adverse health effects arise.

However, evaluating the health effects of housing improvements is not a straightforward process, and there are further confounding factors that are impossible to control. For example, housing improvement programmes are often part of major neighbourhood improvement programmes, during which original residents may be displaced or move voluntarily. And although the randomized controlled trial may be the ideal experimental model for demonstrating effects, it is difficult to apply to housing improvement programmes, and such trials have rarely been conducted in the field of housing research (113). Other study designs need to be considered as best available research evidence for housing improvement and other complex social interventions. These include prospective, retrospective, controlled and uncontrolled studies, and in the absence of a well-conducted, randomized controlled trial, well-conducted, prospective controlled studies are the most desirable. However, regardless of design, there is a distinct lack of evaluative studies on the health impacts of housing improvement. Therefore, it is still necessary to draw heavily on the wealth of cross-sectional surveys that report associations between housing conditions and health.

Annex 2: Methods and research sources used for this review

Review methods and sources

This paper presents a comprehensive review that draws on the best available evidence on housing and health. To date, housing and health research has focused on identifying direct links between specific physical housing characteristics and health. Although an ecological approach to such research has been recommended, it has rarely been implemented (3,78). and there is very little empirical research to illuminate the complex pathways of how poor housing may impact health. These limitations are reflected in this paper. Where possible, attention has been drawn to important social and economic factors that have been used to explain housing-related health impacts, e.g. housing costs (81,82) and difficult-to-heat homes (17–19). The review findings are divided into three sections based on the methods and sources used:

- 1) The first section on *housing-related determinants of health and available interventions* presents a comprehensive literature review that draws on systematic reviews where available. The literature reviewed is mainly cross-sectional epidemiological surveys that document specific physical housing characteristics and biohazards with strong links to health effects. Also reviewed is qualitative research that reports resident views, satisfaction levels and values associated with specific housing characteristics that can influence mental health and well-being. In rare cases, there have been evaluative studies of the health impacts of housing improvements that target specific health hazards; they have been included when available.
- 2) The second section on the *effectiveness of housing improvements in improving health* presents a systematic review of the types of health impacts that have been observed following housing improvements and includes studies regardless of language, format or location. When this systematic review was conducted in 2000, it identified 14 studies in progress. An update is planned for 2005, when it is hoped that most of the studies under way will have produced publicly available findings². The systematic review only reviews housing intervention studies, but includes both experimental and non-experimental studies (randomized controlled trials and prospective and retrospective observational studies) as well as quantitative and qualitative health outcomes (health, well-being, illness, mortality). Cross-sectional studies that did not investigate the effects of housing improvement before and after the intervention were not included. Housing interventions were defined as rehousing as well as any physical changes to housing infrastructure, for example heating installation, insulation, double glazing and general refurbishment. Studies of interventions to improve the indoor environment by means of furniture or indoor equipment were *excluded* unless such means were part of other housing improvements.

The included studies for this review were identified from searches in 17 clinical, social science and grey literature databases dating back to 1887 (ASSIA, CAB Health, Cochrane Controlled Trials Database, DHSS-DATA, EMBASE, HealthSTAR, IBSS, MEDLINE, PAIS, PsycINFO, SIGLE, Social SciSearch, Sociological Abstracts, Social Sciences Citation Index, SPECTR, Urbanisc and the World Wide Web). Personal collections and the bibliographies of all the reports, papers and textbooks reviewed were hand-searched. In addition, United Kingdom health authorities, housing departments, academic departments, local authorities, housing associations and the subscribers to a national housing studies newsletter were contacted with requests for information on unpublished and ongoing studies.

At least two reviewers independently screened all abstracts identified by the searches. Three reviewers critically appraised the methods and validity of the findings reported in the included

² For full details of the systematic review please consult the following sources: Thomson et al., 2001 (78) and Thomson et al., 2002 (80).

studies.

- 3) The third section dealing with the *effects of housing improvement and regeneration that may have an indirect impact on health* is a literature review that draws on individual studies as well as summaries of one systematic and two comprehensive reviews. Important changes that are not directly part of housing improvement, such as rent increases, relocation and neighbourhood improvement, can also accompany housing improvement programmes; research reporting health or social impacts of such changes is also reviewed in this section.

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