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Housing and public health: a review of reviews of interventions for improving health

Evidence briefing

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This document presents the findings from a review of reviews of housing interventions for improving health. This review was undertaken by the Health Development Agency (HDA) but published after the functions of the HDA were transferred to NICE on 1 April 2005. This document does not represent NICE guidance.

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Foreword

The Health Development Agency (HDA) was established in 2000. Between then and 2005, when the functions of the HDA were transferred to the National Institute for Health and Clinical Excellence (NICE), the HDA helped to build the evidence base in public health with an emphasis on what works and a special focus on reducing inequalities in health.

The HDA had the task of mapping and synthesising the evidence across priority areas of public health. It developed a number of ways of taking a systematic approach to compiling the evidence, identifying gaps and making the evidence base accessible. The evidence briefing series was one of the ways in which the HDA Evidence Base was disseminated (full details of the process of developing the Evidence Base and the associated methodological activities can be found in Graham and Kelly, 2004; Kelly et al., 2002, 2003, 2004; Killoran and Kelly, 2004; Swann et al., 2003). This evidence briefing on housing interventions in public health is the latest in the series.

The HDA and NICE have published other evidence briefings that cover:

- Teenage pregnancy and parenthood
- HIV prevention
- Prevention of sexually transmitted infections
- Management of obesity and overweight
- Prevention of low birth weight
- Breastfeeding
- Accidental injuries in children and older people
- Public health interventions for increasing physical activity among adults
- Smoking and public health
- Drug misuse
- Youth suicide prevention
- Health impact assessment
- Prevention and reduction of alcohol misuse
- Prevention and reduction of exposure to second-hand smoke.

Taken together these briefings provide a comprehensive synthesis of the evidence drawn from review-level literature. They are available on the NICE website – www.publichealth.nice.org.uk

These evidence briefings have been based on evidence drawn from systematic and other kinds of reviews. This means that the type of evidence that does not traditionally find its way into reviews has not been considered in detail for these documents. In another HDA evidence series, evidence reviews, the scope of the coverage is extended to primary research, other kinds of evidence and other types of study. Evidence reviews on resilience, transport, maternal and child nutrition, smoking, drug misuse prevention and accidental injury prevention for children are currently in preparation.

The construction of the HDA Evidence Base involved collaboration with a number of partners who have interests and expertise in practical and methodological matters concerning the drawing together of evidence and its dissemination. In particular the HDA acknowledged the following: the Centre for Reviews and Dissemination at the University of York; the EPPI-Centre at the Institute of Education, University of London; Health Evidence Bulletins Wales; the ESRC UK Centre for Evidence Based Policy and Practice at Queen Mary College, University of London and its nodes at City University London and the MRC Public Health Sciences Unit at the University of Glasgow; members of the Cochrane and Campbell collaborations; the United Kingdom and Ireland Public Health Evidence Group and the members of the Public Health Evidence Steering Group. This latter organisation acted as the overall guide for the HDA's evidence-

building project. The cooperation of colleagues in these institutions and organisations has been of significant help in the general work in preparing the framework for how we assess the evidence.

Every effort has been made to be as accurate and up to date as possible in the preparation of this briefing. However, we would be very pleased to hear from readers who would like to comment on the content or on any matters relating to the accuracy of the briefing. We will make every effort to correct any matters of fact in subsequent editions. Comments can be made by using our website, www.publichealth.nice.org.uk

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Graham, H. and Kelly, M. P. (2004). *Health inequalities: concepts, frameworks and policy*. London: Health Development Agency.

Kelly, M. P., Swann, C., Morgan, A., Killoran, A., Naidoo, B. and Barnett-Paige, E. (2002). *Methodological problems in constructing the evidence base in public health*. London: Health Development Agency.

Kelly, M. P., Chambers, J., Huntley, J. and Millward, L. (2003). *Method 1 for the production of effective action briefings and related materials*. London: Health Development Agency.

Kelly, M. P., Speller, V. and Meyrick, J. (2004). *Getting evidence into practice in public health*. London: Health Development Agency.

Killoran, A. and Kelly, M. P. (2004). Towards an evidence-based approach to tackling health inequalities: the English experience. *Health Education Journal* 63: 7-14.

Swann, C. J., Falce, C., Morgan, A., Kelly, M. and Powell, G. (2003). *HDA Evidence Base: process and quality standards manual for evidence briefings*. London: Health Development Agency.

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Summary

Introduction

This briefing (a review of reviews) aims to:

- Identify all relevant systematic reviews, syntheses, meta-analyses and review-level papers on public health interventions relating to housing
- Review these papers and highlight what housing-related interventions work to promote health for all population groups, but with particular reference to disadvantaged and vulnerable groups
- Identify cost-effectiveness data for housing-related interventions to promote health for all population groups
- Highlight any gaps in the evidence and provide recommendations for future research.

This briefing is intended to inform policy and decision makers, NHS providers, housing officials, public health physicians and other public health practitioners in the widest sense.

Housing and health

The association between housing conditions and physical and mental ill health has long been recognised and there are a broad range of specific elements relating to housing that can affect health outcomes (reviewed by Bonnefoy et al., 2004). However, this relationship is complex and the nature of causal links between different dimensions of housing, neighbourhood environment and health can operate at a number of interrelated levels including the home, neighbourhood and macro-policy environment. Furthermore, poor housing conditions often coexist with other forms of deprivation (unemployment, poor education, ill health, social isolation etc), making it difficult to isolate, modify and assess the overall health impact of housing conditions. A range of specific housing-related factors are known to adversely affect health:

- Agents that affect the quality of the indoor environment such as indoor pollutants (eg asbestos, carbon monoxide, radon, lead, moulds and volatile organic chemicals)
- Cold and damp, housing design or layout (which in turn can affect accessibility and usability of housing), infestation, hazardous internal structures or fixtures, noise
- Factors that relate more to the broader social and behavioural environment such as overcrowding, sleep deprivation, neighbourhood quality, infrastructure deprivation (ie lack of availability and accessibility of health services, parks, stores selling healthy foods at affordable prices), neighbourhood safety, and social cohesion
- Factors that relate to the broader macro-policy environment such as housing allocation, lack of housing (homelessness, whether without a home or housed in temporary accommodation), housing tenure, housing investment, and urban planning.

Housing inequalities

The *English House Condition Survey* (ODPM, 2003a) is undertaken every five years and assesses the overall condition of the housing stock. For 2001, the survey reported:

- Of 21.1 million dwellings in England, 7 million do not provide decent homes, 5.6 million (80% of all non-decent homes) fail to provide an adequate level of thermal comfort, 2 million (27%) are in disrepair, 0.9 million (3%) are unfit and 0.5 million (7%) require

modernisation. Non-decent housing stock remains concentrated mainly among older dwellings (51% of pre-1919 stock is non-decent) and flats
- Some 6.7 million households live in non-decent homes. Of these, 5.2 million households live in the private sector and 1.5 million are social tenants
- The most vulnerable people live in non-decent homes. Households that rent privately, people who live alone, ethnic minorities and households with no-one in full-time employment are most likely to be living in non-decent homes
- The majority (53%) of homes in poor neighbourhoods are non-decent and over a quarter are situated in areas of 'limited' demand.

UK policy context

The government's commitment to promoting health and tackling health inequalities through policies concerned with housing, regeneration and sustainable development is clearly defined in *Tackling Health Inequalities: a programme for action* (Department of Health, 2003). It states that actions likely to have the greatest impact over the long term include improving social housing conditions and reducing fuel poverty among vulnerable populations. Furthermore, key interventions that will contribute to closing the life expectancy gap include improving housing quality by tackling cold and dampness. Similarly, those that will contribute most to closing the gap in infant mortality rates relate to improving housing conditions for children in disadvantaged areas.

Public health is an integral concern within urban planning processes relating to the physical and social environment. The planning system comprises different tiers. Central government provides national planning guidance to local authorities, in addition to Regional Planning Guidance (RPG) based on advice from regional planning conferences. Regional Spatial Strategies are prepared by each English region and Local Development Frameworks by unitary and district councils. Local Strategic Partnerships have responsibility for ensuring an inter-agency approach to community planning, including the development of local housing strategies. Health impact assessment provides an important mechanism for ensuring the health consequences of housing and other environmental developments are fully considered at each of the different tiers within the planning system.

The public health aspects of key policies concerned with housing, regeneration and sustainable communities are summarised in Box 1 (see p13).

The government's key framework for securing a decent home for all is set out in the *Communities Plan (Sustainable Communities: Building for the future)* (ODPM, 2003b). The corresponding public service agreement target aims to bring all social housing into a 'decent condition' by 2010. To be considered 'decent' a dwelling must:

- Meet the statutory minimum standard for housing (ie be fit)
- Be in a reasonable state of repair
- Have reasonably modern facilities and services
- Provide a reasonable degree of thermal comfort.

The Housing Health and Safety Rating System (HHSRS) is the government's new approach to the evaluation of the potential risks to health and safety from any deficiencies identified in dwellings. The HHSRS is evidence based – it is supported by extensive reviews of the literature and by detailed analyses of statistical data on the impact of housing conditions on health (ODPM, 2004a).

The government's *A new commitment to neighbourhood renewal: national strategy action plan* (Social Exclusion Unit, 2001) is viewed as a central focus for addressing the multiple aspects of deprivation experienced in the poorest areas. A recent review of this strategy by the Prime Minister's Strategy Unit stated that poor quality housing, badly maintained local environments, problems with anti-social behaviour, and crime and disorder including drug and alcohol misuse can cause instability in many deprived areas. This exacerbates local economic problems as residents who are generally better skilled and educated move out, leaving behind increasing concentrations of deprivation. Areas of low housing demand are more likely to suffer crime, vandalism and litter and those living in social housing estates are five times more likely to perceive local disorder and antisocial behaviour as a problem. These problems are often compounded by social housing policies in which housing allocations can lead to further concentration of the most deprived in a particular area (Strategy Unit, 2005).

Review methodology

This evidence briefing seeks to answer the following research question:

What housing interventions are effective at improving health outcomes?

We defined the 'house' as the usual residential home of an individual or family. All housing interventions acting at either the macro- or micro-policy level were included. Papers were included if they reviewed housing interventions in which health-related outcomes or the economic costs of health-related outcomes were assessed. We also included measures of outcomes that relate to the wider, underlying determinants of health, which can include social, economic, cultural and environmental factors (Dahlgren and Whitehead, 2001).

The following process was applied:

- Systematic searching of all English language literature from January 1996 to October 2004
- Selection of relevant reviews
- Critical appraisal of the reviews (transparency, systematicity, quality and relevance)
- Analysis and synthesis of the evidence for different topic areas and population groups.

A total of 15 review-level papers passed the critical appraisal process. Papers were compared and top-level findings were collated and presented in the following core themes:

A – Rehousing and neighbourhood regeneration

- Medical priority rehousing
- Rehousing plus relocation from slum or socially isolated areas
- Rehousing or housing improvement plus neighbourhood regeneration
- Housing subsidy programmes for low-income families

B – Refurbishment and renovation

- General refurbishment
- Improvement in housing energy efficiency measures
- Accidental injury prevention
- Smoke alarms
- Prevention of allergic respiratory disease

Evidence statements were derived from each paper based on the following categories:

- **Evidence of effectiveness:** derived from the review-level literature where the results were all in agreement
- **Currently, a lack of evidence of effectiveness:** applied to interventions in the review-level literature that currently showed no impact on outcomes
- **Conflicting evidence:** derived from the review-level literature where the interpretation and/or conclusions of the review papers and/or primary studies within review paper/s were not in agreement.

Findings

Listed below are all the review-level evidence statements for the two core themes.

A – REHOUSING AND NEIGHBOURHOOD REGENERATION

Medical priority rehousing

- There is review-level evidence that anxiety and depression scores are reduced in people who are rehoused on the basis of medical need.

Rehousing plus relocation from slum or socially isolated areas

- There is review-level evidence that rehousing people from slum areas can improve self-reported physical and mental health outcomes in the longer term (18 months).
- There is also review-level evidence that rehousing people from slum areas can adversely affect self-reported health outcomes in the short term (9 months).
- Currently, there is a lack of review-level evidence on the effectiveness of rehousing from a socially isolated area or substandard housing in improving health.

Rehousing or housing improvement plus neighbourhood regeneration

- Currently, there is a lack of review-level evidence of the effectiveness of interventions involving rehousing or housing improvement combined with neighbourhood regeneration initiatives in improving health outcomes.

Housing subsidy programmes for low-income families

- There is review-level evidence from the US that rental voucher programmes can improve household safety by providing families with the choice to move to neighbourhoods with reduced exposure to violence.
- Currently, there is a lack of review-level evidence on the effectiveness of rental voucher programmes in improving other health-related outcomes.
- Currently, there is a lack of review-level evidence on the effectiveness of interventions involving mixed-income housing developments in improving health outcomes.

B – REFURBISHMENT AND RENOVATION

General refurbishment

- Currently, there is a lack of review-level evidence of the effectiveness of interventions involving general refurbishment initiatives in improving health outcomes.

Improvement in housing energy efficiency measures

- There is review-level evidence that housing interventions involving improvements to energy efficiency measures, such as installation of new windows, can positively affect health outcomes.

Accidental injury prevention

Children and young adults

- There is review-level evidence that home visits to people in lower socioeconomic areas plus provision of advice on home hazards, combined with health education and media campaigns, are effective in encouraging parents to make physical changes to the home environment to ensure their homes are safer.
- There is review-level evidence that the provision of free or discounted home safety equipment and/or educational campaigns may lead to behavioural and environmental change.
- There is conflicting review-level evidence on the effectiveness of interventions comprising healthcare counselling or education, provision of safety information or free thermometers in encouraging people to use safe hot water temperatures.
- Currently, there is a lack of review-level evidence on the effectiveness of provision of home safety equipment and/or educational campaigns in reducing physical injuries in children and young adults through modification of the home environment.

Older people

- There is review-level evidence to suggest that home hazard modification interventions that seek to remove and repair safety hazards are effective in reducing falls in older people. This effect was strongest for people with a history of falling prior to intervention and men aged ≥75 years.
- There is a lack of review-level evidence on the effectiveness of interventions in reducing the risk of injurious falls in older people through modification of the home environment compared with control measures.

Smoke alarms

- There is review-level evidence that community based interventions that provide free smoke alarms (with or without installation) may reduce fire-related injuries. However, methodological weaknesses limit the reliability of this finding.
- There is review-level evidence from the US that smoke detector legislation can reduce the number of fire-related deaths compared with communities without smoke detector legislation. However, there was no difference in the number of smoke detectors installed between communities.
- There is conflicting review-level evidence of the effectiveness of education-based interventions combined with provision of discounted smoke detectors in increasing the proportion of people that install smoke detectors.
- Currently, there is a lack of review-level evidence to demonstrate effectiveness of community based injury or burn prevention education programmes in reducing injuries or burns.

Prevention of allergic respiratory disease

Asthma

- Currently, there is a lack of review-level evidence of effectiveness of air filtration systems in improving health outcomes in people with asthma.
- Currently, there is a lack of review-level evidence on the effectiveness of interventions that aim to reduce exposure to house dust mite allergen in the home in

improving health outcomes in people with mite-sensitive asthma.

Asthma and allergic rhinitis

- There is review-level evidence to suggest that the use of physical (intensive home cleaning, vinyl mattress covers, daily wet cleaning of floors, boiling of top bedding covers and removal of soft furnishing) and/or chemical measures (air filters loaded with Enviracaire and acaracide spray and cleaning products) may lead to a reduction in allergen load for those with house dust mite-provoked respiratory disease when combined with maintenance drug treatments. However, the magnitude of the effect cannot be reliably isolated from that of the maintenance drug treatment.

Gaps in the evidence base

We have identified a number of gaps and compiled a list of research recommendations based on both our observations and those made by the authors of the Evidence Base papers. It is important to note that we have not systematically searched for gaps in the primary research, although some of our recommendations are likely to impact on primary research.

Inequalities and vulnerable groups

The Evidence Base papers report that there is review-level evidence of effectiveness for the following housing-related interventions that specifically targeted socio-economically deprived or vulnerable groups:

- Rehousing people from slum areas can improve self-reported physical and mental health outcomes in the longer term (18 months). However, it is important to note that rehousing people from slum areas can also adversely affect self-reported health outcomes in the short term (nine months)
- Rental voucher programmes in the US can improve household safety by providing lower socio-economic families with the choice to move to neighbourhoods with reduced exposure to violence
- Home visits to people in lower socio-economic areas plus provision of advice on home hazards, and combined with health education and media campaigns, are effective in encouraging parents to make physical changes to the home environment to ensure their homes are safer.

However, overall, very few studies found evidence of effectiveness of housing interventions in improving health outcomes in these groups and further research needs to be undertaken to address this important gap in the evidence base.

Cost effectiveness

There is an urgent need for primary research to be undertaken to examine the cost effectiveness of housing-related interventions to improve health outcomes in both the general population and disadvantaged and vulnerable groups.

Research recommendations

- The effectiveness or cost effectiveness of interventions that target specific housing elements that are known to affect health outcomes needs to be determined. These include interventions that seek to minimise exposure to indoor pollutants (such as asbestos, carbon monoxide, radon, lead and volatile organic chemicals); infestation; hazardous internal structures or fixtures; noise; and cold or damp.
- Similarly, the effectiveness of housing-related interventions that seek to address problems in the broader social and behavioural environment such as overcrowding, sleep deprivation, neighbourhood quality, infrastructure deprivation (ie lack of availability and accessibility of health services, parks, stores selling healthy foods at affordable prices); neighbourhood safety; and social cohesion also needs to be determined.
- Finally, there is a lack of evidence of effectiveness of housing-related interventions that relate to the broader macro-policy environment such as housing allocation, lack of housing, housing tenure, housing investment and urban planning. Further research will be required in each of these areas to more comprehensively inform the policy making process.

In their recent review, Thomson et al. (2001, 2002) identified 14 ongoing studies in the UK that aim to assess health outcomes from housing interventions. Findings from these studies will be key in informing a relatively depleted evidence base.

Introduction

Background: the evidence base for public health

Decisions about policy and practice in the public sector are increasingly driven by consideration of the best available evidence. The process of drawing together, analysing and synthesising evidence from research is a central principle of evidence-based practice. Typically, the process of reviewing an area of practice or intervention will include the production of a systematic review of effectiveness, a meta-analysis or some other review-level synthesis and interpretation of evidence from research. However, as more reviews and meta-analyses are carried out across the spectrum of public health, there is an increasing need to map the areas that they cover, assess their quality and pull together any common findings about what works in particular areas to improve health and reduce health inequalities.

In 1999, the white paper *Saving Lives: Our Healthier Nation* (Department of Health, 1999) signalled the establishment of the Health Development Agency (HDA) to build the evidence base in public health. In April 2001, the Department of Health's *Research and Development Strategy* (Department of Health, 2001) identified the HDA's task as 'maintaining an up-to-date map of the evidence base of public health and health improvement…and effective and authoritative dissemination of evidence to practitioners'.

From 2000-2005 the HDA undertook the task of mapping and synthesising the evidence for the effectiveness of interventions to improve health and reduce health inequalities, across priority areas of public health. Wanless (2004) further highlighted the need for appraising the effectiveness of public health interventions, not only to reduce inequalities but also to maximise cost effectiveness. The government's recent white paper, *Choosing Health* (Department of Health, 2004b) similarly reiterates the importance of building and maintaining an evidence base for public health. From April 2005 the HDA's evidence base work continued under the auspices of the National Institute for Health and Clinical Excellence (NICE).

The HDA's process for building the public health evidence base was underpinned by a two-tier structure:

- A Public Health Evidence Steering Group (PHESG) with membership drawn from universities, public health and research and development divisions of the Department of Health, other government departments, public health practitioners, representatives of research funding bodies, the Centre for Reviews and Dissemination, Cochrane and Campbell collaborations, the EPPI-Centre, and other UK and WHO representatives. The group was chaired by a high-ranking official from the Department of Health on behalf of the Chief Medical Officer for England. This overarching group advised on the broad strategic direction of the evidence base and had a remit to quality assure the processes developed by the HDA in constructing the evidence base
- For each topic area covered (eg smoking and alcohol), there was a reference group. These reported to the PHESG, and consisted of key academics, practitioners and officials with expertise in the area. Reference groups advised on the content of the evidence base and guided the production of evidence briefings.

One of the core outputs produced by the HDA's evidence base project were evidence briefings – essentially 'reviews of reviews'. They synthesised the best available review-level evidence for a topic area, analysed the strengths and weaknesses, identified gaps in the evidence and made recommendations for future primary and secondary research. Both a full length publication and a free-standing summary are produced for each topic and they are also published on, and supported by, the NICE website (www.publichealth.nice.org.uk).

Aims of this briefing

This briefing aims to:

- Identify all housing-related systematic reviews, syntheses, meta-analyses and review-level papers
- Review these papers and highlight what housing-related interventions work to promote health for all population groups, but with particular reference to disadvantaged and vulnerable groups
- Identify cost effectiveness data for housing-related interventions to promote health for all population groups
- Highlight any gaps in the evidence and provide recommendations for research commissioners.

Who is this briefing for?

This briefing is intended to inform policy and decision makers, NHS providers, public health physicians, housing officials and other public health practitioners in the widest sense. It is designed to be accessed by a variety of users including those simply looking for headline findings and for those wanting complete and detailed syntheses. However, it is important to note that this briefing is not a comprehensive review of all available evidence for this topic, as it is restricted to review-level evidence only.

Housing and health

The association between housing conditions and physical and mental ill health has long been recognised and there are a broad range of specific elements relating to housing that can affect health outcomes (reviewed by Bonnefoy et al., 2004). These include:

- Agents that affect the quality of the indoor environment such as indoor pollutants (eg asbestos, carbon monoxide, radon, lead, moulds and volatile organic chemicals)
- Cold, damp, housing design or layout (which in turn can affect accessibility and usability of housing), infestation, hazardous internal structures or fixtures, noise
- Factors that relate more to the broader social and behavioural environment such as overcrowding, sleep deprivation, neighbourhood quality, infrastructure deprivation (ie lack of availability and accessibility of health services, parks, stores selling healthy foods at affordable prices), neighbourhood safety and social cohesion
- Factors that relate to the broader macro-policy environment such as housing allocation, lack of housing (ie homelessness, whether without a home or housed in temporary accommodation), housing tenure, housing investment, and urban planning.

Although a substantial body of evidence exists that establishes the causal pathways between presence of indoor pollutants and adverse health outcomes (see for example Burr, 1999; Chauhan et al., 2003; Darby et al., 2005), the relationship between other housing aspects and health is less well defined. For example, there is limited evidence on the health impact of indoor temperature, the impact of indoor air quality on respiratory conditions, the affect of housing conditions on mental health outcomes and the health affects of chronic noise exposure. Likewise, there is relatively limited evidence on how community conditions affect health outcomes.

The World Health Organization LARES (Large Analysis and Review of European housing and health Status) project was initiated with the aim of identifying and comparing across eight European countries the existing health risks associated with a number of housing conditions. It will ultimately provide policy makers with an evidence base from which to identify housing policies that promote health and are environmentally sustainable. Preliminary results indicate a clear association between mental health and housing quality (particularly depression, anxiety and stress), which in turn is also related to problems of sleep disturbances and inadequate noise insulation (B. Croxford, University College London, personal communication, 2005).

It is likely that the causal link between housing and health works in both directions, with housing affecting an individual's health and health also affecting an individual's housing opportunities. There also appears to be a 'dose-response' relationship between poor housing and ill health, with increased housing deprivation at one point increasing the probability of ill health; and a sustained experience of housing deprivation over time further increasing the probability of ill health.

Finally, there appears to be a significant link between housing deprivation early in life and ill health in

adulthood, with poor housing in childhood associated with higher rates of hospital admissions and increased morbidity and mortality in adult life (Marsh et al., 1999).

Housing inequalities

The *English House Condition Survey* (ODPM, 2003a) is undertaken every five years and assesses the overall condition of the housing stock. For 2001, the survey reported:

- There were 21.1 million dwellings in England, of which 7 million do not provide decent homes. 5.6 million (80% of all non-decent homes) fail to provide an adequate level of thermal comfort; 2 million (27%) are in disrepair; 0.9 million (3%) are unfit and 0.5 million (7%) require modernisation. Non-decent housing stock remains concentrated mainly among older dwellings (51% of pre-1919 stock is non-decent) and flats
- Some 6.7 million households live in non-decent homes. Of these, 5.2 million households live in the private sector and 1.5 million are social tenants
- The most vulnerable people live in non-decent homes. Households that rent privately, people who live alone, ethnic minorities and households with no-one in full-time employment are most likely to be living in non-decent homes
- The majority (53%) of homes in poor neighbourhoods are non-decent and over a quarter are situated in areas of 'limited' demand.

Aspects of poor housing that can adversely affect health

Epidemiological studies have demonstrated strong associations between housing and health. However, this relationship is complex and the causal links between different dimensions of housing, neighbourhood environment and health can operate at a number of interrelated levels. Furthermore, poor housing conditions often coexist with other forms of deprivation (unemployment, poor education, ill health, social isolation etc), making it difficult to isolate, modify and assess the overall health impact of housing conditions. The evidence of the association between health and the different dimensions of housing and the wider physical and social environment is discussed below.

Neighbourhood deprivation

There is now broad consensus that an 'area effect' ie living in deprived, urban neighbourhoods, increases the risk of poor health, even after controlling for individual risk characteristics, such as poor socio-economic status (Diez Roux et al., 1997; Kawachi and Berkman, 2003).

A recent review by the Prime Minister's Strategy Unit (Strategy Unit, 2005) found that poor health in deprived neighbourhoods is in part driven by a series of social and environmental factors, such as:

- Poor housing and local environments
- Limited social networks
- Income, poverty and worklessness
- Poor local transport and access to services
- Low educational attainment
- Drug and alcohol misuse.

Damp

A number of descriptive epidemiological studies indicate that the occupants of damp homes have poorer average health (Evans, 2000; Packer, 1994; Somerville, 2000). Furthermore, a strong association has been found between damp, mouldy housing and an increased prevalence of respiratory conditions (particularly asthma) and skin problems (British Medical Association, 2003). This association is independent of the health effects of confounding variables such as low income, smoking and overcrowding. The strongest evidence for the causal links between damp and mould and poor health is among children, who have an increased risk of respiratory illnesses (Peat et al., 1998). Of particular concern is an increased risk of asthma, which can be caused by allergy to mould spores and house dust mites found in damp housing (Colloff et al., 1992).

Damp conditions can also aggravate existing respiratory conditions such as bronchitis and tuberculosis. Other agents which are detrimental to health, such as viruses and bacteria, may also thrive in moist conditions (Buckland and Tyrell, 1962; Hatch et al., 1976; Kingdom, 1960). Similarly, large-scale studies have indicated that mould is responsible for allergic reactions and respiratory conditions such as asthma, rhinitis and alveolitis (Burr et al., 1988; Hosen, 1978; Maunsell, 1954; Strachan and Elton, 1986).

There is much evidence that cold temperature is the main contributor to dampness (Collins, 1993; Markus, 1993), alongside a range of other factors such as substandard

construction materials, poor ventilation and inefficient heating (British Medical Association, 2003).

Cold

The Excess Winter Death Index (EWDI) is calculated by comparing the percentage of extra deaths in the four winter months (December-March) compared with the average for the non-winter seasons. In England between 1988 and 1997 the excess winter mortality rate was 19% (31,000 excess deaths). The majority of these deaths were due to ischaemic heart disease, strokes and other circulatory diseases, and respiratory disease (Healy, 2003). This was higher than countries with colder average annual temperatures – possibly because those countries are better prepared and equipped for cold conditions.

A regression analysis of excess winter deaths in England and Wales indicates that each degree Celsius by which the average winter temperature falls is associated with 8,000 more excess deaths (Curwen and Devis, 1988). There appears to be no association between socio-economic deprivation or social class and excess winter mortality (Lawlor et al., 2000, 2002; Donaldson and Keatinge 2003; Shah and Peacock, 1999; Van Rossum et al., 2001; Wilkinson et al., 2004), although 'it seems plausible' (Lawlor et al., 2002) that there would be a correlation.

However, studies have found that cold homes are an important contributing factor – lack of central heating is associated with higher excess winter mortality (Aylin et al., 2001). A report by the Joseph Rowntree Foundation (2001) on the impact of housing conditions on excess winter deaths found that the excess was greater in those people living in dwellings that appear to be poorly heated, in dwellings with low energy-efficiency ratings and in those predicted to have low indoor temperatures during cold periods. The risk was also greatest for those living in the oldest properties.

Apart from the likely contribution to excess winter deaths and hospital admissions, it has been increasingly recognised that cold housing may have adverse effects on health and quality of life. The World Health Organization recommended in 1984 that indoor temperatures should be between 18 and 24°C. However, people at particularly vulnerable ages may require warmer temperatures – older people may need to be slightly warmer if they have a sedentary lifestyle and newborn babies need slightly higher temperatures for the first few weeks (Collins, 1993).

Fuel poverty

Everybody who lives in cold damp homes is at risk of ill health but the most vulnerable (older people, children, disabled people and those with long-term illnesses) need to heat their houses for longer periods of time, and often they are the least able to do so, due to low income (fuel poverty) and thermally inefficient housing.

Fuel poverty is defined as a need for a household to spend over 10% of its income to achieve temperatures required for health and comfort. The second annual report of the UK Fuel Poverty Strategy (DEFRA, 2004) states that the number of fuel-poor households in England fell to 1.7 million in 2001, of which 1.4 million were considered vulnerable. The UK Fuel Poverty Strategy, which seeks an end to fuel poverty among vulnerable households by 2010, is an important public health intervention.

Indoor pollutants and infestation

A comprehensive review of the risks and health hazards of building fabric and indoor air quality indicated that the highest health risks were associated with hygro-thermal conditions, radon, house dust mites, environmental tobacco smoke and carbon monoxide (Raw, 2001). Short-term elevations in ambient particles are strongly associated with increased mortality and morbidity. Acute cardiopulmonary impairment is the main effect and vulnerable groups such as older people and asthmatics are most at risk (Holmes and Tuckett, 2000).

Home safety

Accidents can also be caused by poor housing conditions. Each year approximately 4,000 people in the UK die following injury in the home. Over a third of all adult injuries take place in the home. About one million children aged under 15 years attend accident and emergency departments as a result of injury in the home, and each week there are three deaths (British Medical Association, 2003). Injury rates for children in the lowest social class are more than three times those of children in the highest social class. Older people are also a risk group, with approximately 1,500 deaths a year in those aged over 65 following a fall in the home (British Medical Association, 2003).

Fire is another factor in non-fatal and fatal injury in the home. In 1999, over 72,000 domestic fires resulted in approximately 500 deaths and 14,600 injuries (Watson et al., 2000). Domestic fires are more prevalent in areas of low income, in those households with children and in

households in which the adults smoke (British Medical Association, 2003).

Those living in houses of multiple occupation and those in temporary accommodation are also at high risk of injury due to fire, burns and scalds.

Overcrowding

Overcrowding is another factor that can adversely affect health, although in common with other housing-related components, it can interrelate with other factors so that it is difficult to measure its precise effect. For example, overcrowding, family income, energy efficiency, design and location of the property may in turn influence other housing-related factors, such as damp, cold, noise penetration, smoking behaviour and indoor air quality.

Houses in multiple occupation (HMOs), are defined as a dwelling or converted residential building which is occupied by more than one household. In 2001, HMOs comprised 1.1 million dwellings and provided homes for 1.3 million households (ODPM, 2003a). There is evidence to suggest that those living in houses of multiple occupations are four times as likely to suffer injury and twice as likely to die in a fire as those in single dwellings (Dugdale and Draper, 1993).

Overcrowding has also been found to adversely affect mental health. In a study of adult women in West London, Gabe and Williams (1997) observed that the more crowded the dwelling, the greater the number of psychological symptoms reported.

Flat dwelling has been linked to social isolation, crime, reduced privacy and fewer opportunities for safe play for children (Burridge and Ormandy, 1993). There is some evidence that decreased levels of mental health are associated with increased housing height and multi-unit dwelling (Evans et al., 2000).

Housing tenure

Home ownership may provide a degree of security and control, although the direction of the relationship needs to be investigated further (Hiscock et al., 2000). There is cultural variation in the rate and meaning of home ownership across different countries and likewise the nature of the relationship varies internationally. Home ownership can also have a negative relationship on health. One study found that people who experienced difficulties in meeting mortgage repayments also suffered increased insecurity and poorer mental health (Nettleton and Burrows, 1998).

Quality of environment

The quality of the environment around the home is almost as important to health and wellbeing as the quality of the home itself. Almost 8 million people, just over 15% of the population of England, live in the most deprived areas. Within these neighbourhoods a cycle of decline operates, with some 0.5 million households affected by vandalism, graffiti and other forms of anti-social behaviour; 2.5 million dwellings affected by heavy traffic and parking; and 1 million dwellings having poorly maintained or neglected buildings, private gardens and public spaces (ODPM, 2003a).

Structural condition, cost of heating, location and design all influence the popularity of properties (private and public sector), which can then affect levels of vacant properties, household turnover, risk of accidents, fires, assaults and other crime. This can result in an unfortunate spiral, resulting in negative equity, high maintenance and operational costs, and concentrations of low income and vulnerable households.

Increasing polarisation in the UK housing market between owner-occupied and rental housing has contributed to an over-concentration and separation of households with high levels of need in areas with poor amenities (Acheson, 1998). The characteristics of such neighbourhoods are increasing spatial segregation, diminishing social housing, high rates of crime, low perceptions of trust, weakened social networks and poor access to services (Acheson, 1998).

A range of policy measures are being employed by the government to address the multiple dimensions of living in poor neighbourhoods (see 'UK policy context', p12).

Social cohesion and community safety

There is growing evidence of a relationship between social relationships and networks, and health. The concept of 'social capital' has been used to describe the degree of community cohesion and to define the different dimensions of this 'community resource' (reviewed by Morgan and Swann, 2004). It highlights the importance of social networks within a community as a determinant of quality of life.

The importance of social cohesion is best illustrated by the impact of 'fear of crime' in addition to experience of crime on physical and psychological health (Crime Concern, 1999). Victims of crime often suffer severe psychological distress and subsequent mental health problems, but the fear of crime can also alter people's lifestyle and affect their health (Crime Concern, 1999).

Homelessness

The health impacts of homelessness are particularly stark, with very high mortality rates, particularly for rough sleepers and hostel users, and high levels of health need (Acheson, 1998; Social Exclusion Unit, 2000).

The Centre for Housing Policy at the University of York found that when compared with the general population, single homeless people (whether living in temporary accommodation such as hostels or B&Bs or sleeping rough) were more likely to report having health problems and were also more likely to report having more than one health problem (Bines, 1994). More than a third of people living in hostels and B&Bs and well over a half of people sleeping rough reported having more than one health problem, compared with less than a quarter of the general population.

Likewise, homeless people were more likely to report having specific health problems such as musculoskeletal problems, difficulties with seeing or hearing, wounds, skin ulcers, chronic chest or breathing problems, digestive problems and headaches, compared with the general population. Of particular note was the disparity in mental health problems – depression, anxiety or nerves – which were reported by 40% of people sleeping rough compared with just 5% of the general population.

There were just over 97,000 households accepted as homeless by local authorities in England at the end of 2003/4, about 7% of which were in bed and breakfast accommodation (ODPM, 2004b).

Policy context

The government's commitment to promoting health and tackling health inequalities through policies concerned with housing, regeneration and sustainable development is clearly defined in *Tackling Health Inequalities: a programme for action* (Department of Health, 2003). It states that actions likely to have the greatest impact over the long term include improving social housing conditions and reducing fuel poverty among vulnerable populations. Furthermore, key interventions that will contribute to closing the life expectancy gap include improving housing quality by tackling cold and dampness. Similarly, those that will contribute most to closing the gap in infant mortality rates relate to improving housing conditions for children in disadvantaged areas.

Public health is an integral concern within urban planning processes relating to developments concerned with the physical and social environment. The planning system comprises different tiers. Central government issues national planning guidance to local authorities in addition to Regional Planning Guidance (RPG) based on advice from regional planning conferences. Regional Spatial Strategies are prepared by each English region and Local Development Frameworks by unitary and district councils. Local Strategic Partnerships have responsibility for ensuring an inter-agency approach to community planning, including the development of local housing strategies. Health impact assessment provides an important mechanism for ensuring the health consequences of housing and other environmental developments are fully considered at each of the different tiers within the planning system.

The public health aspects of key policies concerned with housing, regeneration and sustainable communities are summarised in Box 1.The government's key framework for securing a decent home for all is set out in the *Communities Plan* (ODPM, 2003b). The corresponding public service agreement target aims to bring all social housing into a 'decent condition' by 2010 (see Box 1). To be considered 'decent' a dwelling must:

- Meet the statutory minimum standard for housing (ie be fit)
- Be in a reasonable state of repair
- Have reasonably modern facilities and services
- Provide a reasonable degree of thermal comfort.

The Housing Health and Safety Rating System (HHSRS) is the government's new approach to the evaluation of the potential risks to health and safety from any deficiencies identified in dwellings. The HHSRS is evidence based – it is supported by extensive reviews of the literature and by detailed analyses of statistical data on the impact of housing conditions on health (ODPM, 2004a).

The government's *A new commitment to neighbourhood renewal: national strategy action plan* (Social Exclusion Unit, 2001) is viewed as a central focus for addressing the multiple aspects of deprivation experienced in the poorest areas. A recent review of this strategy by the Prime Minister's Strategy Unit stated that poor quality housing, badly maintained local environments, problems with anti-social behaviour and crime and disorder including drug and alcohol misuse, can cause instability in many deprived areas (Strategy Unit, 2005). This exacerbates local economic problems, as residents who are generally better skilled and educated move out, leaving behind increasing concentrations of deprivation. Areas of low housing demand are more likely to suffer crime, vandalism and litter and those living in social housing estates are five times more likely to perceive local disorder and antisocial behaviour as a problem. These problems are often compounded by social housing policies in which housing allocations can lead to further concentration of the most deprived in a particular area.

Box 1: Summary of the key government departments, policies and strategies relating to housing, regeneration, and sustainable development

Office of the Deputy Prime Minister *Housing Act 2004*	Aims to 'protect the most vulnerable in society and help create a fairer and better housing market'. Main provisions are: introduction of the new Housing Health and Safety Rating System, enabling local authorities to target the worst-condition properties; introduction of a mandatory licensing scheme for larger, higher risk houses in multiple occupation and discretionary powers for local authorities to license smaller multi-occupied properties; introduction of new powers to local authorities, enabling them to selectively license private landlords to help tackle low demand housing and the difficulties of anti-social behaviour.
Office of the Deputy Prime Minister *Supporting People programme 2003*	Designed to deliver housing-related support services to vulnerable people, such as the homeless, older people, people with mental health problems and physical disabilities, and victims of domestic violence. 'Supporting People' is a partnership of local government, service users and support agencies. For more information see www.spkweb.org.uk
Social Exclusion Unit *A new commitment to neighbourhood renewal: national strategy action plan, 2001*	The action plan sets out a 'new approach to renewing poor neighbourhoods', through delivery of economic prosperity, safe communities, high quality education, decent housing and better health to the poorest parts of the country. It aims to tackle social exclusion and deliver neighbourhood renewal, working across government departments to help them meet their Public Service Agreement (PSA) floor targets, in particular narrowing the gap in health, education, crime, worklessness, housing and liveability outcomes between the most deprived areas and the rest of England, with measurable improvement by 2010. Additional investment will be available through the Neighbourhood Renewal Fund and New Deal for Communities.
Department for Environment Food and Rural Affairs *The UK Fuel Poverty Strategy/Warm Front*	The Warm Front programme is the main grant-funded programme for tackling fuel poverty and aims to ensure that the most vulnerable in society can affordably heat their home. It seeks to improve the energy efficiency of the homes of vulnerable households; extend benefit entitlement checks to households in hard-to-heat homes; provide all eligible households with central heating and appropriate insulation; and encourage greater activity in areas where there are high proportions of fuel poverty. PSA target: Eliminate fuel poverty in vulnerable households in England by 2010 in line with the government's fuel poverty strategy objective.
NHS Modernisation Agency *National Enhanced Service for care of the homeless – service level agreement*	The National Enhanced Services (NES) are designed to provide more specialist services to meet the needs of vulnerable and previously under-served groups, such as homeless people, who are beyond the scope of essential services. Local authorities have a duty to carry out reviews of homelessness and produce strategies for tackling and preventing it. Additional investment aims to reduce rough sleeping and end use of B&B hotels as a form of temporary accommodation for homeless families with children.
Office of the Deputy Prime Minister *Communities Plan (Sustainable communities: building for the future* – ODPM, 2003b*).* Delivered through *Sustainable Communities: Homes for All* (five year strategy 2005) and *Sustainable Communities: People, Places, Prosperity* (five year strategy 2005)	The *Communities Plan* sets out the policies, resources and partnerships that will achieve the step change needed to continue the transformation of communities across England. It details the ways in which the government will tackle housing shortages in the South East and abandonment in the North and Midlands, and build thriving, sustainable communities in both urban and rural areas. It aims to support increasing home ownership, particularly for first time buyers, offering council and housing association tenants the chance to buy 'a stake' in their home. It also promotes a mix of housing tenure and encourages greater community engagement, through strengthening the role of local authorities and tenant associations. PSA target: By 2010, bring all social housing into a decent condition, with most of the improvement taking place in deprived areas and for vulnerable households in the private sector, and increase the proportion of people who live in homes that are in decent condition.
Urban and rural white papers (ODPM, 2000; DEFRA, 2000)	The two papers have different but complementary perspectives. The urban white paper has a strong emphasis on the government's regeneration agenda and outlines the rationale and programme that the government was undertaking to ensure that England's cities and towns would be attractive places in which to live and to work.
Office of the Deputy Prime Minister *Living places – cleaner, safer, greener* (ODPM, 2002)	Plan to create cleaner, safer and greener communities by improving the quality of planning, design, management and maintenance of public spaces and the built environment. PSA target: Lead the delivery of cleaner, safer and greener public spaces and improvement of the quality of the built environment in deprived areas across the country, with measurable improvement by 2008.

Methodology

The methodology used for this briefing is outlined below. For a detailed description of the HDA's Evidence Base methodology, refer to Swann et al., 2005.

Research question

This evidence briefing seeks to answer the following research question: what housing interventions are effective at improving health outcomes?

Literature search

An extensive and systematic search of the literature published since January 1996 was conducted by the HDA's health intelligence team in October 2004. A list of the search terms and strategy is shown in Appendix 1. All identified citations were imported directly into a Reference Manager file and duplicates were removed. To identify further review-level literature the following additional sources were consulted: the HDA's Housing and Health Reference Group – a number of key experts were asked to provide details of any relevant published or unpublished publications; a number of housing-related websites were searched (see below); and finally, the reference lists of all retrieved papers were screened.

The electronic databases and websites searched were:

Databases

- AMED
- ASSIA
- CINAHL
- Cochrane
- Current Contents
- DARE
- EMBASE
- HTA Database
- IDOX
- MEDLINE
- National Research Register
- PsycINFO
- ReFeR
- Regard (ESRC)
- Sociological Abstracts
- TRiP
- Urbadisc

Websites

- Info4local – www.info4local.gov.uk
- Housing Corporation – www.housingcorp.gov.uk
- Audit Commission – www.audit-commission.gov.uk
- University of Bristol, Centre for Urban Studies – www.bris.ac.uk/sps/research/cus/default.shtml
- University of Birmingham, School of Public Policy – www.publicpolicy.bham.ac.uk
- ESRC Centre for Neighbourhood Research – www.neighbourhoodcentre.org.uk/edu_conf.html
- Evidence Network – www.evidencenetwork.org/cgi-win/enet.exe/resourcesmain
- Queen Mary, University of London, Health Research Group – www.geog.qmul.ac.uk/health/publications/index.html
- Scottish Executive – www.scotland.gov.uk/Topics/Housing
- Health Evidence Bulletin Wales – http://hebw.uwcm.ac.uk
- National Guideline Clearinghouse – www.guideline.gov
- NHS Health Technology Assessment Programme – www.ncchta.org
- National Institute for Clinical Excellence – www.nice.org.uk
- Scottish Intercollegiate Guidelines Network – www.sign.ac.uk

Data-handling process

A total of 1,414 citation titles and abstracts were identified in the initial literature search. In addition, a further four papers were suggested by reference group members.

All citations were independently assessed by two of three reviewers as to whether the paper was likely to meet the requisite inclusion/exclusion criteria (described below). In the event that the two reviewers did not agree on a paper's inclusion, or no clear decision could be made on the basis of the title or abstract, the full paper was requested for retrieval. A further 11 papers were identified through manual searching of the bibliographies of retrieved papers. The abstracts of these papers were obtained and assessed for relevance by two independent reviewers. Seven of these papers were then requested for retrieval.

As a result of this process, a total of 62 papers were requested for retrieval. All papers requested for retrieval or identified by reference group members were then subjected to critical appraisal using the following inclusion/exclusion criteria:

Inclusion criteria

Papers were included if they were:

- Published between 1996 and October 2004
- Published in the English language
- Systematic reviews, meta-analyses, syntheses or review-level papers
- Reviews of housing interventions (defined below) that assessed health outcomes.

Definitions
For the purposes of this briefing we defined the 'house' as the usual residential home of an individual or family.

Interventions
All housing interventions, acting at either the macro- or micro-policy level were included, for example:

- Macro-level: central and local government-directed initiatives (provided they have either a housing focus or component) relating to:
  – Investment in housing
  – Investment in urban and housing planning (ie relating to any new or future housing)
  – Regeneration
  – Management of existing housing stocks, housing allocation, and re-housing
  – Evaluations of government programmes, policies or strategies relating to housing, provided that they operated at a national level, or if they evaluated a pilot study that was ultimately destined for national roll-out
- Micro-level: physical changes or improvements to the infrastructure or indoor environment of the house, eg:
  – Installation of heating
  – Heat and noise insulation
  – Double glazing
  – Changes to housing design or layout to improve accessibility or usability for older and/or disabled people etc
  – General refurbishment
  – Installation of air purifiers
  – Vacuuming, chemical treatments
  – Replacement of mattresses.

Outcomes
Papers were included if they reviewed housing interventions in which health-related outcomes or the economic costs of health-related outcomes were assessed. We included measures of both direct (eg physical and mental health outcomes) and indirect (eg increased levels of physical activity, smoking cessation, and installation of devices to reduce injury in the home) health outcomes. We also included measures of outcomes that relate to the wider, underlying determinants of health, which can include social, economic, cultural and environmental factors (Dahlgren and Whitehead, 2001).

Exclusion criteria

Papers were excluded if they:

- Examined the causal relationship between poor housing conditions and adverse health impact (for example, evidence of the harmful health effects of homelessness; poor heating; overcrowding or exposure to radon, lead, asbestos etc)
- Examined interventions in the workplace, hospital environment, supported or sheltered housing environments or other institutionalised care homes
- Examined interventions relating to the delivery of home-based clinical services, unless such interventions were supported by housing interventions (for example, interventions that sought to reduce exposure to air

allergens through educational campaigns were included if the intervention also supported the provision of bedding materials to reduce exposure; or interventions that sought to reduce the risk of accidental injury in the home through provision of educational materials were included if safety modifications to the home were also carried out)
- Examined interventions in developing countries (for example installation of mosquito screens on windows in countries in which malaria was prevalent)
- Assessed indirect health outcomes such as safety knowledge or allergen awareness.

Related reviews

There are a number of related HDA evidence briefings that have reviewed the evidence for effectiveness of interventions which may be of interest to readers of this briefing. These include:

- Reviews of interventions to reduce exposure to second-hand tobacco smoke in the home are assessed in *Public health interventions for the prevention and reduction of exposure to second-hand smoke: a review of reviews* (due for publication in 2005)
- *Ante- and post-natal home-visiting programmes: a review of reviews* (Bull et al., 2004).
- *Prevention and reduction of accidental injury in children and older people* (Millward et al., 2003).

Critical appraisal process

The critical appraisal process seeks to identify the extent to which the identified papers address both the briefing's research question and passes the requisite inclusion/exclusion criteria (detailed above) using the following threshold rules:

- Systematicity – does the review apply a consistent and comprehensive approach?
- Transparency – is the review clear about the processes involved?
- Quality – are the appropriate methods and analysis undertaken?
- Relevance – is the review relevant in terms of focus (ie populations, interventions and settings)?

A two-stage critical appraisal form (see Appendix 2) is used to guide reviewers in their identification of relevant papers. If a paper passes initial quality inclusion criteria (transparency and systematicity of review methodology), then the reviewer proceeds to an assessment of the quality and relevance of the findings section of each review paper. Only those papers passing both stages of the critical appraisal form are accepted for inclusion in the briefing.

However, in situations in which a paper passes all quality inclusion criteria but elicits a series of 'no' or 'unsure' responses to the 'relevance to the UK' section of the critical appraisal form it may also be accepted for inclusion in the briefing. In such cases, the findings and evidence statements produced would be subject to caveats that reflect the limitations associated with generalising the data. A prime example of this problem in relation to this briefing is that some review-level papers draw very heavily on US-based studies. In such situations generalising to settings outside the US would be limited in light of the differing healthcare systems and/or governmental structures – and the appropriate findings and evidence statements would be appropriately qualified.

For this briefing, a total of 62 papers were requested for retrieval and critical appraisal. However, five of these papers were not delivered within the timeframe allocated for this briefing, and have not yet been critically appraised: (Ambrose, 2001; Atkinson, 2004; Doyal, 2000; Evans, 2002; Marks and Allegrante, 2004).

The remaining 57 retrieved papers were critically appraised independently by two of five reviewers. There was no blinding of authorship of papers. The critical appraisal form was completed by each reviewer and a joint decision was made about whether or not the paper was to be accepted for the 'Findings' section. Papers not meeting the threshold for inclusion were discarded. Disagreements were resolved through discussion or, if necessary, by recourse to a third reviewer.

Presentation of findings

The critical appraisal process identified 15 review-level papers for inclusion in the Evidence Base. A summary of the findings for those papers which failed the critical appraisal process is shown in Appendix 3. All the accepted papers (referred to as Evidence Base papers) were compared and core themes identified. A summary table (Table 1) of all included papers is provided in the Evidence Base papers section of this briefing.

The key findings of the included papers were then collated and a narrative synthesis produced under the following core themes:

- Rehousing and neighbourhood regeneration
- Refurbishment and renovation.

A number of evidence statements about effectiveness of interventions were derived from the findings of the Evidence Base papers. It should be stressed that the evidence statements are not those of the review authors but are derived from our interpretation of their review findings and have been referenced accordingly. Each evidence statement categorises the evidence of effectiveness as follows:

- **Evidence of effectiveness:** derived from the review-level literature where the results were all in agreement
- **Currently, a lack of evidence of effectiveness:** applied to interventions in the review-level literature that showed no current impact on outcomes
- **Conflicting evidence:** derived from the review-level literature where the interpretation and/or conclusions of review papers and/or primary study papers incorporated within review paper/s were not in agreement.

A key remit of this briefing was to scrutinise the reviews for details on the effect on inequalities in health and on the cost effectiveness of the interventions. Where this information is available it has been described under the relevant themes and is also reflected in the evidence statements.

A number of gaps in the review-level evidence and associated research recommendations were also identified and these are presented on p42.

Peer review

A first draft of this briefing was sent to two peer reviewers and circulated to members of the housing reference group in February 2005 for comment. A number of changes were made in light of the feedback received.

Evidence Base papers

The following 15 review-level papers passed the critical appraisal process and were included onto the Evidence Base, which can be viewed at: www.publichealth.nice.org.uk. Characteristics of the studies included in the papers are shown in Table 1.

Anderson, L. M., St Charles, J., Fullilove, M. T., Scrimshaw, S. C., Fielding, J. E., Normand, J. and Task Force on Community Preventive Services (2003). Providing affordable family housing and reducing residential segregation by income. A systematic review. *American Journal of Preventive Medicine* 24 (3 Suppl): 47-67.

Anderson, L. M., Shinn, C., St Charles, J., Fullilove, M. T., Scrimshaw, S. C., Fielding, J. E., Normand, J., Sanchez-Way, R., Richardson, T. and Centers for Disease Control and Prevention (2002). Community interventions to promote healthy social environments: early childhood development and family housing. A report on recommendations of the Task Force on Community Preventive Services. *Morbidity and Mortality Weekly Report*: *Recommendations and Reports* 51 (RR-1): 1-8.

Centre for Reviews and Dissemination (1996a). Preventing unintentional injuries in children and young adolescents. *Effective Health Care* 2 (5). Available at: www.york.ac.uk/inst/crd

Centre for Reviews and Dissemination (1996b). Preventing falls and subsequent injury in older people. *Effective Health Care* 2 (4). Available at: www.york.ac.uk/inst/crd

Chang, J. T., Morton, S. C., Rubenstein, L. Z., Mojica, W. A., Maglione, M., Suttorp, M. J., Roth, E. A. and Shekelle, P. G. (2004). Interventions for the prevention of falls in older adults: systematic review and meta-analysis of randomised clinical trials. *British Medical Journal* 328 (7441): 680.

Coleman, P., Munro, J., Nicholl, J., Harper, R., Kent, G. and Wild, D. (1996). *The effectiveness of interventions to prevent accidental injury to young persons aged 15-24 years: a review of the evidence*. University of Sheffield: Medical Care Research Unit.

DiGuiseppi, C. and Higgins, J. P. (2001). Interventions for promoting smoke alarm ownership and function. *The Cochrane Database of Systematic Reviews*, Issue 2.

Gillespie, L. D., Gillespie, W. J., Cumming, R., Lamb, S. E. and Rowe, B. H. (2003). Interventions for preventing falls in elderly people. *The Cochrane Database of Systematic Reviews*, Issue 4.

Gotzsche, P. C., Johansen, H. K., Schmidt, L. M. and Burr, M. L. (2004). House dust mite control measures for asthma. *The Cochrane Database of Systematic Reviews*, Issue 4.

Lyons, R. A., Sander, L. V., Weightman, A. L., Patterson, J., Jones, S. A., Rolfe, B., Kemp, A. and Johansen, A. (2003a). Modification of the home environment for the reduction of injuries. *The Cochrane Database of Systematic Reviews*, Issue 4.

McDonald, E., Cook, D., Newman, T., Griffith, L., Cox, G. and Guyatt, G. (2002). Effect of air filtration systems on asthma: a systematic review of randomized trials. *Chest* 122 (5): 1535-42.

Sheikh, A. and Hurwitz, B. (2003). House dust mite avoidance measures for perennial allergic rhinitis: a systematic review of efficacy. *British Journal of General Practice* 53 (489): 318-22.

Thomson, H., Petticrew, M. and Morrison, D. (2001). Health effects of housing improvement: systematic review of intervention studies. *British Medical Journal* 323 (7306): 187-90.

Thomson, H., Petticrew, M. and Morrison, D. (2002). Housing improvement and health gain: a summary and systematic review. Occasional Paper 5.University of Glasgow: MRC Social and Public Health Sciences Unit.

Towner, E., Dowswell, T., Mackereth, C. and Jarvis, S. (2001). *What works in preventing unintentional injuries in children and young adolescents?* An updated systematic review. London: Health Development Agency.

Table 1: Characteristics of the review-level evidence of housing interventions that assess health outcomes

Author and year	Objective	Number and type of studies included	Setting	Participants	Intervention	Findings
Anderson et al. (2002, 2003)	To select and review evidence and summarise the recommendations of the Task Force on Community Preventative Services regarding community interventions that promote healthy social environments.	Studies had to: – Be based in the US – Include comparison of outcomes among groups of persons exposed to the intervention with groups not exposed to the intervention – Assess relevant health outcomes. Databases searched from 1965 to 2000.	US	All programmes reviewed were in urban areas and included families with children from low-income socioeconomic groups. Programmes that targeted older people or people with special health needs were excluded from the review.	The objective of the review was to assess the health impact of mixed-income housing programmes. Mixed-income housing is created either by moving higher-income households into lower socioeconomic status (SES) neighbourhoods, or by moving lower-income households to higher SES neighbourhoods, and there were two specific interventions selected for review that aimed to achieve these goals. The first seeks to create mixed-income housing development in low SES neighbourhoods by providing both market rate and subsidised housing units within multifamily rental properties, the second utilises a tenant-based rental voucher programme which provides lower-income families with housing subsidies that they can use within the private rental market.	No studies were identified that assessed effectiveness of mixed-income housing developments. A total of 23 articles and reports on tenant-based rental voucher programmes were included. Meta-analysis of six studies found that tenants' experiences of crime victimisation was reduced as a result of the programme as it provided families with the choice to move to neighbourhoods with reduced exposure to violence. There was insufficient evidence to support the effectiveness of rental voucher programmes in improving other health-related outcomes.
Centre for Reviews and Dissemination (1996a)	A systematic review of research evaluating the effectiveness of preventing unintentional injuries in young people (aged 0-14 years).	Three RCTs for the prevention of general home accidents were included and two RCTs for home interventions to prevent burns and scalds. Databases searched up to: not stated.	Interventions were in the UK, US and New Zealand.	Home environment interventions to prevent general home accidents – target group was young children, under 5 years (n= 640). Home interventions to prevent burns and scalds – target group was children, particularly under 3 years (n=807).	Home environment interventions included the use of safety devices such as smoke detectors, fireguards, stairgates, safety catches for cupboards, coiled kettle flexes, safety harnesses, safety film for interior glazing and thermostat controls for tap water.	The use of safety devices in the home such as smoke detectors has been shown to reduce the risks of home injuries. Other devices such as fireguards, stairgates, safety catches for cupboards etc have been associated with reduced risk. However, it is not clear what the efficacy of these are, and high risk sections of the population are the least likely to have access to these devices. Interventions designed to increase the use of smoke detectors have shown a small reduction in fire fatalities. The provision of thermometers with counselling was effective in reducing scalds. Local implementation of national mass media campaign can also result in a reduction in hot water temperatures.

Table 1: Characteristics of the review-level evidence of housing interventions that assess health outcomes (cont.)

Author and year	Objective	Number and type of studies included	Setting	Participants	Intervention	Findings
Centre for Reviews and Dissemination and (1996b)	To investigate the effectiveness of interventions to prevent falls and subsequent injury in older people.	Only RCTs evaluating the effectiveness of preventative measures on falls, fall-related injury or change in risk factor for falls were included. Nine RCTs were found that evaluated home assessments and surveillance interventions. Databases searched up to: not stated.	UK (two studies), North America (six studies) and Canada (one study).	Adults aged 60 years and over. Five studies recruited adults 70 years and over. Six of the studies had more than 100 people in the intervention group.	Home assessments and surveillance interventions involved visiting older people at home, assessing the safety of the home environment and a range of interventions such as safety checks, safety modifications, referral to care, and recommendations for exercise.	Home visiting to identify and remedy environmental and personal risks for falling may reduce the risk of falling. The type of safety changes included removal of throw rugs and objects in pathways, and installation of improved night lights and bath non-skid mats. Visits could be carried out by health visitors, nurses, occupational therapists or trained volunteers.
Chang et al. (2004)	To assess the relative effectiveness of interventions to prevent falls in older adults.	Only RCTs with a focus on primary prevention of falls in participants aged 60 or more were included. 40 RCTs were included in the meta-analyses. Databases searched up to 2002.	No details given.	14,598 participants aged >60 years were included. No further details presented.	Meta-analyses investigated multifactorial falls risk assessment and management, exercise, environmental modifications and education. Environmental modification programmes often comprised a home visit by a professional who checked for environmental hazards such as poor lighting or sliding carpets and recommended modifications. Some programmes also assisted with implementation of recommendations.	No clear evidence was found for the effectiveness of environmental modification programmes.
Coleman et al. (1996)	A systematic review of research into the effectiveness of interventions aiming to prevent accidents or minimise injury among adolescents and young adults aged 15-24 years.	Two studies of environmental engineering interventions in the home to prevent burn-related injuries were included (one cohort/case controlled study and one multiple time series/uncontrolled experiment). Three studies of home hazard identification and modification interventions were included (two cohort/case controlled studies and one multiple time series/ uncontrolled experiment). Databases searched up to 1994.	US, Sweden and Norway	Adolescents and young adults, aged 15-24 years. No further details presented.	Interventions were reviewed under the headings of road, work, home, and sports and leisure. The only home interventions relevant to this age group were measures to prevent burn-related injuries (smoke detector give-away programmes) and community approaches that include home hazard inspection and modification.	Environmental engineering measures in the home to prevent burn-related injuries and home hazard identification and modification programmes were both awarded an overall grade C, indicating that there was poor evidence to recommend support for these interventions and therefore these areas may require further research.

Table 1: Characteristics of the review-level evidence of housing interventions that assess health outcomes (cont.)

Author and year	Objective	Number and type of studies included	Setting	Participants	Intervention	Findings
DiGuiseppi and Higgins (2001)	To review the effectiveness of interventions to promote residential smoke alarms in increasing smoke alarm ownership, smoke alarm function, fires and burns and other fire-related injuries.	A total of 26 trials (13 RCTs and 13 non-RCTs) were included. Databases were searched up to 1998.	No details given.	The study population included parents, pregnant women, schoolchildren and older people. Cluster randomised controlled trials included general practices, school classes, prenatal and parenting classes, areas in deprived communities and physicians in training.	Interventions covered in this review were delivered in either clinical, home or school settings.	The review reported a significant reduction in fire-related injury rates following the provision of free smoke alarms – with or without installation compared with control. The authors do, however, note that highest baseline injury rates were used as selection criteria in one of the trials and this may account for some of the reported reduction. The authors also report a 'modest' non-significant effect associated with community injury prevention education interventions but no effect for community burn prevention education interventions.
Gillespie et al. (2003)	To assess the effects of interventions designed to reduce the incidence of falls in older people (living in the community, or in institutional or hospital care).	RCTs only were included (including RCTs in which the method of allocation to treatment or control group was inadequately concealed). 62 studies (21,668 people) were accepted for inclusion of which four investigated home hazard modification interventions. All studies had a one year follow-up. Databases searched up to January 2003.	Australia and France.	Participants included older people living in the community. Two of the studies had more women subjects (53% and 60%) and in one trial subjects had previously been hospitalised for a fall.	Home visit by health professional (doctor, nurse, physiotherapist, occupational therapist or social worker) assessing environmental hazards and supervision of home modifications. One study also included free installation of safety devices and an educational programme; another trial provided exercise, correction of visual deficiency and home hazard modification, either alone or in combination.	Home hazard assessment and modification that is professionally prescribed for older people with a history of falling is likely to be beneficial. However, home hazard modification for older people without a history of falling has unknown effectiveness.
Gotzsche et al. (2004)	To assess the effects of reducing exposure to house dust mite antigens in the homes of people with mite-sensitive asthma.	Only RCTs were accepted for inclusion. 49 trials were identified. 31 trials investigated physical methods, 10 assessed chemical methods and 8 trials a combination of physical and chemical. Databases searched up to June 2004.	Home environment. No other details given.	2,733 participants were included, all of whom had been diagnosed as having bronchial asthma by a physician.	Interventions included: – Chemical treatment (acaricides) – Physical (for example vacuum cleaning, heating, ventilation, freezing, washing, barrier methods, air filtration and ionisers) – Combinations of these. Length of intervention and follow-up varied from two weeks to one year.	There were no statistically significant differences either in number of patients improved, asthma symptom scores or in medication usage. Chemical and physical methods aimed at reducing exposure to house dust mite allergens cannot be recommended.

Table 1: Characteristics of the review-level evidence of housing interventions that assess health outcomes (cont.)

Author and year	Objective	Number and type of studies included	Setting	Participants	Intervention	Findings
Lyons et al. (2003)	To review the effect on injuries of interventions that have a primary focus on reducing physical hazards through modification of the home environment.	28 primary studies were included (13 RCTs, 14 controlled clinical trials and one combined before-and-after study). Databases searched up to 2002.	Not reported.	Study populations included families with children aged <5 years, independent community living older people, emergency department patients, parents and specialist physicians in training.	Interventions comprised one of three designs: a single component that directly modified the domestic environment; a combined approach where an educational strategy was included in addition to the environmental modification, or a combined approach that comprised environmental modification in addition to targeted nutritional deficiencies, fitness, exercise medication and medical conditions. Modifications to the home environment included: installation of grab bars, stair gates, handrails, fire guards or cupboard locks; reduction of hot water temperatures; repair of damaged flooring and stabilisation of flooring surfaces; and improvement in lighting levels.	There was considerable heterogeneity between trials in terms of study design, intervention and outcomes assessed, so the authors presented a narrative synthesis of findings. Four trials found that the risk of falling was reduced in older people with intervention compared with control. One study found a significant protective effect of the intervention for slipping and tripping compared with control. Two trials found inconclusive results and two studies found no significant effect of intervention.
McDonald et al. (2002)	To systematically review the evidence of randomised trials evaluating the effects of residential air filtration systems on people with asthma.	10 RCTs were identified. Databases searched up to 2000.	Home environment. No other details given.	The sample size ranged from 9 to 45 participants in each study, with a total of 216 people across all studies. Five studies enrolled adults only. One study included children only. Participants included symptomatic asthmatics, asthmatics with primarily house dust mite allergy and cat-allergic asthmatics.	Air filtration in the home using high-efficacy particulate air (HEPA) filters. Some interventions compared a HEPA filter with no filter, hypo-sensitisation (via avoidance and containment methods), cleaning and education.	Two trials found that air filters were associated with significantly fewer asthma symptoms. Two further trials found that air filters significantly reduced airway responsiveness. Meta-analysis using a fixed effects model of four trials found a significant improvement in symptoms scores with air filters compared with control. However, this result should be interpreted with caution as there was significant heterogeneity across trials.

Table 1: Characteristics of the review-level evidence of housing interventions that assess health outcomes (cont.)

Author and year	Objective	Number and type of studies included	Setting	Participants	Intervention	Findings
Sheikh and Hurwitz (2003)	To assess the benefits and harms of measures designed to reduce house mite exposure in the management of house mite sensitive allergic rhinitis.	Only RCTs were included, with four accepted. Databases searched up to 2000.	Home environment. No other details given.	A total of 122 subjects aged between four and 61 years of age (with evidence of house dust mite provoked respiratory disease). In three studies, subjects were required to have a proven diagnosis of house dust mite sensitive rhinitis.	The studies assessed the efficacy of chemical (acaricide) and physical (high efficiency particulate air filter and barrier bedding) interventions for reducing house dust mite load.	All trials resulted in statistically significant reductions in house dust mite load, although it is unclear whether these studies achieved clinically important reductions in symptoms. It is not possible to reliably estimate the magnitude or the clinical significance of this reduction as the trials all employed different medication and/or symptom scores, none of which have been formally validated or assessed for reliability.
Thomson et al. (2001, 2002)	To review the evidence on the health effects of interventions to improve housing.	19 completed primary studies were included. Of these, 11 were prospective in design (six of which employed a control group), and seven were retrospective in design (three of which employed a control group). An additional 14 ongoing UK-based studies were also identified. All primary studies were graded on a scale from level A (strongest evidence) to level C. Databases searched up to 2000.	Studies were conducted in the UK (13), the US (4), Japan (1) and Denmark (1).	A total of 6,537 participants across 19 studies.	Three UK studies examined the health impacts of rehousing based on medical need; 12 studies examined the health effects of rehousing or refurbishment and renovation (seven of which assessed housing improvement in the context of area or community regeneration); and four studies examined measures to improve energy efficiencies.	Evidence statements were restricted to those arising from higher quality studies (grade A or B). Only three grade B studies were found. The first study found a significantly greater reduction in anxiety and depression scores in people who had been rehoused on mental health grounds, compared with people who had not been rehoused. The second study found an initial increase in the number of illness episodes with rehousing from a slum area after nine months, although at 18 months there was a greater reduction in illness episodes after rehousing compared with the control. The third study found significant reductions in self-reported symptoms of joint pain, headache and neck or back pain after window replacement to improve energy efficiency compared with the control.
Towner et al. (2001)	To investigate the effectiveness of health promotion interventions in preventing unintentional injuries in childhood and young adolescence.	10 studies (five RCTs, one controlled trial and four before-and-after studies). Databases searched up to 2000.	The majority of studies targeted low income, poor housing or people at high risk of injury. Studies were conducted in the US, UK and Australia.	All studies targeted children aged under five years, with the exception of one study that targeted children and young adolescents (0-16 years). The total number of participants is unknown as studies list individuals, families, households and GP practices.	Interventions designed to prevent general accidents in the home (including falls, burns and scalds, lacerations, electrocution and drowning).	Home assessments and the provision of home safety equipment can achieve some positive benefit, but overall results are inconclusive. Interventions had little impact on the rates of injury observed. Many families provided with safety devices use them in an attempt to make their homes safer. However, a study looking at prevention of falls from windows (with free window guards) reported a decrease in falls.

Findings

REHOUSING AND NEIGHBOURHOOD REGENERATION

Medical priority rehousing

Health effects of housing improvement: systematic review of intervention studies (Thomson et al., 2001); Housing improvement and health gain: a summary and systematic review (Thomson et al., 2002)

This systematic review (reported in two publications), identified a total of 19 completed primary studies and an additional 14 ongoing studies based in the UK (see Table 1). The authors graded the strength of evidence from each primary study on a scale from A (strongest evidence; prospective studies with a follow-up rate of >80% and >6 months and objective assessment of health outcomes) to C (prospective and retrospective studies that did not adjust for confounding factors). Evidence-based conclusions of the review were restricted to consideration of studies graded as A or B. Of the 19 identified studies, none were graded as A, three were graded as B and 16 were graded as C. We have presented the results of all 19 studies in this briefing and, in agreement with the strategy adopted by Thomson et al., we have restricted our evidence statements to those arising from the higher quality grade B studies.

Three primary studies were identified that assessed health outcomes from rehousing on the basis of medical need. The first study, a prospective, controlled observational study (56 people; grade B) from the UK found a significantly greater reduction in anxiety and depression scores in people who had been rehoused by their council on mental health grounds, compared with people who had not been rehoused (anxiety: -6.5 vs -0.6, p=0.0003; depression: -6.0 vs -1.5. p=0.005). However, the study was small and there was no control for potential confounding factors.

The second study was a retrospective cross-sectional study from the UK (grade C). It found significant improvements in self-reported health status in people who had been rehoused by their council compared with people who were awarded priority but had not yet been rehoused (Nottingham Health Profile scores [rehoused vs not rehoused] energy: 44.8 vs 63.4; pain: 30.6 vs 44.4; emotion: 26.2 vs 44.5; all: $p<0.05$). Of those people with mental health problems, 56% (number not stated) reported an improvement in their mental health after rehousing.

The third study was a retrospective cross-sectional study based in the UK (grade C). It found that 57 of 151 (37.7%) households surveyed reported improvements to their health two to three years after rehousing. The most common reason (56.5%) given by rehoused residents for their health gain was due to a 'lack of stairs' (one third of those rehoused had been moved because of osteoarthritis).

There is review-level evidence that anxiety and depression scores are reduced in people who are rehoused on the basis of medical need (Thomson et al., 2001, 2002).

Rehousing plus relocation from slum or socially isolated areas

Health effects of housing improvement: systematic review of intervention studies (Thomson et al., 2001); Housing improvement and health gain: a summary and systematic review (Thomson et al., 2002)

For background on Thomson et al., (2001, 2002) and the study grades referred to see p24. This review (reported in two papers) identified three primary studies that assessed health outcomes from rehousing from a slum area.

The first study, a prospective, controlled study from the US (1,000 people; study grade B) found an initial increase in the number of illness episodes with rehousing from a slum area compared with controls after nine months (+301.2 vs +261.4 episodes per 1,000 persons; significance not stated). At 18 months, however, there was a greater reduction in the number of illness episodes with rehousing compared with the control (rehousing vs control: -129.9 vs -100.9; significance not stated). There were also greater improvements in social adjustment and mental health outcomes with rehousing (rehousing vs control – sit and talk: 11.1% vs 1.9%; positive mood: 13.6% vs 10.6; satisfaction with status quo: 23.3% vs 19.5%; significance not stated for any of these outcomes).

The second study, a prospective controlled study from the UK (grade C), found that age-standardised mortality rates increased in the rehoused population (22.91 vs 26.10 per 1,000) but fell in the slum area (26.1 vs 22.78) after five years. Although infant mortality rates fell in both groups, the decrease was more pronounced in those rehoused compared with those in the slum area (infant mortality rates rehoused vs slum area: -54.8 vs -39.2; significance not stated). Rents in the improved area also doubled compared with the slum area, which adversely affected households' ability to buy quality food. The quantities of different food groups consumed failed to meet the British Medical Association's Scale of Minimum Diets (set out in the 1930s), although these deficiencies were more extreme in the intervention group (results not presented).

The third study (167 people) was a retrospective controlled study (grade C) from the US that assessed hospital outpatient visits before and 12 months after rehousing. It found that among children (0-9 years) there was a significant reduction in outpatient visits after rehousing (all causes: -1.667 vs -0.130, p=0.03; housing related visits: -0.963 vs 0.020, p=0.05). There were no significant differences in outpatient visits across other age groups. There was also a significant reduction in housing-related visits among rehoused women (-0.538 vs 0.120, p=0.02) but not men. However, this result should be interpreted with caution as the review authors note that the groups also differed significantly at baseline.

Thomson et al. also identified a number of studies that assessed health outcomes after rehousing from a socially isolated area or substandard housing. The first study was a prospective controlled study (grade C) from the US that assessed self-reported health outcomes before and eight years after rehousing. It found that self-reported ratings of 'good' or 'excellent' health fell significantly more in the control group compared with the intervention after eight years (fall in self-reported health rating of good or excellent, intervention vs control: -13% vs -28%, p=0.02). There was also a greater increase in the proportion of people who reported low life satisfaction from baseline to eight years with intervention compared with control (intervention group: 17% vs 18%; controls: 10% vs 38%; significance not stated).

One small (23 women, grade C) prospective, uncontrolled study from the US assessed mental health outcomes five months to three years after rehousing. It found a significant reduction in psychological distress both at first follow-up and after three years compared with pre-move measures (mean Psychiatric Epidemiological Research Instrument [PERI] score: 31 pre-move vs 22.6 at five months, t=4.00, p<0.001; 31 pre-move vs 23.22 at three years, t(22)=4.19; p<0.001).

There is review-level evidence that rehousing people from slum areas can improve self-reported physical and mental health outcomes in the longer term (18 months).

There is also review-level evidence that rehousing people from slum areas can adversely affect self-reported health outcomes in the short term (9 months).

Currently, there is a lack of review-level evidence on the effectiveness of rehousing from a socially isolated area or substandard housing in improving health.

(Thomson et al., 2001, 2002)

Rehousing or housing improvement plus neighbourhood regeneration

Health effects of housing improvement: systematic review of intervention studies (Thomson et al., 2001); Housing improvement and health gain: a summary and systematic review (Thomson et al., 2002)

For general background on Thomson et al. (2001, 2002) and the study grades referred to see p24. This review (reported in two papers) identified five studies from the UK that assessed health outcomes after interventions involving rehousing or housing improvement combined with neighbourhood regeneration initiatives.

The first study was a prospective uncontrolled study (study grade C) that assessed health outcomes before and five years after a comprehensive intervention involving refurbishment, neighbourhood renewal, and improvements to security and safety in the area.
It found that after the intervention there were both improvements and impairments to health outcomes. Positive health outcomes included:

- A significant reduction in the proportion of people with a self-reported mental health problem (before vs after intervention: adults 52% vs 41%, $p<0.05$; children 21% vs 2%, $p<0.05$)
- A significant reduction in the proportion of people reporting 'trouble with nerves' (before vs after intervention: 20% vs 10%, $p<0.05$)
- A significant reduction in the proportion of smokers (before vs after intervention: 72% vs 28%, $p<0.001$)
- A significant increase in the proportion of people who regarded the area as very/quite safe (before vs after intervention: 25% vs 50%, $p<0.001$).

Adverse health outcomes included:

- A significant reduction in self-reported ratings of good general health status (before vs after intervention: 53% vs 51%, $p<0.01$)
- An increase in chronic respiratory conditions (before vs after intervention – adults: 32% vs 44%, $p<0.05$; children: 23% vs 26%, $p>0.05$).

The second study was also a prospective uncontrolled study (grade C). It assessed health outcomes before and one to four years after an intervention involving rehousing or housing improvement plus area regeneration. It also found that there were both improvements and impairments to health outcomes with the intervention. Positive health outcomes with the intervention included significant reductions in:

- Aches and pains (before vs after intervention: 23% vs 12%; $p=0.0004$)
- Asthmatic and bronchial symptoms (17% vs 6%, $p=0.0001$)
- Stress and depression measures (6% vs 1%, $p=0.002$)
- Use of GP services (74.6% vs 59.4%, $p<0.0001$)
- Prescription use (65.4% vs 51.0%, $p=0.0002$)
- Use of casualty or outpatient services (20% vs 5%, $p<0.0001$)
- Number of illness days (per person, per day: 0.37 vs 0.05).

There were also significant improvements in general feelings of safety (46.7% vs 72.0%, $p<0.0001$); feelings of a sense of belonging to community and social networks, and significant reductions in concerns about criminal activity and behaviour of young people. There was no difference in dietary and digestive disorders (12% vs 15%, $p=0.3$), or in the purchase of proprietary medicines (25% vs 26%, $p=0.8$), after the intervention.

Adverse health outcomes included:

- An increase in illness episodes (from 0.0036 to 0.0056/person/day [a 56% increase], significance not stated) which was in part due to a flu epidemic
- A significant increase in coughs and colds (before vs after intervention: 42% vs 67%, $p<0.0001$).

Residents also reported significantly decreased access to health and hospital services.

The third study used a mixed cross-sectional and prospective design (grade C) to assess health outcomes before and one year after a refurbishment and community regeneration initiative. It found a significant reduction in anxiety and depression scores after one year (Hospital Anxiety and Depression Scale [HADS] scores for anxiety: 8.2 vs 5.8, $p<0.05$; HADS scores for depression: 5.4 vs 3.6, $p<0.05$). There was a non-significant increase in self-esteem scores (Rosenberg Scale Scores for self-esteem: 53.1 vs 57.5, $p<0.1$). There were also a number of improvements in neighbourhood involvement after the intervention: residents were more likely to attend residents' association meetings (before vs after: 3% vs

19%, significance not stated), and they were more likely to recognise neighbours (55% vs 74%, significance not stated).

The fourth study was a retrospective controlled study (grade C) that compared prescribing practices of two GP practices that covered either a regeneration area or control areas that were matched for population, Townsend score and social class (obtained from census data). It found that two to seven years after the intervention, hypnotic prescribing was reduced in the practices that covered the regeneration area compared with the control area (-10.85 vs +1.9, significance not stated). Prescriptions of anxiolytics also fell in one intervention practice compared with the control area (Area A: -0.45, Area B: -25.56 vs control area: +16.22, significance not stated), although there were mixed results for antidepressant prescribing (A: +29.88, B: +53.59 vs +55.57). The study also found no beneficial effect of housing renewal on respiratory prescribing (A: +4.75, B: +18.11 vs 4.4, significance not stated). The review authors note that factors other than area regeneration may account for these changes.

The fifth study was a retrospective cross-sectional study (160 people; grade C) from the UK that assessed health outcomes 6-12 months after rehousing. It found significant reductions in both the number of visits to GPs (before vs after: 86% vs 69%, p=0.003) and in the number of frequent users (>6 GP visits per year, before vs after: 38% vs 22%, p=0.01) after rehousing. There were also large reductions in residents' sense of isolation (before vs after: 19% vs 6%), fear of crime (60% vs 16%), problems with traffic (39% vs 22%) and an increased involvement in community affairs (14% vs 21%) after rehousing.

One additional study from the UK was described in Thomson et al. (2002) that had been excluded from the first publication. The study was a small, retrospective cross-sectional study (28 people; grade C) that found that residents associated rehousing with health improvements and decreased stress levels.

Currently, there is a lack of review-level evidence of effectiveness of interventions involving rehousing or housing improvement combined with neighbourhood regeneration initiatives in improving health outcomes.
(Thomson et al., 2001, 2002).

Housing subsidy programmes for low-income families

Community interventions to promote healthy social environments: early childhood development and family housing. A report on recommendations of the Task Force on Community Preventive Services (Anderson et al., 2002); Providing affordable family housing and reducing residential segregation by income: a systematic review (Anderson et al., 2003)

This systematic review (published in two publications) was part of a larger series of evidence reviews on the effectiveness of socio-cultural factors that influence health. Although the first publication focused on both early childhood development and family housing interventions, only results of interventions relating to housing are presented here.

The authors identified 'neighbourhood living conditions' as an intermediate indicator along a causal pathway that directly links resources in the social environment to health outcomes. It was found that residential segregation of poor households may have a significant adverse affect on individual social, economic and health outcomes. The objective of the review was to assess the health impact of mixed-income housing programmes. Mixed-income housing is created either by moving higher-income households into lower socioeconomic status (SES) neighbourhoods, or by moving lower-income households to higher SES areas.

There were two interventions selected for review that aimed to achieve these goals. The first sought to create mixed-income housing developments in poverty neighbourhoods (defined as a community in which >20% of households have an income below the federal poverty level) by providing both market rate and publicly subsidised housing units within multifamily rental properties. The second provided lower-income families with housing subsidies in the form of rental vouchers that they could use in the private rental market, giving them access to higher income neighbourhoods. Studies were included if they assessed effectiveness either of mixed-income housing developments or rental voucher programmes, were carried out in the US and were published since 1965. Consequently, an important limitation of this review is that the findings may not be applicable outside the US. Outcomes assessed included:

- Housing hazards (defined as substandard housing conditions that pose health and safety risks)

- Neighbourhood safety (defined as intentional injuries, victimisation from crime, crime against person and property and social disorder)
- Social isolation and social and health risks (defined as unemployment, school drop-out rates)
- Mental or physical health status (defined as physical or psychological morbidity and unintentional injury).

No studies were identified that assessed the effectiveness of mixed-income housing developments. A total of 12 studies (reported in 23 publications) on rental voucher programmes were identified. Five studies reported on neighbourhood safety and found that tenant's experiences of crime victimisation was reduced within an average of six months after implementation of the programme as it provided families with the choice to move to areas with reduced exposure to violence (median effect size for household member victimised by crime: -6% [range from -22% to +6%], significance not stated). Four studies found an overall median reduction in neighbourhood social disorder (median change: -15.5% [range from -89% to -3%], significance not stated). One study compared neighbourhood murder rates between neighbourhoods of origin versus neighbourhood to which households relocated and found a decrease of 52% (significance not stated). However, it should again be stressed that these results may not be applicable outside the US.

There was insufficient evidence to support the effectiveness of rental voucher programmes in improving any of these health-related outcomes: substandard housing conditions; behavioural problems in school or at home, delinquent acts or arrests for either violent or property crime; self-reported symptoms of depression and anxiety; self-rated health status; use of preventive or medical services by children.

There is review-level evidence from the US that rental voucher programmes can improve household safety by providing families with the choice to move to neighbourhoods with reduced exposure to violence.

Currently, there is a lack of review-level evidence on the effectiveness of rental voucher programmes in improving other health-related outcomes.

Currently, there is a lack of review-level evidence on the effectiveness of interventions involving mixed-income housing developments in improving health outcomes.

(Anderson et al., 2002, 2003)

REFURBISHMENT AND RENOVATION

General refurbishment

Health effects of housing improvement: systematic review of intervention studies (Thomson et al., 2001); Housing improvement and health gain: a summary and systematic review (Thomson et al., 2002)

For general background on Thomson et al. (2001, 2002) and the study grades referred to see p24. The authors identified one retrospective uncontrolled study (345 people; study grade C) from Japan that assessed health outcomes 6-24 months after improvements to housing conditions (ranging from a new bed to major renovation). An important limitation of this study is that the findings may not be applicable outside Japan. It found that 34% of respondents reported an increase in activity levels with the intervention (compared with 42% who reported no change in activity levels and 7% who reported a decline in activity levels; significance not stated). Alterations to residential entrances and approaches were most closely associated with improvement in daily activities. The study also found that carers' workload declined in 39% of cases with the intervention (compared with 36% no change, 3% increased) and also found a 40.3% reduced likelihood of hospitalisation (no further details reported).

Currently, there is a lack of review-level evidence of the effectiveness of interventions involving general refurbishment initiatives at improving health outcomes (Thomson et al., 2001, 2002).

Improvement in housing energy efficiency measures

Health effects of housing improvement: systematic review of intervention studies (Thomson et al., 2001); Housing improvement and health gain: a summary and systematic review (Thomson et al., 2002)

For general background on Thomson et al. (2001, 2002) and the study grades referred to see p24. Four studies that assessed health outcomes after interventions to improve housing energy efficiency measures were found.

The first study was a large prospective controlled study (641 people; study grade B) from Denmark that assessed

health outcomes before and nine months after window replacement. It found significant reductions in self-reported symptoms of joint pain (OR=0.28, p<0.01), headache (OR=0.72, p<0.01), and neck or back pain (OR=0.18, p<0.01) with the intervention. However, a large number of people were lost to follow-up in this study (31% at three to nine months), limiting the reliability of these results.

The second study was a prospective uncontrolled study (72 schoolchildren; grade C) from the UK that assessed health outcomes before and three months after the installation of central heating. It found a significant reduction after the intervention both in respiratory symptoms (p<0.001) and the number of days lost per 100 school days because of asthma (before vs after the intervention: 9.3 vs 2.1, p<0.01). There was no significant difference in the number of school days lost for other reasons before and after the intervention (days lost per 100 school days before versus after intervention: 1.4 vs 3.2, p>0.05).

The third study was a prospective controlled study (254 households; grade C) from the UK that assessed health outcomes before and up to 12 months after initiation of a 'heat with rent' programme. It should be noted that follow-up at 12 months was only 30%. It found no significant difference in the overall mean number of symptoms reported before and after the intervention (results not presented). However, there was a significant increase in the number of self-reported aches and pains in the intervention group after heat installation compared with before (before vs after: 9.1 vs 25.5, p<0.05). Change in the reported level of dampness was significantly associated with change in reporting of 'runny nose' (t=2.41, p<0.01).

The fourth study was a retrospective controlled study (275 people; grade C) from the UK that assessed health outcomes after an intervention to improve energy efficiency measures in tower blocks. It found that people living in improved housing had significantly higher health status scores (SF36 test) on two of the eight dimensions: 'physical role' (mean 87.7 vs 73.9, p=0.003) and 'energy and vitality' (mean 59.9 vs 51.9, p=0.014). There was no significant difference in measures of physical function, emotional role, social function, mental health, pain, or general health perception.

There is review-level evidence that housing interventions to improve energy efficiency, such as installation of new windows, can positively affect health outcomes (Thomson et al., 2001, 2002).

ACCIDENTAL INJURY PREVENTION

Children and young adults

Effectiveness of interventions to prevent accidental injury in young persons aged 15-24 years (Coleman et al., 1996)

This review examined the effectiveness of community approaches to accident prevention. It should also be noted that although this systematic review is of a high standard methodologically the reporting of study details is often poor.

Three studies were identified that reported results of relevance to the 15-24 years age group (two cohort/ case-controlled studies and one multiple time series/uncontrolled experiment, with or without the intervention). These studies comprised interventions involving education, inspection, and environmental and engineering modifications to the physical home environment.

The multiple time series/uncontrolled experiment was a major community intervention programme in a rural municipality in Sweden and involved the cooperation of local authorities, agencies and individual citizens. While there were some methodological difficulties in comparing accident rates between two areas, the study was unique in reporting outcomes specifically to the 15-24 years age group. A fall in accidents was reported in the home following the intervention period. One of the cohort/case-controlled studies, the 'Safe Block' project, was carried out in the US and involved a poor urban minority population in Philadelphia. Coleman et al. (1996) did not present any detail on the remaining study.

No further information or findings of these studies were presented. The review authors evaluated the three studies and graded the overall strength of recommendation. The two cohort/case controlled studies were awarded a grade C, indicating that there was poor evidence to support the use of this intervention and the multiple time series/ uncontrolled experiment in Sweden was awarded a grade B, indicating that there is fair evidence to support this intervention. Home hazard identification and modification programmes were awarded an overall grade C indicating that there was poor evidence to recommend support for these interventions.

Modification of the home environment for the reduction of injuries (Lyons et al., 2003)

This systematic review identified 28 primary studies (13 RCTs, 14 controlled clinical trials and one combined before-and-after study) that examined the effect on injuries of interventions that had a primary focus on reducing physical hazards through modification of the home environment. The review did not include interventions to promote smoke alarm ownership and function; interventions relating to items within the home that did not form part of the building structure (such as household chemicals brought into the home, firearms etc); or interventions unrelated to building structure (such as hip protectors for older people, medicines etc).

Study populations included families with children aged under five years, independent older people, emergency department patients, parents, and specialist physicians in training. Interventions comprised one of three designs: a single component that directly modified the domestic environment; a combined approach where an educational strategy was included in addition to the environmental modification; or a combined approach that targeted nutritional deficiencies, fitness, exercise medication and medical conditions in addition to environmental modification. Modifications to the home environment included installation of grab bars, stair gates, handrails, fire guards or cupboard locks; reduction of hot water temperatures; repair of damaged flooring and stabilisation of flooring surfaces; and improvements in lightings. Outcomes assessed were either direct or indirect measures of injury in the home (such as number of falls, hospital admission, medical attendance), or measures of hazard reduction (such as measures of safety knowledge, possession, use and compliance of safety equipment). Results relating to hazard reduction are not presented here, as they are not within the scope of this briefing (see inclusion/exclusion criteria in the methodology section). There was considerable heterogeneity between trials in terms of study design, intervention and outcomes assessed, so the review authors presented a narrative synthesis of findings.

Three studies reported data on injuries in children. Two of these found no significant difference in injury occurrence with the intervention compared with the control (frequency of ≥1 medically attended injury: OR 0.97, 95% CI 0.72 to 1.30; ≥1 attendance at an accident and emergency department for injury: OR 1.02, 95% CI 0.76 to 1.37; ≥1 primary care attendance for injury: OR 0.69, 95% CI 0.42 to 1.12). Between-group comparisons were not reported for the third trial.

One study assessed injuries in the general population. It found no significant difference in injury rates between intervention and control for people aged 0-18 years (injury mechanisms or rates for: 0-18 year olds, RR 0.79, 90% CI 0.60 to 1.06).

Preventing unintentional injuries in children and young adolescents (Centre for Reviews and Dissemination, 1996a).

This systematic review identified seven trials that examined the effect of interventions that had a primary focus either on reducing general home accidents (three RCTs) or on preventing burns and scalds in the home (three RCTs, and one controlled trial) through modification of the home environment. The review included interventions if they related solely or in part to the prevention of unintentional injuries in children and adolescents (0 to 14 years) and if they were designed to prevent accidents or reduce the impact of accidents. Settings covered included the road, home and leisure environments, and the broader community. Only those findings relating to the home environment are presented here.

All of the interventions reviewed were multi-component interventions comprising environmental modification strategies in addition to educational strategies (such as personalised counselling and provision of information materials). Modifications to the home environment included provision of free electrical-outlet covers and door catches, reduction of hot water temperatures and provision of smoke detectors. Results were collated in a narrative synthesis.

Three RCTs focused on reducing general home accidents for children and young people. The first RCT found that more people from a low socio-economic area in the UK made physical changes to make their homes safer after the intervention (provision of a copy of a campaign booklet, assessment of physical hazards in the home and advice on how to reduce hazards) compared with the control (families told about campaign and sent a reminder) (proportion of people making physical changes to their home: 60% intervention vs 9% control; significance not stated).

Two further RCTs were based in primary healthcare settings in the US, so the findings may not be applicable to settings in other countries. The first RCT found no difference in the number of observed hazards between intervention (personalised counselling session, provision of literature on prevention of injuries, provision of outlet covers and door catches and household hazard assessment) and the control (household hazard assessment) (results not presented). There was, however, evidence of safety proofing in the intervention group (70% of people made at least one change), although comparative results for the control group were not presented. The second RCT found a significant increase in the use of electrical-outlet covers in both the intervention group (education and provision of free safety devices/outlet covers and cupboard catches and instructions on use) and the control group (provision of free safety devices/outlet covers and cupboard catches and instructions on use) (between-group comparisons not presented).

Two studies were identified that focused on reducing burns and scalds. The first RCT found no significant difference in the proportion of people reporting use of lower water temperatures between the intervention (healthcare counselling and literature on safe domestic hot water temperature, provision of a free thermometer, and home visits to assess water temperatures) and the control (pamphlet and discussion about tap water scald prevention and home visits to assess water temperatures). The second RCT found that more people had safe hot water temperatures with the intervention (education session and discount coupons for smoke detectors) compared with the control (standard health and safety information) (% of people with safe hot water temperatures: 65% with intervention vs 0% with control; significance not reported).

What works in preventing unintentional injuries in children and young adolescents? An updated systematic review (Towner et al., 2001)

This systematic review updated two earlier reviews to examine the role of education, environmental modification and legislation and combinations of these approaches in prevention of injury in children aged 0-14 years. Ten studies evaluated interventions designed to prevent general accidents in the home (including falls, burns and scalds, lacerations, electrocution and drowning). Of these studies, five were RCTs, one was a controlled trial and four were before-and-after studies. All of the studies targeted children under five years except one (0-16 years) with a focus on low income, poor housing or high risk areas in the US, UK and Australia.

The interventions were delivered in a range of settings and involved a variety of approaches. Three studies included individual counselling on home safety delivered in healthcare settings and in two of these low-cost home safety devices such as cupboard catches and electric socket covers were provided free. One study carried out in a high risk area in the US focused on the prevention of falls from windows and included the distribution and installation of window guards. Of the five UK studies, two provided smoke alarms at low cost, two ran local mass media campaigns with targeted home visits on home safety and one provided a home safety equipment loan scheme.

A range of outcome, impact and process measures were used to assess the effect of the various interventions. These included recorded attendance at hospital A&E departments following injury, medically attended injuries (where children were seen either by family doctors or where they attended A&E departments), information from hospital records, self-reported injuries or mortality statistics for the specific causes involved. Other outcome data reported included home hazards before and after the intervention (using absolute numbers of hazards recorded or using hazard check lists), changes in specific hazards such as hot water temperatures, use of safety equipment and programme reach. The quality of the evidence was assessed using a published quality rating scale used by the Centre for Reviews and Dissemination at the University of York. Quality was mixed: two studies were rated as good, two as good/reasonable, three as reasonable and three as reasonable/weak.

The results of these studies suggest that counselling, media campaigns, home assessments and the provision of home safety equipment can achieve some positive benefit but, overall, results are inconclusive. One study (4,200 families) found that the provision of free window guards did reduce the number of falls from windows (31% decrease in reported falls and a 35% decrease in mortality due to falls; significance not stated).

Where injury data were reported, results suggest that interventions had little impact on the rates of the injury observed. Three studies were unable to demonstrate that interventions led to any reduction in the number of

children seeking medical attention after accidents in the home (trial 1: no significant differences in injuries before and after intervention; trial 2: home accidents in children under five decreased by 10% but not able to demonstrate effect on injury outcomes; trial 3: no significant differences between intervention and control groups for medically attended injuries).

However, the interventions appeared to have some effect in terms of achieving behavioural change. Several studies indicated that home hazards were reduced in intervention homes at follow-up visits. One study reported that 60% of intervention families had made some change to improve home safety compared to 9% of controls and another study reported an overall reduction in hazards in study homes and a reduction in mean hot water temperatures at follow-up visits. Finally, several studies also reported that if families are provided with free or low cost safety equipment they are likely to use it.

There is review-level evidence that home visits to people in lower socioeconomic areas plus provision of advice on home hazards, combined with health education and media campaigns, are effective in encouraging parents to make physical changes to the home environment to make their homes safer (Centre for Reviews and Dissemination, 1996a).

There is review-level evidence that the provision of free or discount home safety equipment and/or educational campaigns may lead to behavioural and environmental change (Towner et al., 2001).

There is conflicting review-level evidence on the effectiveness of interventions comprising healthcare counselling or education, provision of safety information or free thermometers in encouraging people to use safe hot water temperatures (Centre for Reviews and Dissemination, 1996a).

Currently, there is a lack of review-level evidence on the effectiveness of provision of home safety equipment and/or educational campaigns in reducing physical injuries in children and young adults through modification of the home environment (Coleman et al., 1996; Lyons et al., 2003; Towner et al., 2001).

Older people

Modification of the home environment for the reduction of injuries (Lyons et al., 2003)

For general background on Lyons et al., (2003) refer to p30. Twelve of the trials identified in this review collected data on falls in the home, all of which focused on older people.

Two trials found that the risk of falling was significantly reduced in older people with the intervention compared with the control (trial 1: OR 0.39, 95% CI 0.23 to 0.66; trial 2: OR 0.85, 95% CI not stated, $p<0.05$). Although these trials also found no significant difference in hospital admission rates between the intervention and control (trial 1: OR 0.61, 95% CI 0.35 to 1.05; trial 2: OR 0.91, 95% CI not stated). One trial found that the adjusted incidence ratio for falling was significantly reduced with the intervention compared with the control (0.69, 95% CI 0.52 to 0.90). One study found a significant protective effect of the intervention for slipping and tripping compared with the control (adjusted hazard ratio [HR] for slipping: 0.42, 95% CI 0.26 to 0.69; adjusted HR for tripping: 0.36, 95% CI 0.24 to 0.54). However there was no significant effect of the intervention on risk of falls (adjusted HR: 0.70, 95% CI 0.48 to 1.01). One trial found that significantly fewer people reported a fall with the intervention compared with the control (9.3% difference, 95% CI 4.1% to 14.5%).

Two trials found inconclusive results, with significant effect of the intervention only being observed in a subgroup analysis, or when results from three intervention arms were combined. One trial found no significant effect of the intervention in the cumulative number of falls, having one or more falls or in the mean number of falls, compared with the control (cumulative number of falls: 311 vs 241; $p=0.34$; 1 or more falls: 79.2% vs 72.0%, $p=0.30$; mean number of falls: 4.0 vs 3.2, $p=0.43$). The final study found no significant reduction in the incidence of falls with the intervention compared with the control (adjusted rate ratio: 1.17, 95% CI 0.85 to 1.60).

Seven trials reported injury data for older people. One trial found a significant reduction in injurious falls with the intervention compared with the control during the first year of follow-up (9.9% with the intervention vs 14.5% with the control, $p<0.01$). One study found no significant effect of the intervention on the number of falls resulting in injury (results not presented). Four studies found no significant effect of the intervention in the

number of falls resulting in injury or fractures compared with the control (trial 1: reduction in number of all fractures – 14% intervention vs 37% control; significance not stated; trial 2: adjusted relative risk – 0.92, 95% CI 0.73 to 1.14; trial 3: proportion of fractures – 5% intervention vs 4% control; significance not stated; trial 4: results not reported). One trial found a significant overall reduction in fracture rates with the intervention compared with the control (p=0.01).

One additional study assessed injuries in the general population. It found no significant difference in injury mechanisms or rates between the intervention and control for people aged >65 years (RR 0.67, 90% CI 0.19 to 2.22).

Preventing falls and subsequent injury in older people (Centre for Reviews and Dissemination, 1996b)

This systematic review sought to assess effectiveness of interventions for the prevention of falls and subsequent injury in older people. Interventions for the prevention of falls included exercise-based interventions, home assessment and surveillance interventions, and footware assessment and modification interventions. Only those interventions comprising physical changes or improvements to the home are examined further in this briefing.

Five RCTs were identified that examined the effect of home assessment combined with surveillance and modification interventions on prevention of falls in older people.

The first study (>2,000 people aged 65 years and over living in the community in the US) found that those that offered a home intervention to remove and repair safety hazards showed a reduction in falls compared with controls (those receiving the home intervention reduced their odds [0.85] of falling relative to the control group, p<0.05). This effect was strongest for men aged 75 years and over.

The second study assessed a multicomponent intervention comprising home visits from nurses and follow-up targeted interventions (not further described). The authors report significantly fewer falls in the intervention group compared with control in the first year of follow-up (28% falls in intervention group vs 37% in control). However, this difference was not sustained at two years (31% with intervention vs 29% with control). Similar results were found in the rate of injurious falls, with significant differences observed between groups at one year but not two year follow-up. These results suggest that the effect of the intervention may be lost if discontinued.

The third study evaluated an intervention comprising home safety assessment combined with education about safety and home modification measures. It found no significant difference in implementation of home safety changes between the intervention and control (home visits with no safety information). However, the review authors note that this was a very small study that may have lacked statistical power to detect an effect.

One trial assessed the effects of a specialised post-fall assessment program comprising a physical examination and environmental assessment by a nurse practitioner coupled with referrals for preventive and therapeutic interventions. Although the authors report fewer falls were observed in the intervention group compared with the control, this difference was not significant (71% falls with intervention vs 76% falls with control at one year; at two years this was 81% vs 84%, differences not significant).

The final trial examined whether a targeted intervention delivered by health visitors comprising home assessment and correction of hazards in the home and assessment and improvement of nutritional deficiencies and fitness levels could reduce the incidence of fractures in older people. The study found no significant difference in the rate of falls between the intervention and control (23% with intervention vs 16% with control). However, the review authors note that there was more disability in the control group than in the intervention group at baseline, limiting the reliability of the findings.

Interventions for preventing falls in elderly people (Gillespie et al., 2003).

This systematic review assessed the effects of interventions designed to reduce the incidence of falls in older people (living in the community, or in institutional or hospital care). Sixty two RCTs were included of which four investigated the effectiveness of home hazard modification interventions. These trials involved an assessment of environmental hazards with supervision of home modifications by an experienced health professional such as an occupational therapist, doctor or nurse. One study also included free installation of safety devices and an educational programme; another trial provided exercise, correction of visual deficiency and home hazard

modification, each alone and in combination. In one trial all subjects had previously been hospitalised for a fall. All the trials had a minimum of one year follow-up.

Among those participants with a history of falling in the year prior to randomisation there was a significant reduction in the number sustaining two or more falls during the study period (RR 0.66, 95%CI 0.54 to 0.81). An overall analysis including all participants, fallers and non-fallers prior to randomisation showed a significant, but smaller, effect (RR 0.85, 95%CI 0.74 to 0.96). In those without a history of falls in the previous year there was no evidence for the effectiveness of home hazard modification (RR 1.03, 95%CI 0.75 to 1.41). In this study, the rate of falls away from home was reduced by a similar extent to the reduction in falls at home.

In a cluster randomised study of individual households in a population with mixed fall status, one trial was unable to identify a difference in the rate of falls (overall and falls at home), the rate of fall injuries, or the proportion of fallers in the intervention group compared with the control group after one year. Finally, in the trial which provided exercise, correction of visual deficiency and home hazard modification, the impact of these combined was a significant reduction in the number of participants falling (RR 0.76, 95%CI 0.61 to 0.94).

One trial conducted an economic evaluation of the intervention and reported that the mean cost per fall prevented for those with a fall in the previous year was Australian $3,980 (at 1997 prices, incorporating total healthcare resource use for 12 months from randomisation).

Interventions for the prevention of falls in older adults: systematic review and meta-analysis of randomised clinical trials (Chang et al., 2004)

This meta-analysis sought to identify effective interventions for preventing falls. One of the categories was environmental modification – these programmes often include a home visit by a professional who checks for environmental hazards such as poor lighting or sliding carpets and recommends changes. Some programmes also assisted with implementation of recommendations.

This meta-analysis builds on the earlier Cochrane review by Gillespie et al. (2003). Only RCTs assessing intervention programmes comprising multifactorial falls risk assessment and management, exercise, environmental modifications or education to prevent falls in people aged 60 years or more were included. A total of 40 RCTs were identified. Combined analysis using a random effects model of trials with people who had fallen at least once found a significant reduction in both the risk of falling and the monthly rate of falling (risk of falling [22 RCTs]: RR 0.88, 95% CI 0.82 to 0.95; monthly rate of falling [27 RCTs]: RR 0.80, 95% CI 0.72 to 0.88). Meta-regression analysis was then used to assess the relative effect of individual intervention components (eg environmental modifications). Environmental modification was found to be a primary component of only five studies and the pooled estimate was not statistically significant (risk of falling: 0.90, 95% CI 0.77 to 1.05).

There is review-level evidence to suggest that home hazard modification interventions that seek to remove and repair safety hazards are effective in reducing falls in older people (Centre for Reviews and Dissemination, 1996b; Chang et al., 2004; Gillespie et al., 2003; Lyons et al., 2003). This effect was strongest for people with a history of falling prior to intervention (Gillespie et al., 2003) and men aged ≥75 years (Centre for Reviews and Dissemination, 1996b).

There is a lack of review-level evidence on the effectiveness of interventions in reducing the risk of injurious falls in older people through modification of the home environment compared with control measures (Gillespie et al., 2003; Lyons et al., 2003).

Smoke alarms

Preventing unintentional injuries in children and young adolescents (Centre for Reviews and Dissemination, 1996a).

For general background on Centre for Reviews and Dissemination (1996a) refer to p30.

Two studies were identified that focused on increasing the proportion of people who install smoke detectors. The first RCT found no difference in the installation of smoke detectors between the intervention (education session and discount coupons for smoke detectors) compared with the control (standard health and safety information; results not further reported).

The second study was based in the US and compared the prevalence of smoke detectors in a community in which smoke detector legislation had been implemented five years previously with a community in which there was no smoke detector legislation. Although the reduction in deaths was greater in the intervention group compared with the control group (results not further described), there was no difference between groups in the rate of detectors installed. The findings from this study may not be applicable to settings outside the US. The third RCT found a significant increase in the rate of detector installation with the intervention (paediatrician counselling, information pamphlet and smoke detectors made available at cost price) compared with the control (usual care) (rate of smoke detector installation: 25/55 intervention vs no change in control; results not further described).

Effectiveness of interventions to prevent accidental injury in young persons aged 15-24 years (Coleman et al., 1996)

For general background on the review by Coleman et al. (1996) see p29. Two studies were included (one cohort/case controlled study and one multiple time series/uncontrolled experiment [with or without the intervention]). Both studies were from the US and involved the installation of smoke detectors in a give-away programme.

The review authors report that smoke detectors were shown to reduce the risk of fires in some residential settings. Community interventions that comprised simple give-away smoke detectors reduced fire-related deaths and injury even among high-risk populations. No other findings from these studies were reported. The cohort/case controlled study was awarded a grade B by Coleman et al. (1996), indicating that there was fair evidence to support the intervention. The multiple time series/uncontrolled experiment was awarded a grade C, indicating that there was poor evidence to support the intervention. Smoke detector programmes were awarded an overall grade C indicating that there was poor evidence to recommend support for the intervention.

Interventions for promoting smoke alarm ownership and function (DiGuiseppi and Higgins, 2001)

This systematic review sought to review the effectiveness of interventions to promote use of residential smoke alarms in increasing smoke alarm ownership and function, fire incidence, burns and other fire-related injuries.

A total of 26 trials (13 RCTs and 13 non-RCTs) were included. The study population included parents, pregnant women, schoolchildren and older people. Cluster RCTs included general practices, school classes, prenatal and parenting classes, areas in deprived communities and physicians in training. Interventions were delivered in clinical, home or school settings. Outcomes assessed included smoke alarm ownership, burns or fire-related injury, or fire incidence. There was no significant heterogeneity ($p>0.10$) between RCTs in primary outcome measures (post-intervention proportions with functional, newly acquired and newly functional smoke alarms, incidence of fires, burns and fire-related injuries), so results were combined in a meta-analysis using a random effects model. Results from non-RCTs were not quantitatively combined.

Of the 13 RCTs, two assessed injury outcome-related data (however, specific fire-related injury data was unavailable). Of the 13 non-RCTs, only 8 were completed, four of which were community based trials that reported on burns or fire-related injuries. The community based trials comprised a combination of mass media, school or community education, clinical counselling sessions and provision of free smoke alarms and/or alarm installation.

The review found that fire-related injury rates were reduced following the provision of free smoke alarms with or without installation (written confirmation provided by authors of primary study) compared with the control. However, the review authors note that the

highest baseline injury rates were used as a selection criterion in one of the trials and this may account for some of the reported reduction.

There is review-level evidence that community based interventions that provide free smoke alarms (with or without installation) may reduce fire-related injuries. However, methodological weakness in the study design limits the reliability of this finding (DiGuiseppi and Higgins, 2001).

There is review-level evidence from the US that smoke detector legislation can reduce the number of fire-related deaths (Centre for Reviews and Dissemination, 1996a; Coleman et al., 1996). However, there was no difference in the number of smoke detectors installed between communities with or without smoke detector legislation (Centre for Reviews and Dissemination, 1996a).

There is conflicting review-level evidence of the effectiveness of education-based interventions combined with provision of discounted smoke detectors in increasing the proportion of people that install smoke detectors (Centre for Reviews and Dissemination, 1996a).

Currently, there is a lack of review-level evidence to demonstrate effectiveness of community based injury or burn prevention education programmes in reducing injuries or burns (DiGuiseppi and Higgins, 2001).

PREVENTION OF ALLERGIC RESPIRATORY DISEASE

Asthma sufferers

Effects of air filtration systems on asthma: a systematic review of randomized trials (McDonald et al., 2002)

This systematic review identified 10 RCTs that examined the health effect of a residential air filtration system on people with asthma. Five of these trials enrolled exclusively adults and one enrolled exclusively children.

Multiple outcome measures were used to assess the effectiveness of air filtration systems across the 10 studies (including measures of lung function, symptom scores, allergen levels). Only one study used an objective measure of symptoms.

Three trials found that air filters were associated with significantly fewer asthma symptoms. Two further trials found that air filters significantly reduced airway responsiveness. The remaining five trials found no significant effect of air filters on a variety of asthma-related outcomes.

Meta-analysis using a fixed effects model of four trials found a significant improvement in symptoms scores with air filters compared with control (weighted mean difference 0.47, 95% CI 0.69 to 0.25, $p<0.01$). However, this result should be interpreted with caution as there was significant heterogeneity across trials ($p<0.01$), and analysis under a more conservative, random-effects model found no significant effect (weighted mean difference 0.76, 95% CI 2.17 to 0.65, $p=0.29$).

House dust mite control measures for asthma (Gotzsche et al., 2004)

This systematic review identified 49 RCTs (2,733 people) that examined the health effects of interventions (chemical, physical and combined methods) for reducing exposure to house dust mite antigens in the homes of people with mite-sensitive asthma. Mite sensitisation was confirmed by skin testing, bronchial provocation tests or serum assays for immunoglobulin E (IgE: a trace serum protein [antibody] that is associated with allergic reactions). Length of the intervention and time to follow-up ranged from two weeks to one year.

Thirty one trials assessed physical methods to reduce dust mite exposure (such as installation of HEPA air filters, vacuum cleaning of the bed and laundry, provision of new bedding materials, enclosure of the mattress with a plastic cover etc); 10 trials used chemical methods (eg acarosan or microstop treatment of bedding and carpets) and eight assessed a combination of chemical and physical methods.

Asthma symptom scores were significantly heterogeneous across all trials (p=0.0004). However, after exclusion of two small trials of poor quality, heterogeneity disappeared (p=0.19). Meta-analysis of the remaining trials found no significant effect of interventions to reduce house dust mite exposure either on asthma symptoms scores (standardised mean difference -0.01, 95% CI -0.10 to 0.13), or in medication usage (standardised mean difference -0.05, 95% CI -0.18 to 0.09), compared with the control. The authors conclude that the most plausible explanation is that the methods reviewed did not adequately reduce mite antigen levels since it seems implausible that complete removal of a major provoking agent would be ineffective at improving asthma symptoms.

Currently, there is a lack of review-level evidence of the effectiveness of air filtration systems in improving health outcomes in people with asthma (McDonald et al., 2002).

Currently, there is a lack of review-level evidence on the effectiveness of interventions that aim to reduce exposure to house dust mite allergen in the home in improving health outcomes in people with mite-sensitive asthma (Gotzsche et al., 2004).

Asthma and allergic rhinitis

House dust mites avoidance measures for perennial allergic rhinitis: a systematic review (Sheikh and Hurwitz, 2003)

This systematic review identified four RCTs (122 people) that aimed to assess the effectiveness of house dust mite control measures in the management of perennial allergic rhinitis. One of these trials was included and one excluded in the review by Gotzsche et al. (2004). All four of the studies recruited participants aged between four and 61 years who had evidence of respiratory disease provoked by house dust mites (house dust mite sensitive rhinitis and/or asthma). Dust mite sensitivity was established using skin prick testing and measures of serum-specific IgE.

One study assessed the use of a high efficiency particulate air filter loaded with an active Enviracaire filter for four weeks. The second study assessed the effectiveness of 12 months' intensive home cleaning with or without acaracide (solidified benzylbenzoate). The third study assessed the use of Acardust acaricide spray in bedrooms as a supplement to regular bedroom cleaning and the fourth study assessed the effectiveness of a four-week trial consisting of provision of verbal advice on allergen avoidance or provision of a range of bedroom interventions (vinyl mattress cover, daily wet cleaning of floors, fortnightly boil washing of top bed covers and removal of soft furnishings) in addition to the subject's usual rhinitis treatment.

The primary outcome measure in all studies was a symptom and/or medication score. Additional outcome measures included: particulate counts in bedroom air and subjective responses to treatment (first study); physician assessment, total and mite specific IgE and blood and nose eosinophils (second study); twice weekly peak flows, monthly clinical assessments and house dust mite antigen concentrations at 0, 90 and 180 days (third study); and change in house dust mite load (fourth study).

The first study reported a reduction in aggregated 12-hour rhinitis and asthma symptom and medication scores with active filtration compared with the control (day-time score: 8.79 with filtration vs 10.38 with the control; night-time score: 8.28 with filtration vs 9.90 with control; significance not stated). The study also reported a 'significant' reduction in 24 hour nasal congestion and discharge, eye irritation and upper airway scores (no further data provided).

The second study found a significant reduction in three month and 12 month symptom scores for those using acaricide compared with the control (matched pairs, p=0.025). More patients in the intervention group than the control group demonstrated an improvement in their physician assessment scores; however, the difference was not significant (matched pairs, start to end, p=0.05).

The third study reported a reduction in nasal secretion

symptoms (sneezing, lacrimation and itching) and a reduction in combined rhinitis and asthma symptoms scores with the intervention (bedrooms sprayed with Acardust) compared with the control (results not reported).

The fourth study found a reduction in the mean daily rhinitis symptom scores with the intervention compared with the control after four weeks of active treatment (from 5 at baseline to 2.1; mean difference = -2.9, $p=0.001$) and also at the end of the trial (from 4.2 at baseline to 3.9; mean difference = -0.3), $p>0.05$). In addition, significant benefits were also reported in nasal symptoms scores with bedroom environmental measures compared with the control.

A number of methodological limitations were identified by the review authors and need to be taken into consideration. For example, power calculations were not presented and the sample included both adults and children. The review authors were also uncertain as to whether participants were representative of house dust-mite allergic perennial rhinitis sufferers in the general population (not further explained).

The authors also suggest that despite the apparent success of the interventions in reducing rhinitis symptoms, it is important to note that the interventions were given in combination with maintenance drug treatment in many cases and it is difficult to estimate reliably the magnitude of the clinical effect that is due to intervention alone.

There is review-level evidence to suggest that the use of physical (intensive home cleaning, vinyl mattress covers, daily wet cleaning of floors, boiling of top bedding covers and removal of soft furnishing) and/or chemical measures (air filters loaded with Enviracaire and acaracide spray and cleaning products) may lead to a reduction in allergen load for those with house dust mite-provoked respiratory disease when combined with maintenance drug treatments. However, the magnitude of the effect of the housing-related intervention cannot be reliably isolated from that of the maintenance drug treatment (Sheikh and Hurwitz, 2003).

Discussion

The review-level evidence derived from 15 Evidence Base papers that have assessed the effectiveness of a range of housing interventions for improving health is summarised in Table 2 (p41).

There is review-level evidence that a number of housing-related interventions are effective at improving health outcomes. These include:

- Medical priority rehousing
- Rehousing plus relocation from slum areas
- Housing subsidy programmes for low-income families
- Improving housing energy efficiency measures
- Accidental injury prevention measures
- Installation of smoke alarms
- Measures to prevent allergic respiratory disease.

Note, however, that a number of methodological issues were encountered during the course of preparing this evidence briefing, and it is important to consider the findings in light of these limitations.

To best inform thinking about the effectiveness of a public health intervention or approach, it is recognised that evidence can be derived from a vast range of sources (eg experimental, observational, qualitative study designs etc). However, to provide an initial, comprehensive map of the state of the evidence for a particular subject area, evidence briefings – or review of reviews – allow a rapid synthesis of high quality review-level evidence. Systematic reviews, meta-analyses and other reviews have the advantage over other types of evidence, as they aggregate, evaluate and summarise large amounts of primary data (Elliott et al., 2001). For pragmatic reasons, the type of evidence reviewed in an evidence briefing is restricted to recently published (post-1996), systematic and transparent review-level literature (see also Methodology section). But this approach is not without its limitations.

As with all systematic electronic searches, the restricted search parameters of an evidence briefing may mean that potentially relevant reviews are not captured. However, hand-searching of reference lists of all retrieved articles and consultation with reference group members can minimise this risk. It is also acknowledged that the evidence briefing approach tends to identify, select and appraise reviews that favour a relatively narrow spectrum of potential evidence – mostly drawn from RCTs. Other types of methodological approaches, for example, qualitative work, tend to be under-represented in this type of evidence (Kelly et al., 2002). Similarly, systematic reviews, meta-analyses and other reviews of effectiveness tend to rely solely on published sources, and publication policies that exclude primary studies with inconclusive or negative findings (publication bias) will further restrict the type of evidence that is captured within review-level literature.

A further inherent problem with review methodology or indeed with any secondary research synthesis stems from the ultimately subjective, interpretative representation of primary study results. This potential source of reporting bias is further confounded by employing review of review-level literature methodology, such as that adopted for this evidence briefing.

The limitations of the critical appraisal process also need highlighting. While the process is designed to be as objective as possible, we acknowledge that decisions as to whether a paper is selected or not do contain a subjective element. Although subjectivity is minimised by having two independent reviewers, consideration of subjectivity must be given when reading the 'Findings' section. Linked to the critical appraisal process, it must also be noted that while many of the reviews initially identified for appraisal had useful and relevant results or insights, if the paper did not meet our quality threshold

for inclusion (ie reviews must be systematic and transparent), then they were not accepted as Evidence Base papers. This becomes problematic when review authors fail to adequately report on the methodology employed or on the results of primary studies, referring the reader to the primary study for detailed findings. Unfortunately the time limits imposed for production of this briefing do not allow us to contact review authors for further information, and it is entirely possible that good quality reviews have been excluded from this briefing simply because they did not provide enough detail either about their methodological approach or the results of primary studies.

Reviews of housing interventions

General methodological issues aside, it has become apparent that there are also a number of limitations to keep in mind when using a review of reviews approach to assess effectiveness of interventions that address the wider, underlying determinants of health, such as housing conditions.

For example, as noted by Thomson and colleagues (2001, 2002), poor housing conditions often coexist with other forms of deprivation (unemployment, poor education, ill health, social isolation etc), making it difficult to isolate, modify and assess the overall health impact of housing conditions. This complexity is further compounded by the political and institutional plurality that serves to address deprivation in each of these areas (ie housing conditions are traditionally the remit of regional and local regeneration bodies, whereas health issues are traditionally the domain of health services).

In light of this complexity, it seems that comparatively few researchers have undertaken primary research studies of the health effects of housing interventions. Where primary studies do exist, they often fail to capture the impact of – and on – the wider, underlying socio-economic causes of ill-health. Indeed, housing intervention studies tend to be one-dimensional studies (for example, refurbishment, installation of hand rails, heating installation etc) whereas the most successful housing interventions from a broad health perspective are likely to be those that are multi-tiered and which serve to address multiple housing-related components (such as programmes that address both indoor and neighbourhood-wide aspects).

Consequently, few good quality primary level research studies mean that there is a limited evidence base from which review authors may draw. This is best illustrated by the recent review carried out by Thomson and colleagues (2001, 2002), in which after a comprehensive search of the literature they identified only 19 primary studies, none of which met their criteria for a good quality study. So where there are few good quality primary studies, there will be few systematic reviews, and likewise few reviews from which to draw on in a review of reviews.

The evidence review approach – complementary to the briefing series – whereby other sources of evidence are collated and synthesised, is likely to be a more 'lucrative' approach for reviewing effectiveness of housing interventions. Such an approach would enable incorporation of findings from particularly relevant study designs for this area of research (for example, health impact assessments, reports of local regeneration initiatives, government policy documents or reports, cost effectiveness studies etc) and which have generally been excluded from this briefing because they failed to employ a systematic and transparent review methodology (see for example: Brown, 2002; Douglas and Thomson 2003; ODPM, 2003c; Stewart and Rhoden 2003; Thomson et al., 2003)

Table 2: Summary of evidence statements derived from the Evidence Base papers

Intervention	Review-level evidence of effectiveness	Lack of review-level evidence	Conflicting review-level evidence
Medical priority rehousing	There is review-level evidence that anxiety and depression scores are reduced in people who are rehoused on the basis of medical need.		
Rehousing plus relocation from slum or socially isolated areas	There is review-level evidence that rehousing people from slum areas can improve self-reported physical and mental health outcomes in the longer term (18 months). There is also review-level evidence that rehousing people from slum areas can adversely affect self-reported health outcomes in the short term (9 months).	Currently, there is a lack of review-level evidence on the effectiveness of rehousing from a socially isolated area or substandard housing in improving health.	
Rehousing or housing improvement plus neighbourhood regeneration		Currently, there is a lack of review-level evidence of effectiveness of interventions involving rehousing or housing improvement combined with neighbourhood regeneration initiatives in improving health outcomes.	
Housing subsidy programs for low-income families	There is review-level evidence from the US that rental voucher programmes can improve household safety by providing families with the choice to move to neighbourhoods with reduced exposure to violence.	Currently, there is a lack of review-level evidence on effectiveness of interventions involving mixed-income housing developments in improving health outcomes. Currently, there is a lack of review-level evidence on effectiveness of rental voucher programmes in improving other health-related outcomes.	
General refurbishment		Currently, there is a lack of review-level evidence of effectiveness of interventions involving general refurbishment initiatives in improving health outcomes.	
Improvement in housing energy efficiency measures	There is review-level evidence that housing interventions to improve energy efficiency, such as installation of new windows, can positively affect health outcomes.		
Accidental injury prevention: children and young adults	There is review-level evidence that home visits to people in lower socioeconomic areas plus provision of advice on home hazards, combined with health education and media campaigns, are effective in encouraging parents to make physical changes to the home environment to make their homes safer. There is review-level evidence that the provision of free or discount home safety equipment and/or educational campaigns may lead to behavioural and environmental change.	Currently, there is a lack of review-level evidence on the effectiveness of provision of home safety equipment and/or educational campaigns in reducing physical injuries in children and young adults through modification of the home environment.	There is conflicting review-level evidence on the effectiveness of interventions comprising healthcare counselling or education, provision of safety information or free thermometers in encouraging people to use safe hot water temperatures.

Table 2: Summary of evidence statements derived from the Evidence Base papers (cont.)

Intervention	Review-level evidence of effectiveness	Lack of review-level evidence	Conflicting review-level evidence
Accidental injury prevention: older people	There is review-level evidence to suggest that 'substantial home hazard modification' interventions that seek to remove and repair safety hazards are effective in reducing falls in older people. This effect was strongest for men aged ≥75 years.	Currently, there is a lack of review-level evidence for the effectiveness of a home assessment programme combined with surveillance interventions in the prevention of falls in older people.	There is conflicting review-level evidence on the effectiveness of interventions in reducing the risk of falls or the number of injurious falls in older people through modification of the home environment compared with control measures.
Smoke alarms	There is review-level evidence that community based interventions which provide free smoke alarms (with or without installation) may reduce fire-related injuries. However, due to methodological weakness in the study design, the reliability of this finding may be limited. There is review-level evidence from the US that smoke detector legislation can reduce the number of fire-related deaths compared with communities without smoke detector legislation. However, this study also found no difference in the number of smoke detectors installed between communities.	Currently, there is a lack of review-level evidence to demonstrate the effectiveness of community based 'injury or burn prevention education programmes' in reducing injuries or burns.	There is conflicting review-level evidence of the effectiveness of education-based interventions combined with provision of discounted smoke detectors in increasing the proportion of people who install smoke detectors.
Prevention of allergic respiratory disease: asthma sufferers		Currently, there is a lack of review-level evidence of the effectiveness of air filtration systems in improving health outcomes in people with asthma. Currently, there is a lack of review-level evidence on the effectiveness of interventions that aim to reduce exposure to house dust mite allergen in the home in improving health outcomes in people with mite-sensitive asthma.	
Prevention of allergic respiratory disease: asthma and allergic rhinitis	There is review-level evidence to suggest that the use of physical (intensive home cleaning, vinyl mattress covers, daily wet cleaning of floors, boiling of top bedding covers and removal of soft furnishing) and/or chemical measures (air filters loaded with Enviracaire and acaracide spray and cleaning products) may lead to a reduction in allergen load for those with house dust mite-provoked respiratory disease when combined with maintenance drug treatments. However, the magnitude of the effect of the housing-related intervention cannot be reliably isolated from that of the maintenance drug treatment		

Gaps in the evidence base and recommendations for research

Based on the findings of this briefing, there is a general lack of review-level evidence for a wide range of topic areas relating to the effectiveness of housing interventions in improving health. It should be stressed, however, that a lack of review-level evidence of effectiveness does not necessarily mean that interventions are ineffective, rather that primary studies demonstrating effectiveness may not have been captured by, or included in, review-level literature.

Specifically, there is a lack of review-level evidence regarding the effectiveness or cost effectiveness of interventions that target specific housing elements that are known to affect health outcomes. These include interventions that might seek to minimise exposure to indoor pollutants (such as asbestos, carbon monoxide, radon, lead and volatile organic chemicals); infestation; hazardous internal structures or fixtures; noise; and cold or damp.

Similarly, there is a lack of evidence of effectiveness of housing-related interventions that might seek to address problems in the broader social and behavioural environment such as overcrowding, sleep deprivation, neighbourhood quality, infrastructure deprivation (ie lack of availability and accessibility of health services, parks, stores selling healthy foods at affordable prices); neighbourhood safety; and social cohesion.

Finally, there is a lack of evidence of effectiveness of housing-related interventions that relate to the broader macro-policy environment such as housing allocation, lack of housing, housing tenure, housing investment, and urban planning. Further research will be required in each of these areas to more comprehensively inform the policy making process.

Inequalities and vulnerable groups

The Evidence Base papers report that there is review-level evidence for the following housing-related interventions that target socio-economically deprived or vulnerable groups:

- Rehousing people from slum areas can improve self-reported physical and mental health outcomes in the longer term (18 months). However, it is important to note that rehousing people from slum areas can also adversely affect self-reported health outcomes in the short term (nine months)
- Rental voucher programmes in the US can improve household safety by providing families with the choice to move to neighbourhoods with reduced exposure to violence
- Home visits to people in lower socio-economic areas plus provision of advice on home hazards, combined with health education and media campaigns, are effective at encouraging parents to make physical changes to the home environment to make their homes safer.

However, overall, very few studies found evidence of effectiveness of housing interventions in improving health outcomes in these groups and further research needs to be undertaken to address this important gap in the evidence base.

Cost effectiveness

There is an urgent need for primary research to be undertaken to examine the cost effectiveness of housing-related interventions to improve health outcomes in both the general population and disadvantaged and vulnerable groups.

Research recommendations

We have made a number of research recommendations, primarily relating to specific interventions that were reviewed in the Evidence Base papers. These recommendations are based both on our own observations, in addition to those made by the authors of the Evidence Base papers. It is important to note that we have not systematically searched for gaps in the primary research, although it is likely that some of the recommendations will impact on such research.

Many of the Evidence Base papers state a need for further research to identify and quantify the impact of housing interventions on health. Toward this end, the emphasis is on well designed and evaluated programmes, using randomised controlled designs wherever possible, and integrating qualitative methods and economic evaluations. It has also been suggested that research which examines ways to promote collaborative multi-agency working and which provides sufficient operational detail on successful initiatives would be useful (Centre for Reviews and Dissemination ,1996a).

There are a number of key study design issues that have been noted by review authors as requiring particular attention in any future studies aiming to assess the effectiveness of housing interventions.

First, a number of authors have commented that the main limiting factor of interventions to date relates to small sample sizes (McDonald et al., 2002; Thomson et al., 2001, 2002). Adequate follow-up time is also a key concern, particularly when assessing the impact of interventions in deprived areas, as it has been noted that response and follow-up rates in such areas are often low (Thomson et al., 2001). Similarly, the 'low penetration' of many minor interventions (for example, reduction of home hazards through installation of grab rails, stair gates, cupboard locks etc) can be difficult to overcome if people are 'ambivalent or not really convinced about the benefits of the intervention' (Lyons et al., 2003). Such ambivalence might be overcome through initiatives in which active participation of the target population is encouraged in the planning, design, implementation and evaluation of future studies (Centre for Reviews and Dissemination, 1996b; Lyons et al., 2003).

A number of Evidence Base papers included in this briefing relied on primary studies that were carried out in non-UK settings. For example, the rehousing initiatives reviewed by Anderson and colleagues (2002, 2003) were all US programmes. In light of the specific political and cultural context within which these primary studies were carried out, the transferability of the findings to UK settings is likely to be limited. Wherever possible, we have tried to note the setting in which primary studies were carried out. Further research in UK-specific settings is required before the effectiveness or otherwise of interventions in the UK can be confirmed.

Finally, it should be stressed that adverse effects of housing interventions have been observed in a number of primary studies (see Thomson et al., 2002; Anderson et al., 2002) and this should be taken into account before embarking on interventions of this nature.

Rehousing initiatives

Although Anderson and colleagues (2002, 2003) found no primary studies that assessed the effectiveness of mixed-income housing developments, the authors do stress the need for well-designed evaluations in this area. The authors' review of rental assistance programmes identified 12 studies, all of which focused on families with children from urban areas of low socioeconomic status. They recommended that the effectiveness of this intervention needs to be assessed both in older populations and also in those people with special health needs.

Anderson and colleagues (2002, 2003) conclude that there is evidence from the US that rental voucher programmes can improve household safety by providing families with the choice to move to neighbourhoods with reduced exposure to violence. However, it remains to be determined if there are any adverse effects of rental assistance programmes. For example, the authors note that movement of families to neighbourhoods of greater prosperity may disrupt established social networks in the neighbourhood of origin, which in turn can result in increased social deterioration in an already declining area. Similarly, the impact of the arrival of poorer families in higher socio-economic neighbourhoods may also have adverse affects through destabilisation of the new area.

Interventions for the prevention of accidental injury

This briefing has found that there is little high-grade evidence that supports the effectiveness of modifying the home environment in reducing the risk of physical injury.

However, to address as many underlying causes of accidental injury as possible (such as environmental hazards, a failure to react, bone fragility etc), many of the interventions reviewed were multi-component interventions, comprising environmental modification strategies in addition to physical exercise, nutritional advice and educational strategies. Home modification alone cannot address all of the causative elements in accidental injury and further research is required before the relative effectiveness of specific components of such multifactorial interventions can be identified. This might best be achieved through use of factorial research designs (Lyons et al., 2003).

A better understanding of the most effective component in accidental injury prevention interventions will further help to identify the most cost effective ways of reducing home environmental and personal risks of falling. For example, it would be useful to know if information from the annual screening of older people and GP records is helpful (Centre for Reviews and Dissemination, 1996b). Similarly, economic evaluation of interventions should also be encouraged (Gillespie et al., 2003).

One further difficulty of research in injury prevention relates to the relative rarity of the outcome, which can limit the overall power of the study (ie a larger sample size will be required to reliably detect any effect of the intervention, should one exist). For example, although many injuries occur in older people following a fall, only a small proportion of falls result in an injury. Consequently, research to date has tended to focus on fall prevention as a proxy measure of injury prevention. It is recommended that future studies in this area be sufficiently powered to detect modest but important changes in injury incidence.

Finally, some authors have stressed the importance of prevention of fire-related injuries, particularly in childhood, as they are the second leading cause of injury and death in this age group. It is suggested that the effectiveness of educational or counselling programmes in preventing both fire and fire-related injuries needs to be evaluated. Similarly, good quality randomised controlled trials are required to assess the effectiveness in reducing fire-related injuries of smoke alarm promotion programmes delivered as part of general child health surveillance in primary care, and of community based smoke alarm provision (Coleman et al., 1996; DiGuiseppi and Higgins, 2001).

Interventions for asthma and allergy sufferers

One systematic review reports that there is a lack of evidence on the effectiveness of interventions to reduce house dust mite exposure in people with mite-sensitive asthma at improving asthma symptoms (Gotzsche et al., 2004). The authors conclude that the most plausible explanation for this finding is that the methods reviewed did not adequately reduce mite antigen levels since it seems implausible that complete removal of a major provoking agent would be ineffective at improving asthma symptoms. The authors further suggest that if additional primary studies are undertaken in this area they should be methodologically rigorous and employ alternative mite-eradication methods to those used so far.

A similar review of interventions to eradicate house dust mite in homes of people with perennial allergic rhinitis concludes that additional good quality randomised controlled trials (with large samples to attain adequate power, and validated outcome measures with sufficient follow-up periods – more than six months) need to be undertaken to assess the effectiveness of house dust mite control measures in perennial allergic rhinitis sufferers, ideally with participants not receiving concomitant medical therapy. Furthermore, studies will need to ensure that adequate data are provided in relation to sub-groups of study participants (eg those with asthma vs those with rhinitis vs those with both) to disentangle efficacy of the intervention on rhinitis symptoms alone from effects on asthma symptoms. Finally, cost effectiveness was not assessed in any of the trials identified and it is recommended that it is evaluated in future studies.

Conclusion

In summary, large studies that investigate the broader social context of housing interventions and health outcomes are required. Cost effectiveness data of such interventions are also required, as it is this information that is likely to be most useful for informing policy decisions. In their recent review, Thomson et al. (2001, 2002) identified 14 ongoing studies in the UK that aim to assess health outcomes from housing interventions. Findings from these studies will be key in informing a relatively depleted evidence base.

References

Acheson, D. (1998). *Independent inquiry into inequalities in health*. London: Stationery Office.

Ambrose, P. J. (2001). Living conditions and health promotion strategies. *Journal of the Royal Society of Health* 121 (1): 9-15.

Anderson, L. M., Shinn, C., St Charles, J., Fullilove, M. T., Scrimshaw, S. C., Fielding, J. E., Normand, J., Sanchez-Way, R., Richardson, T. and Centers for Disease Control and Prevention (2002). Community interventions to promote healthy social environments: early childhood development and family housing. A report on recommendations of the Task Force on Community Preventive Services. *Morbidity and Mortality Weekly Report*: *Recommendations and Reports* 51 (RR-1): 1-8.

Anderson, L. M., St Charles, J., Fullilove, M. T., Scrimshaw, S. C., Fielding, J. E., Normand, J. and Task Force on Community Preventive Services (2003). Providing affordable family housing and reducing residential segregation by income. A systematic review. *American Journal of Preventive Medicine* 24 (3 Suppl): 47-67.

Atkinson, R. (2004). *The place of health in area-based regeneration programmes*. Bristol: ESRC Centre for Neighbourhood Research. www.neighbourhoodcentre.org.uk/research/projects.html

Aylin, P. , Morris, S., Wakefield, J., Grossinho, A, Jarup, L. and Elliot, P. (2001). Temperature, housing, deprivation and their relationship to excess winter mortality in Great Britain, 1986-1996. *International Journal of Epidemiology* 30 (5):1100-8.

Bines, W. (1994). *The health of single homeless people*. Centre for Housing Policy Discussion Paper no. 9. York: Centre for Housing Policy, University of York.

Bonnefoy, X. E., Annesi-Maesano, I., Aznar, L. M., Braubach, M., Croxford, B., Davidson, M., Ezratty, V., Fredouille, J., Gonzalez-Gross, M., van Kamp, I., Maschke, C., Mesbah, M., Moissonnier, B., Monolbaev, K., Moore, R., Nicol, S., Niemann, H., Nygren, C., Ormandy, D., Röbbel, N. and Rudnai, P. (2004). *Review of evidence on housing and health*. Background document to the Fourth Ministerial Conference on Environment and Health, Budapest, Hungary, June 23-25, 2004. Available at: www.euro.who.int/document/HOH/ebackdoc01.pdf

British Medical Association (2003). *Housing and health: building for the future*. London: British Medical Association.

Brown, M. J. (2002). Costs and benefits of enforcing housing policies to prevent childhood lead poisoning. *Medical Decision Making* 22 (6): 482-92.

Buckland, F. E. and Tyrell D. A. J. (1962). Loss of infectivity on drying various viruses. *Nature* 195: 1063-4.

Bull, J., McCormick, G., Swann, C. and Mulvihill, C. (2004). *Ante- and post-natal home-visiting programmes: a review of reviews*. London: Health Development

Burr, M. L., Mullins, J., Merrett, T. and Stott, N. (1988). Indoor moulds and asthma. *Journal of Royal Society of Health* 108: 99-102.

Burr, M. L. (1999). Indoor air pollution and the respiratory health of children. *Pediatric Pulmonology* Suppl 18: 3-5.

Burridge, R. and Ormandy, D. (1993). The legal environment of housing conditions. In: Burridge, R. and Ormandy, D. (eds) *Unhealthy housing. Research remedies and reform*. London: Spon Press.

Centre for Reviews and Dissemination (1996a). Preventing unintentional injuries in children and young adolescents. *Effective Health Care* 2 (5). Available at: www.york.ac.uk/inst/crd

Centre for Reviews and Dissemination (1996b). Preventing falls and subsequent injury in older people. *Effective Health Care* 2 (4). Available at: www.york.ac.uk/inst/crd

Chang, J. T., Morton, S. C., Rubenstein, L. Z., Mojica, W. A., Maglione, M., Suttorp, M. J., Roth, E. A. and Shekelle, P. G. (2004). Interventions for the prevention of falls in older adults: systematic review and meta-analysis of randomised clinical trials. *British Medical Journal* 328 (7441): 680.

Chauhan, A. J., Inskip, H. M., Linaker, C. H., Smith, S., Schreiber, J., Johnston, S. L. and Holgate, S. T. (2003). Personal exposure to nitrogen dioxide (NO_2) and the severity of virus-induced asthma in children. *Lancet* 361 (9373): 1939-44.

Coleman, P., Munro, J., Nicholl, J., Harper, R., Kent, G. and Wild, D. (1996). *The effectiveness of interventions to prevent accidental injury to young persons aged 15-24 years: a review of the evidence*. University of Sheffield: Medical Care Research Unit.

Collins, K. J. (1993). Cold and heat related illnesses in the indoor environment. In: Burridge, R. and Ormandy, D. (eds) *Unhealthy housing. Research, remedies and reform*. London: Spon Press.

Colloff, M. J., Ayres, J., Carswell, F., Howarth, P., Merrett, T. G., Mitchell, E. B., Walshaw, M. J., Warner, J. A., Warner, J. O. and Woodcock, A. A. (1992). The control of allergens of dust mites and domestic pets: a position paper. *Clinical and Experimental Allergy* 22: 1-28.

Crime Concern (1999). *Review to support the development of the health strategy for London: crime and disorder.* A report prepared for the London Regional Office of the NHS executive.

Curwen, M. and Devis, T. (1988). Winter mortality, temperature and influenza: has the relationship changed in recent years? *Population Trends* 54: 17-20.

Dahlgren, G. and Whitehead, M. (2001). *Policies and strategies to promote social equity in health*. Stockholm: Institute for Futures Studies.

Darby, S., Hill, D., Auvinen, A., Barros-Dios, J. M., Baysson, H., Bochicchio, F., Deo, H., Falk, R., Forastiere, F., Hakama, M., Mäkeläinen, I., Muirhead, C., Oberaigner, W., Pershagen, G., Ruano-Ravina, A., Ruosteenoja, E., Schaffrath Rosario, A., Tirmarche, M., Tomáek, L., Whitley, E., Wichmann, H-E. and Doll, R. (2005). Radon in homes and risk of lung cancer: collaborative analysis of individual data from 13 European case-control studies. *British Medical Journal* 330 (7485): 223.

DEFRA (2000). *Our countryside: the future – a fair deal for rural England*. London: Department for Environment, Food and Rural Affairs.

DEFRA (2004). *The UK Fuel Poverty Strategy. 2nd Annual Progress Report*. London: Department for Environment, Food and Rural Affairs.

Department of Health (1999). *Saving Lives: Our Healthier Nation*. London: Stationery Office.

Department of Health (2003). *Tackling Health Inequalities: a programme for action*. London: Stationery Office.

Department of Health (2004). *Choosing Health: making healthier choices easier*. London: Stationery Office.

Diez-Roux, A. V., Nieto, F. J., Muntaner, C., Tyroler, H. A., Comstock, G. W., Shahar, E., Cooper, L. S., Watson, R. L. and Szklo, M. (1997). Neighbourhood environments and coronary heart disease: multilevel analysis. *American Journal of Epidemiology* 146: 48-63.

DiGuiseppi, C. and Higgins, J. P. (2001). Interventions for promoting smoke alarm ownership and function. *The Cochrane Database of Systematic Reviews*, Issue 2.

Donaldson, G. C. and Keatinge, W. R. (2003). Cold related mortality in England and Wales: influence of social class in working and retired age groups. *Journal of Epidemiology and Community Health* 57 (10): 790-1.

Douglas, M. and Thomson, H. (2003). *Health impact assessment of housing improvements: a guide*. Public Health Institute of Scotland.

Doyal, L. (2000). *An integrated approach to injuries in the household: literature review and conceptual development paper*. Bristol: School for Policy Studies, University of Bristol.

Dugdale, B. and Draper, B. (1993). Fire safety in HMOs. Enforcing requirements. *Environmental Health* 101/04: 117-21.

Elliott, L., Crombie, I. K., Irvine, L., Cantrell, J. and Taylor, J. (2001). *A review of the contribution of nurses, midwives and health visitors to improving the public's health*. A report to the Scottish Executive, Dundee. University of Dundee, School of Nursing and Midwifery and Department of epidemiology and public health. Available at: www.scotland.gov.uk/library3/health/ephn/ephn.pdf

Evans, J. (2000). An epidemiological study of the relative importance of damp housing in relation to adult health. *Journal of Epidemiology and Community Health* 54 (9): 677-86.

Evans, M. (2002). *The effect of housing renovation on health: the Riverside Project*. Report of a multi-agency project in Cardiff. Wales: Wales Office of Research and Development for Health and Social Care.

Evans, G. W., Wells, N. M. and Moch, A. (2000). *Housing and mental health: a review of the evidence and a methodological and conceptual critique*. New York Department of Agriculture.

Gabe, J. and Williams, P. (1997). Women, housing and mental health. *International Journal of Health Services* 17: 667-86.

Gillespie, L. D., Gillespie, W. J., Cumming, R., Lamb, S. E. and Rowe, B. H. (2003). Interventions for preventing falls in the elderly. *The Cochrane Database of Systematic Reviews*, Issue 4.

Gotzsche, P. C., Johansen, H. K., Schmidt, L. M. and Burr, M. L. (2004). House dust mite control measures for asthma. *The Cochrane Database of Systematic Reviews*, Issue 4.

Graham, H. and Kelly, M. (2004) *Health inequalities: concepts, frameworks and policy*. London: Health Development Agency.

Handy, S. L., Boarnet, M. G., Ewing, R. and Killingsworth, R. E. (2002). How the built environment affects physical activity: views from urban planning. *American Journal of Preventive Medicine* 23 (Suppl): 64-73.

Hatch, M. T., Holmes M. J., Deig, E. F., Williams, J. A. and Ehresmann, D. W. (1976). Stability of airborne rhinovirus Type 2 under atmospheric and physiological conditions. *Abstracts of the Annual Meeting of the American Society of Microbiology* Q18: 193.

Healy, J. D. (2003). Excess winter mortality in Europe: a cross country analysis identifying key risk factors. *Journal of Epidemiology and Community Health* 57: 784-9.

Hiscock, R., Kearns, A., Macintyre, S. and Ellaway, A. (2001). Ontological security and psycho-social benefits from the home: qualitative evidence on issues of tenure. *Housing, Theory and Society* 18: 50-66.

Holmes, P. and Tuckett, C. (eds) (2000). *Airborne particles: exposure in the home and health effects*. Leicester: MRC Institute of Environment and Health.

Hosen, H. (1978). Moulds in allergy. *Journal of Asthma Research* 15: 151-6.

Joseph Rowntree Foundation (2001). *The impact of housing conditions on excess winter deaths*. York: Joseph Rowntree Foundation.

Kawachi, I. and Berkman, L. F. (2003). *Neighbourhoods and health*. Oxford University Press.

Kelly, M., Swann, C., Killoran, A., Naidoo, B., Barnett-Paige, E. and Morgan, A. (2002). *Methodological problems in constructing the evidence base in public health* London: Health Development Agency.

Kingdom, K.H. (1960). Relative humidity and airborne infections. *American Review of Respiratory Disease* 81: 504-12.

Lawlor D., Harvey, D. and Dews, H. G. (2000). Investigation of the association between excess winter mortality and socio-economic deprivation. *Journal of Public Health Medicine* 22 (2): 176-81.

Lawlor D., Maxwell, R. and Wheeler, B. H. (2002). Rurality, deprivation, and excess winter mortality: an ecological study. *Journal of Epidemiology and Community Health* 56 (5): 373-4.

Lyons, R. A., Sander, L. V., Weightman, A. L., Patterson, J., Jones, S. A., Rolfe, B., Kemp, A. and Johansen, A. (2003). Modification of the home environment for the reduction of injuries. *The Cochrane Database of Systematic Reviews*, Issue 4.

Marks, R. and Allegrante, J. P. (2004). Falls-prevention programs for older ambulatory community dwellers: from public health research to health promotion policy. *Sozial- und Praventivmedizin* 49 (3): 171-8.

Markus, T. A. (1993). Cold, condensation and housing poverty. In: Burridge, R. and Ormandy, D. (eds) *Unhealthy housing. Research, remedies and reform*. London: Spon Press.

Marsh, A., Gordon, D., Pantazis, C. and Heslop, P. (1999). *Home sweet home? The impact of poor housing on health*. Bristol: Policy Press.

Maunsell, K. (1954). Sensitization risk from inhalation of fungal spores. *Journal of Laryngology and Otology* 68: 765-75.

McDonald, E., Cook, D., Newman, T., Griffith, L., Cox, G. and Guyatt, G. (2002). Effect of air filtration systems on asthma: a systematic review of randomized trials. *Chest* 122 (5): 1535-42.

Millward, L., Morgan, A. and Kelly, M. (2003). *Prevention and reduction of accidental injury in children and older people*. London: Health Development Agency.

Morgan, A. and Swann, C. (2004). *Social capital for health: issues of definition, measurement and links to health*. London: Health Development Agency.

Nettleton, S. and Burrow, R. (1998). Mortgage debt, insecure ownership and health: an explanatory analysis. *Sociology of Health and Illness* 20 (5): 731-53.

ODPM (2000). *Our towns and cities: the future*. London: Office of the Deputy Prime Minister.

ODPM (2002). *Living places: cleaner, safer, greener*. London: Office of the Deputy Prime Minister.

ODPM (2003a). *English House Condition Survey Key Findings 2003*. London: Office of the Deputy Prime Minister.

ODPM (2003b). *Communities Plan* (*Sustainable communities: building for the future).* London: Office of the Deputy Prime Minister.

ODPM (2003c). *What Works? Reviewing the evidence base for neighbourhood renewal.* London: Office of the Deputy Prime Minister. Available at: www.neighbourhood.gov.uk

ODPM (2004a). *Housing health and safety rating system: guidance.* (Version 2). London: Stationery Office.

ODPM (2004b). *Housing in England 2002/3*. London: Stationery Office.

ODPM (2005). *Sustainable Communities: Homes for All*. London: Stationery Office.

ODPM (2005). *Sustainable Communities: People, Places, Prosperity*. London: Stationery Office.

Packer, C. N., Stewart-Brown, S. and Fowle S. E. (1994). Damp housing and adult health: results from a lifestyle study in Worcester. *Journal of Epidemiology and Public Health* 48 (6): 555-9.

Peat, J., Dickerson, J. and Li, J. (1998). Effects of damp and mould in the home on respiratory health: a review of the literature. *Allergy* 53: 12-128.

Raw, G. (2001). *Building regulation health and safety*. Watford: UK Building Research Establishment.

Shah, S. and Peacock, J. (1999). Deprivation and excess winter mortality. *Journal of Epidemiology and Community Health* 53: 499-502.

Sheikh, A. and Hurwitz, B. (2003). House dust mite avoidance measures for perennial allergic rhinitis: a systematic review of efficacy. *British Journal of General Practice* 53 (489); 318-22.

Social Exclusion Unit (2000). *National strategy for neighbourhood renewal: action plan*. London: Cabinet Office.

Social Exclusion Unit (2001). *A new commitment to neighbourhood renewal: national strategy action plan*. London: Cabinet Office.

Somerville, M. (2000). Housing and health: does installing heating in their homes improve the health of children with asthma? *Public Health* 114 (6): 434-9.

Stewart, J. and Rhoden, M. (2003). A review of social housing regeneration in the London Borough of Brent. *Journal of the Royal Society of Health*. 123 (1): 23-32.

Strachan, D. and Elton, P. (1986). Relationship between respiratory morbidity in children and the home environment. *Family Practice* 3 :137-42.

Strategy Unit (2005). *Improving the prospects of people living in areas of multiple deprivation in England*. London: Cabinet Office.

Swann, C., Falce, C., Morgan, A., Kelly, M., Powell, G., Carmona, C., Taylor L. and Taske, N. (2005). *HDA Evidence Base: process and quality standards manual for evidence briefings*. 3rd edition. London: Health Development Agency.

Thomson, H., Petticrew, M. and Morrison, D. (2001). Health effects of housing improvement: systematic review of intervention studies. *British Medical Journal* 323 (7306): 187-90.

Thomson, H., Petticrew, M. and Morrison, D. (2002). *Housing improvement and health gain: a summary and systematic review*. Occasional Paper 5. University of Glasgow: MRC Social and Public Health Sciences Unit.

Thomson, H., Petticrew, M. and Douglas, M. (2003). Health impact assessment of housing improvements: incorporating research evidence. *Journal of Epidemiology and Community Health* 57 (1): 11-6.

Towner, E., Dowswell, T., Mackereth, C. and Jarvis, S. (2001). *What works in preventing unintentional injuries in children and young adolescents? An updated systematic review*. London: Health Development Agency.

Van Rossum, C. T. M., Shipley, M. J., Hemingway, H. Grobbee, D. E., Mackenbach, J. P. and Marmot M. G. (2001). Seasonal variation in cause-specific mortality: Are there high-risk groups? 25-year follow-up of civil servants from the first Whitehall study. *International Journal of Epidemiology* 30: 1109-16.

Wanless, D. (2004). *Securing good health for the whole population*. London: HM Treasury.

Watson, l., Gamble, J. and Schofield, R. (2000). *Fire statistics United Kingdom 1999 London*. Home Office, Research Development and Statistics Directorate.

Wilkinson, P., Pattenden, S., Armstrong, B., Fletcher, A., Sari Kovats, R., Mangtani, P. and McMichael, A. J. (2004). Vulnerability to winter mortality in elderly people in Britain: population based study. *British Medical Journal* 329: 647.

APPENDIX 1

Search strategy

1. meta.ab.
2. synthesis.ab.
3. literature.ab.
4. randomized.hw.
5. published.ab.
6. meta-analysis.pt.
7. extraction.ab.
8. trials.hw.
9. controlled.hw.
10. medline.ab.
11. selection.ab.
12. sources.ab.
13. trials.ab.
14. review.ab.
15. review.pt.
16. articles.ab.
17. reviewed.ab.
18. comment.pt.
19. letter.pt.
20. editorial.pt.
21. animal/
22. human/
23. 21 not (21 and 22)
24. or/1-17
25. 24 not (18 or 19 or 20 or 23)
26. exp housing/
27. exp public housing/
28. (hous$ or home$).ti.
29. living environment.ti,ab.
30. living condition.ti,ab.
31. living quarter$.ti,ab.
32. dwelling.ti,ab.
33. residence$.ti,ab.
34. residential.ti,ab.
35. accomodation$.ti,ab.
36. owner occupie$.ti,ab.
37. tenant$.ti,ab.
38. home?owner$.ti,ab.
39. landlord$.ti,ab.
40. rehous$.ti,ab.
41. (flat or flats).ti,ab.
42. (condo or condominium).ti,ab.
43. bungalow$.ti,ab.
44. multi?stor$.ti,ab.
45. high?rise.ti,ab.
46. bed?sit$.ti,ab.
47. abode.ti,ab.
48. maisonette$.ti,ab.
49. apartment$.ti,ab.
50. tower block$.ti,ab.
51. estate.ti,ab.
52. or/26-51
53. (overcrowd$ or crowding or refurbish$ or insulat$ or heating or damp or mold$ or mould$ or sanitation or sanitary).ti,ab.
54. (double glazing or fuel poverty or ventilation or air pollution or air pollutant$ or air quality or air temperature or humidity or condensation or carbon monoxide or cooking gas or asbestos or vacuuming or air purifier$ or radon or lead poisoning or chemical treatment or refurbishment).ti,ab.
55. (mites or rats or mice or cockroaches or vermin or fleas).ti,ab.
56. (asthma or respiratory illness or mental disorder or anxiety or irritability or depression or sleep disturbance$ or allerg$ or eczema).ti,ab.
57. (design or layout or architecture or accessibility or usability or urban design or high-rise or improvement$).ti,ab.
58. (regeneration or neighbourhood or neighborhood or social planning or crime reduction or social environment or leisure facilit$ or renewal or polic$ or supermarket$ or shop$ or park$).ti,ab.
59. or/53-58
60. 52 and 59
61. health$.mp. and (effect$ or intervention$ or improv$ or reduc$ or well?being or inequalit$ or impact$ or prevent$ or benefit$).ti,ab.
62. 61 and 60
63. 62 and 25
64. limit 63 to (human and english language and yr=1996-2004)

APPENDIX 2

Critical appraisal tool

Authors: _____

Title: _____

Source: _____

Relevance to topic			
Does this paper address your topic area?	Yes	No	Unsure
Circle the type of paper:			
• Systematic review			
• Meta-analysis			
• Synthesis			
• Literature review			
• Other review (please specify)			
Does it address (circle as appropriate)?			
• Effectiveness (interventions and treatments)			
• Causation			
• Monitoring and surveillance trends			
• Cost			
• Other (please specify)			
Transparency			
Does the paper have a clearly focused aim or research question?	Yes	No	Unsure
Consider whether the following are discussed:			
• The population studied	Yes	No	Unsure
• The interventions given	Yes	No	Unsure
• The outcomes considered	Yes	No	Unsure
• Inequalities	Yes	No	Unsure
Systematicity			
Do the reviewers try to identify all relevant English language studies?	Yes	No	Unsure
Consider whether details are given for:			
• Databases searched	Yes	No	Unsure
• Years searched	Yes	No	Unsure
• References followed up	Yes	No	Unsure
• Experts consulted	Yes	No	Unsure
• Grey literature searched	Yes	No	Unsure
• Search terms specified	Yes	No	Unsure
• Inclusion criteria described	Yes	No	Unsure
Is it worth continuing?	Yes	No	
Why/why not?			

Quality			
Do the authors address the quality (rigour) of the included studies?	Yes	No	Unsure
Consider whether the following are used:			
• A rating system	Yes	No	Unsure
• More than one assessor	Yes	No	Unsure
If study results have been combined, was it reasonable to do so?	Yes	No	Unsure
Consider whether the following are true:			
• Are the results of included studies clearly displayed?	Yes	No	Unsure
• Are the studies addressing similar research questions?	Yes	No	Unsure
• Are the studies sufficiently similar in design?	Yes	No	Unsure
• Are the results similar from study to study (test of heterogeneity)?	Yes	No	Unsure
• Are the reasons for any variation in the results discussed?	Yes	No	Unsure
What is the overall finding of the review? Consider: • How the results are expressed (numeric – relative risks, etc) • Whether the results could be due to chance (*p*-values and confidence intervals)			
Are sufficient data from individual studies included to mediate between data and interpretation/conclusions?	Yes	No	Unsure
Does this paper cover all appropriate interventions and approaches for this field (within the aims of the study)? If no, what?	Yes	No	Unsure
Relevance to UK			
Can the results be applied/are generalisable to a UK population/population group?	Yes	No	Unsure
• Are there cultural differences from the UK?	Yes	No	Unsure
• Are there differences in healthcare provision from the UK?	Yes	No	Unsure
• Is the paper focused on a particular target group (age, sex, population sub-group etc)?	Yes	No	Unsure
Accept for inclusion onto Evidence Base?	Yes	No	Refer to third party
Additional comments			

Appendix 3: Summary of critical appraisal findings of papers excluded from the briefing

Author and date	Stage one					Stage two			
	Specifies clear and relevant aim or research question	Identifies appropriate range of source databases	Undertakes additional search strategies	Specifies search terms	Specifies inclusion/ exclusion criteria	Rigour of individual studies assessed	Individual studies' findings presented clearly and consistently	Individual studies' findings analysed clearly and consistently	Conclusions presented relate to individual studies' findings
Acevedo-Garcia et al., 2003	✗ (does not meet inclusion criteria)	✓	✓	✓	✓	–	–	–	–
Beghe, 1996	✗ (an extract of a systematic review by the CRD, 1996b [included in evidence base])	✗	✗	✗	✗	–	–	–	–
Blackman, 2004	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Bromiley et al., 2004	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Brown, 2002	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Brugge et al.. 2004	✗ (not a systematic review)	✓	✗	✗	✗	–	–	–	–
Cave et al., 2001	✗ (Guide to health impact assessment)	✗	✗	✗	✗	–	–	–	–
Cave et al., 2005	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Cole and Reeve, 2001	✗ (does not meet inclusion criteria)	✓	✗	✗	✗	–	–	–	–
Cryer, 2001	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Devaney et al., 1997	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Dickey, 2000	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–

Appendix 3: Summary of critical appraisal findings of papers excluded from the briefing (cont.)

Author and date	Stage one					Stage two			
	Specifies clear and relevant aim or research question	Identifies appropriate range of source databases	Undertakes additional search strategies	Specifies search terms	Specifies inclusion/ exclusion criteria	Rigour of individual studies assessed	Individual studies' findings presented clearly and consistently	Individual studies' findings analysed clearly and consistently	Conclusions presented relate to individual studies' findings
Douglas and Thomson 2003	✗ (Guide to health impact assessment)	✗	✗	✗	✗	–	–	–	–
Easterbrook et al., 2001	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Elliott et al., 2001	✓ (review is systematic, although lacks transparency in selection of material presented)	✓	✓	✗	✗	–	–	–	–
Green, 2004	✗ (primary study)	✗	✗	✗	✗	–	–	–	–
Handy et al., 2002	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	
Harrison and Heywood 2000	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Harrison and Phillips, 2003	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Health Evidence Bulletin Wales, 1998	✗ (review strategy not presented)	✗	✗	✗	✗	–	–	–	–
Kendrick et al., 2000	✗ (does not meet inclusion criteria)	✓	✓	✓	✓	✓	✓	✓	✓
Liddament, 2000	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Maantay, 2001	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Moreland et al., 2003	✗ (does not meet inclusion criteria)	✓	✓	✓	✓	✓	✓	✓	✓
Nishioka et al., 2002	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–

Appendix 3: Summary of critical appraisal findings of papers excluded from the briefing (cont.)

Author and date	Stage one					Stage two			
	Specifies clear and relevant aim or research question	Identifies appropriate range of source databases	Undertakes additional search strategies	Specifies search terms	Specifies inclusion/ exclusion criteria	Rigour of individual studies assessed	Individual studies' findings presented clearly and consistently	Individual studies' findings analysed clearly and consistently	Conclusions presented relate to individual studies' findings
Northridge et al., 2003	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
ODPM, 2003	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Olds, 2001	✗ (an extract of a systematic review by Kendrick et al., 2000)	✗	✗	✗	✗	–	–	–	–
Peat et al., 1998	✗ (not a systematic review)	✓	✗	✗	✗	–	–	–	–
Peroni et al., 2002	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Rayner, 1996	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Roberts et al., 1996	✗ (does not meet inclusion criteria)	✓	✓	✓	✓	–	–	–	–
Rosenheck, 2000	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Saegert et al., 2003	✓ (inadequate presentation of data from primary studies)	✓	✓	✓	✓	✓	✗	✗	not clear
Shapiro and Stout, 2002	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Shaw, 2004	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Srinivasan et al., 2003	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–

Appendix 3: Summary of critical appraisal findings of papers excluded from the briefing (cont.)

Author and date	Stage one					Stage two			
	Specifies clear and relevant aim or research question	Identifies appropriate range of source databases	Undertakes additional search strategies	Specifies search terms	Specifies inclusion/ exclusion criteria	Rigour of individual studies assessed	Individual studies' findings presented clearly and consistently	Individual studies' findings analysed clearly and consistently	Conclusions presented relate to individual studies' findings
Stewart and Rhoden, 2003	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Task Force on Community Preventive Services, 2003	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Thomson et al., 2003	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–
Towner et al., 1996	✗ (does not meet inclusion criteria)	✓	✓	✓	✓	–	–	–	–
Wilkinson, 1999	✗ (not a systematic review)	✗	✗	✗	✗	–	–	–	–

References to Appendix 3

Acevedo-Garcia, D., Lochner, K. A., Osypuk, T. L. and Subramanian, S. V. (2003). Racial/ethnic bias and health. Future directions in residential segregation and health research: a multilevel approach. *American Journal of Public Health* 93 (2): 215-21.

Beghe, C. (1996). Meta-analysis: several strategies prevent falls and subsequent injury in older persons. *Evidence-Based Medicine* 1: 169.

Blackman, T. (2004). *NRU scoping assignment on housing and health*. Report commissioned by the ODPM Neighbourhood Renewal Unit. Not published externally – available from tim.blackman@durham.ac.uk
A risk assessment tool included in the report – *Health Risks and Health Inequalities in Housing: an Assessment Tool* – is available at: www.changeagentteam.org.uk (see Housing section).

Bromiley, R., Adamson, D., and Connolly, S. (2004). *Housing, mutuality and community renewal: a review of the evidence and its relevance to stock transfer in Wales*. Cardiff: Welsh Assembly Government.

Brown, M. J. (2002). Costs and benefits of enforcing housing policies to prevent childhood lead poisoning. *Medical Decision Making* 22 (6): 482-92.

Brugge, D., Hyde, J., Weinbach, B. H., Levy, J. I. and Steinbach, S. (2004). Economic benefits of including environmental issues as a component of comprehensive asthma care: a managed care perspective. *Disease Management and Health Outcomes* 12 (4): 259-72.

Cave, B., Curtis, S., Aviles, M. and Coutts, A. (2001). *The East London Health Action Zone guide to health impact assessment of regeneration projects*. Vol II: housing. East London and City Health Action Zone. Available at: www.geog.qmul.ac.uk/health/research/healthaction/Vol2housing.pdf

Cave, B., Molyneux, P. and Coutts, A. (2005). *Healthy sustainable communities: what works?* Milton Keynes/South Midlands sub-region NHS, Health and Social Care project team.

Cole, I. and Reeve, K. (2001). *Housing and physical environment domain: a review of the evidence base*. New Deal for Communities: national evaluation scoping phase. Centre for Regional Economic and Social Research, Sheffield Hallam University.

Cryer, C. (2001). *What works to prevent accidental injury amongst older people: working document*. London: Health Development Agency.

Devaney, B. L., Ellwood, M. R. and Love, J. M. (1997). Programs that mitigate the effects of poverty on children. *Children and Poverty* 7 (2): 88-112.

Dickey, B. (2000). Review of programs for persons who are homeless and mentally ill. *Harvard Review of Psychiatry* 8 (5): 242-50.

Douglas, M. and Thomson, H. (2003). *Health impact assessment of housing improvements: a guide*. Glasgow: Public Health Institute of Scotland.

Easterbrook, L., Horton, K., Arber, S. and Davidson, K. (2001). *International review of interventions in falls among older people*. London: Health Development Agency and the Department of Trade and Industry, London. Available at: www.dti.gov.uk/homesafetynetwork/pdf/fallsint.pdf

Elliott, E., Landes, R., Popay, J. and Edmans, T. (2001). *Regeneration and health: a selected review of research*. King's Fund and the Nuffield Institute for Health, University of Leeds.

Green, G. (2004). *Housing investment and health in Liverpool*. Centre for regional economic and social research, Sheffield Hallam University.

Handy, S. L., Boarnet, M. G., Ewing, R. and Killingsworth, R. E. (2002). How the built environment affects physical activity: views from urban planning. *American Journal of Preventive Medicine* 23 (2 Suppl); 64-73.

Harrison, L. and Heywood, F. (2000). Health begins at home: the housing-health interface for older people. *Reviews on Environmental Health* 15 (1-2): 149-67.

Harrison, M. and Phillips, D. (2003). *Housing and black and minority ethnic communities: review of the evidence base*. London: Office of the Deputy Prime Minister.

Health Evidence Bulletin Wales (1998). *The healthy environments bulletin*. Available at: http://hebw.uwcm.ac.uk/healthyenvironments/index.html

Kendrick, D., Elkan, R., Hewitt, M., Dewey, M., Blair, M., Robinson, J., Williams, D. and Brummell, K. (2000). Does home visiting improve parenting and the quality of the home environment? A systematic review and meta-analysis. *Archives of Disease in Childhood* 82 (6): 443-51.

Liddament, M. W. (2000). A review of ventilation and the quality of ventilation air. *Indoor Air* 10 (3): 193-9.

Maantay, J. (2001). Zoning, equity, and public health. *American Journal of Public Health* 91 (70): 1033-41.

Moreland, J., Richardson, J., Chan, D. H., O'Neill, J., Bellissimo, A., Grum, R. M. and Shanks, L. (2003). Evidence-based guidelines for the secondary prevention of falls in older adults. *Gerontology* 49 (2): 93-116.

Nishioka, Y., Levy, J. I., Norris, G. A., Wilson, A., Hofstetter, P. and Spengler, J. D. (2002). Integrating risk assessment and life cycle assessment: a case study of insulation. *Risk Analysis* 22 (5): 1003-17.

Northridge, M. E., Sclar, E. D. and Biswas, P. (2003). Sorting out the connections between the built environment and health: a conceptual framework for navigating pathways and planning healthy cities. *Journal of Urban Health* 80 (4): 556-68.

ODPM (2003). *What works? Reviewing the evidence base for neighbourhood renewal*.
London: Office of the Deputy Prime Minister.
Available at: www.neighbourhood.gov.uk

Olds, D. (2001). Review: home visiting programmes that include > or = to 1 postnatal home visit are associated with improved quality of home environment and parenting. *Evidence-Based Mental Health* 4 (1): 13.

Peat, J. K., Dickerson, J. and Li, J. (1998). Effects of damp and mould in the home on respiratory health: a review of the literature. *Allergy* 53 (2): 120-8.

Peroni, D. G., Chatzimichail, A. and Boner, A. L. (2002). Food allergy: what can be done to prevent progression to asthma? *Annals of Allergy, Asthma, and Immunology* 89 (6 Suppl 1): 44-51.

Rayner, K. F. (1996). Condensation and mould: the Canadian experience. *Journal of the Royal Society of Health* 116 (2): 83-6.

Roberts, I., Kramer, M. S. and Suissa, S. (1996). Does home visiting prevent childhood injury – a systematic review of randomised controlled trials. *British Medical Journal* 312 (7022): 29-33.

Rosenheck, R. (2000). Cost-effectiveness of services for mentally ill homeless people: the application of research to policy and practice. *American Journal of Psychiatry* 157 (10): 1563-70.

Saegert, S. C., Klitzman, S., Freudenberg, N., Cooperman-Mroczek, J. and Nassar, S. (2003). Healthy housing: a structured review of published evaluations of US interventions to improve health by modifying housing in the United States, 1990-2001. *American Journal of Public Health* 93 (9): 1471-7.

Shapiro, G. G. and Stout, J. W. (2002). Childhood asthma in the United States: urban issues. *Pediatric Pulmonology* 33 (1): 47-55.

Shaw, M. (2004). Housing and public health. *Annual Review of Public Health* 25: 397-418.

Srinivasan, S., O'Fallon, L. R. and Dearry, A. (2003). Reviewing the evidence. Creating healthy communities, healthy homes, healthy people: initiating a research agenda on the built environment and public health. *American Journal of Public Health* 93 (9): 1446-50.

Stewart, J. and Rhoden, M. (2003). A review of social housing regeneration in the London Borough of Brent. *Journal of the Royal Society of Health* 123 (1): 23-32.

Task Force on Community Preventive Services (2003). Recommendations to promote healthy social environments. *American Journal Preventive Medicine* 24: (3 suppl): 21-4.

Thomson, H., Petticrew, M. and Douglas, M. (2003). Health impact assessment of housing improvements: incorporating research evidence. *Journal of Epidemiology and Community Health*. 57 (1): 11-16.

Towner, E., Dowswell, T., Simpson, G. and Jarvis, S. (1996). *Health promotion in childhood and young adolescence for the prevention of unintentional injuries*. Review commissioned on behalf of the Health Education Authority by the Centre for Reviews and Dissemination, University of York.

Wilkinson, D. (1999). *Poor housing and ill health: a summary of research evidence*. A report commissioned by the Scottish Office, Central Research Unit. Available at: www.scotland.gov.uk/cru/documents/poor-housing-01.pdf