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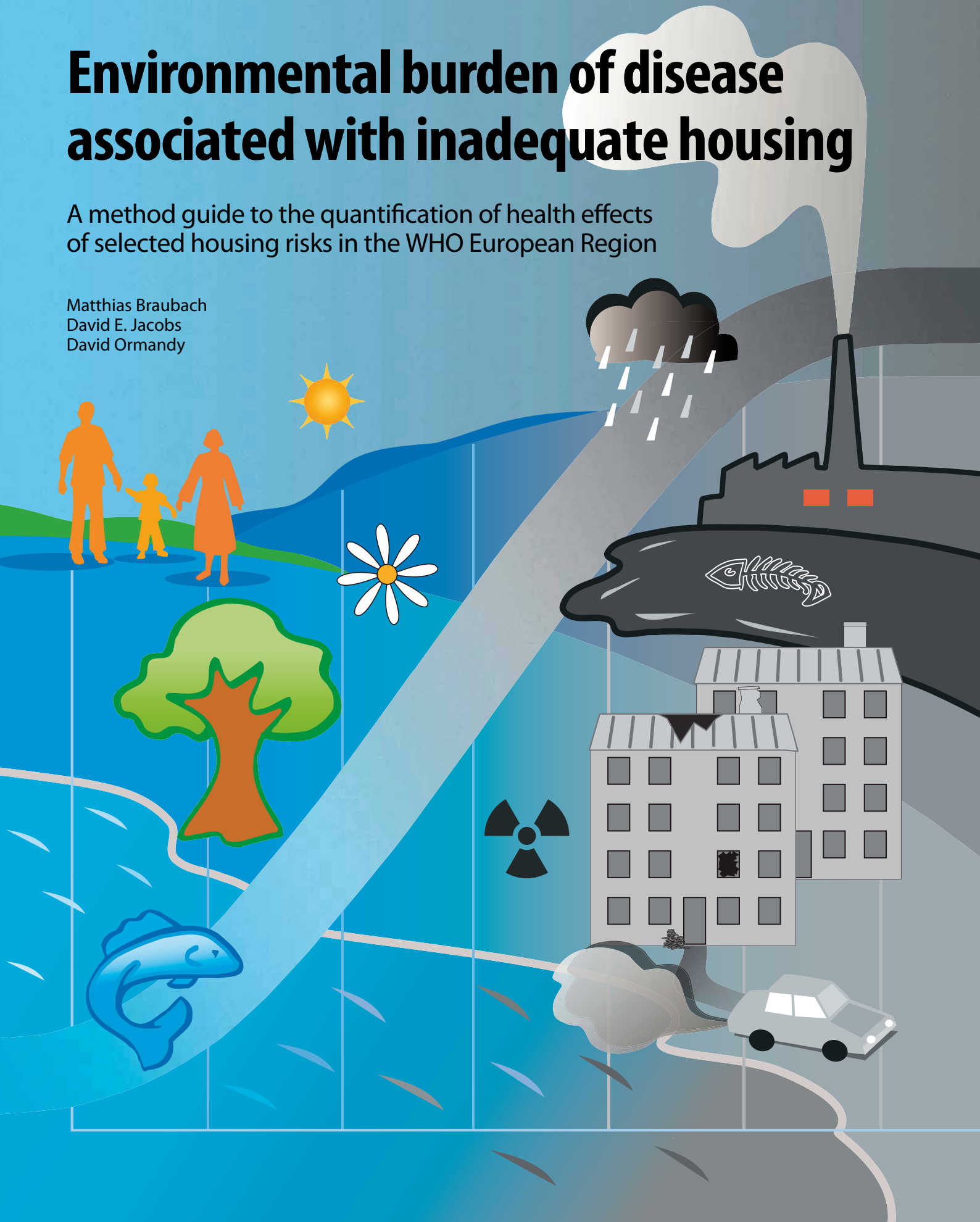
Europe

Summary report

Environmental burden of disease associated with inadequate housing

A method guide to the quantification of health effects
of selected housing risks in the WHO European Region

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The full report *Environmental burden of disease associated with inadequate housing*, which provides all evidence and background information, is available on the WHO Regional Office for Europe web site (http://www.euro.who.int/__data/assets/pdf_file/0003/142077/e95004.pdf).

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Introduction

While housing conditions are known to influence health, little has been done to examine the scale of that influence. Estimating the magnitude of housing-related health impacts is the subject of the report *Environmental burden of disease associated with inadequate housing* (WHO, 2011) which is summarized here.



There is a growing body of evidence on the many ways that inadequate housing adversely affects the health of occupiers. WHO recognizes that housing comprises four interrelated dimensions – the physical structure of the house (or dwelling), the home (psychosocial, economic and cultural construction created by the household), the neighbourhood infrastructure (physical conditions of the immediate housing environment) and the community (social environment and the population and services within the neighbourhood). Each of these four dimensions has the potential to have a direct or indirect impact on physical, social and mental health, and two or more of them combined can have an even larger impact.

In 2005, the WHO Regional Office for Europe (coordinated by the European Centre for Environment and Health, Bonn Office) organized the first of a series of workshops bringing together housing and health experts to investigate how to quantify the negative health impact of certain housing conditions. This and two subsequent workshops developed an approach to the quantification of housing-related health impacts using WHO's environmental burden of disease (EBD) methodology.

The full report quantifies the health impact of risks from various housing hazards, demonstrating that the EBD approach is feasible for the healthy homes field. As the selection of the housing factors considered in the report was based primarily on whether the relevant data are available and amenable to the EBD methodology, not all potential risks from inadequate housing are covered. However, limiting the report to those conditions for which data are available and amenable would have excluded some known high-risk conditions (such as low indoor temperatures) and therefore some chapters use alternative assessment methods.

For certain environmental risks such as lead, radon, second-hand smoke and combustion of solid fuels, EBD assessments already exist. So, rather than duplicate these assessments, the report includes chapters that estimate the proportion of the respective EBD that could be attributed to housing.

Irrespective of the assessment methods applied, all chapters provide:

- an explanation of the topic and its health relevance;
- a summary of how the assessment was calculated and the sources of the data;
- an explanation of how the exposure–risk relationship was derived;
- an overview of exposure to the relevant housing risk factor;
- the housing-related EBD or the alternative assessment for Europe (or the countries for which data are available);
- where possible, estimates for individual Member States of the WHO European Region;
- a description of the uncertainty and restrictions, with suggestions for reducing that uncertainty; and
- policy implications.



For each particular housing risk factor, the related health impacts (if possible) are given in the number of deaths, the number of disability-adjusted life years (DALYs) and/or the number of persons suffering from an associated health outcome. Where possible, the assessment is also expressed as the EBD per 100 000 population per year for the countries covered, in order to provide a more consistent prevalence estimate. All EBD and DALY estimates presented here are annual.

Going beyond the assessment of health impacts, the report also provides information on the effects of housing interventions and estimates the cost to the health sector attributable to inadequate housing conditions.

The WHO global burden of disease (GBD) measures burden of disease using the DALY. This time-based measure combines years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health. The DALY metric was developed in the original GBD 1990 study to assess the burden of disease consistently across diseases, risk factors and regions. For further information, see the WHO web site (WHO (2008)).

In summary, the full report provides various toolkits that can be applied to the quantification of health impacts of housing risks on a national as well as a local level. The housing, environment and health communities can use these examples for developing further work to quantify and report on the health impacts of inadequate housing conditions.

Single vs multiple exposures

In all chapters, the relationship of a single housing risk factor with one or more health outcomes is presented. This segmented approach was taken for practical reasons and was necessary to assess the quality of the evidence for a given housing–health relationship. Nevertheless, this approach is likely to underestimate the true extent of this relationship, as many dwellings will have more than one health-threatening defect. Some conditions are directly linked; for example, energy-inefficient dwellings with low indoor temperatures will be prone to dampness and mould. For others, the presence of one condition may have a synergistic effect increasing the risk from another exposure, such as the parallel presence of

tobacco smoke and radon, which strongly increases the risk of lung cancer.

It is important to recognize the possible interrelationships among the various aspects of housing. This means that improvements to one aspect may affect another, and that effect may be either negative or positive. For example, improvements to energy efficiency may include draught-proofing to reduce heat wasted through excessive air changes, but this could have a negative impact on indoor air quality. Nevertheless, as some conditions may be linked, it may mean that dealing with one problem may also resolve another. For example, improving energy efficiency and ventilation should also reduce the likelihood of damp and mould.



EBD assessments for selected housing risks



Indoor dampness and mould and asthma onset in children

One of the most significant childhood chronic conditions in developed countries is asthma. A considerable proportion of childhood asthma cases is attributable to exposure to indoor dampness and mould. Based on data for 45 countries of the European Region, Jaakkola, Haverinen-Shaughnessy, Douwes and Nevalainen^a estimate that 0.07 asthma-related deaths and 50 asthma-related DALYs per 100 000 children per year are associated with exposure to dampness in dwellings, and that 0.06 deaths and 40



DALYs per 100 000 children per year are associated with exposure to mould. In total numbers, mould exposure is associated with 83 deaths per year.

Reducing exposure to damp and mould would be extremely beneficial to public health and prevent or reduce a large proportion of asthma among adolescents and

adults. The cause of dampness and associated mould can be related to the design, construction, maintenance and use of the building. Good design and proper construction can help prevent problems from occurring. Timely maintenance, including speedy response to flooding or a plumbing malfunction, will help keep the dwelling in a sound condition. And making occupiers aware of how and when moisture is generated and how the use of ventilation can contribute to avoiding a build-up of moisture will also minimize health problems. It may not be possible to avoid acute occurrences such as extreme weather events (e.g. storms and floods) but there should be effective responses to deal with the aftermath.



Housing conditions and home injury

There are many features of dwellings that increase the likelihood of a physical injury and also features that could increase the severity of such injuries. The injury outcomes may be diverse, ranging from relatively minor cuts or bruises and broken bones to paralysis, long-term physical



constraints and even death. They can also include burns and scalds and drowning or near-drowning. The causes include slips, trips and falls, entrapments, collisions, poor lighting and poor ergonomics.

Using data for the whole of the WHO European Region, Keall, Ormandy and Baker calcu-

late that there are 7500 deaths and 200 000 DALYS attributable to a lack of window guards and smoke detectors, with the largest number of deaths by far caused by the lack of smoke detectors (0.9 deaths per 100 000 population).

It is possible to avoid many dangerous features in the design and construction of housing. For existing housing, it is possible to carry out works and repairs (often minor) to improve safety, such as installing smoke detectors/alarms, fencing off pools and ponds, fitting window catches and restrictors, providing adequate guarding to balconies, fitting handrails to stairs and installing carbon monoxide detectors.

^a For the full names and affiliations of these and other authors cited in this summary, see the list of contributors in the full report on the WHO Regional Office for Europe web site (http://www.euro.who.int/__data/assets/pdf_file/0003/142077/e95004.pdf).



Household crowding and tuberculosis

If an infected person is present in the dwelling, the spread of infection is more likely when that dwelling is crowded. Using tuberculosis as an example, the additional infection risk in crowded conditions is estimated by Baker, Venugopal and Howden-Chapman.

Tuberculosis associated with household crowding in the Euro B and Euro C subregions – see box below – results in 0.6 deaths and 6.8 DALYs per 100 000 population (a total of 15 525 tuberculosis cases and 2559 deaths). Crowding is the result of a mismatch between the household and the dwelling; policies directed to promoting an adequate supply of affordable and suitably sized houses, together with the speedy diagnosis and treatment of infectious diseases, would help reduce the possibility of the spread of such infections.

Epidemiological subregions of the WHO European Region

Subregion	Member States covered
Euro A	Andorra, Austria, Belgium, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, San Marino, Slovenia, Spain, Sweden, Switzerland, United Kingdom
Euro B	Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Georgia, Kyrgyzstan, Montenegro, Poland, Romania, Serbia, Slovakia, Tajikistan, the former Yugoslav Republic of Macedonia, Turkey, Turkmenistan, Uzbekistan
Euro C	Belarus, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Republic of Moldova, Russian Federation, Ukraine

Source: Based on WHO, 2000.



Indoor cold and mortality

Deaths from cardiovascular diseases are directly linked to exposure to excessively low indoor temperatures for long periods. It appears that 50–70% of excess winter deaths are attributed to cardiovascular conditions, and some 15–33% to respiratory disease. While the EBD methodology could not be fully applied in this case owing to missing data, an estimate is given for the percentage of excess winter deaths related to cold housing using data from several studies. Rudge estimates that, each year, 38 200 excess winter deaths in 11 European countries are related to low indoor temperatures, representing 12.8 excess deaths per 100 000 population due to indoor cold.



Low indoor temperatures are a combined result of energy inefficiency of the dwelling (poor thermal insulation and/or inefficient or inappropriate provision for heating), the social or economic status of the household and the cost of energy. New dwellings should be designed and constructed to meet energy efficiency standards while also providing for adequate heating and ventilation. For existing dwellings, there are two possible solutions – financial subsidies to those households struggling to meet the cost of energy required to maintain adequate temperatures, and energy efficiency measures (additional insulation and efficient provision for heating and ventilation). The first is a short-term solution but necessary to protect health, while the second will provide a long-term solution that also contributes to measures to mitigate climate change.



Traffic noise and ischaemic heart disease

Noise is a stressor that produces both physical and psychological outcomes, with adverse effects on the nervous, gastrointestinal, immunosuppressive and cardiovascular systems.

Babisch and Kim discuss the methods for quantifying ischaemic heart disease resulting from long-term exposure to road traffic noise, and give an exemplary estimate of the associated EBD for Germany. In their chapter on the EBD of traffic noise, they focus on cardiovascular effects and estimate that there are 4.8 myocardial infarcts and 30.1 ischaemic heart disease cases per 100 000 population caused by traffic noise. There are three possible approaches to protecting residents from road traffic noise: the first directed at reducing the noise sources from vehicles; the second directed at the modification of housing (better sound insulation and attenuation) and the third directed at reducing the possibility of noise reaching residential buildings by barriers or through adequate urban planning measures.



Indoor radon and lung cancer

While the relationship between indoor exposure to radon and lung cancer lacks country-specific estimates, a summary of the evidence and some examples of studies in three European countries are provided. Zeeb shows that the number of deaths per year attributable to exposure to radon in France, Germany and Switzerland is 1234, 1896 and 231, respectively (2.1–3.2 deaths per 100 000 population).

Although the presence of radon is widespread, high levels are regionally limited depending on the local geology. All new dwellings should be designed and constructed to prevent its penetration where radon

exposure is possible, and mitigation measures should be carried out in existing houses in areas with high levels of radon.



Residential second-hand smoke

It is well established that tobacco smoking damages the health of the smoker, and since the early 1970s it has been shown that exposure to second-hand tobacco smoke (SHS) also affects non-smokers through respiratory infections and asthma in children and lung cancer and coronary heart disease in adults.

In total, Jaakkola calculates the number of deaths and DALYs caused by SHS to be 7.3 and 80.7 per 100 000 population, respectively in the European Region, causing a total of 64 700 deaths per year. As smoking and exposure to SHS are not attributable to the design, construction or maintenance of housing, and ventilation rates are by no means an adequate solution to the problem, this health risk cannot be tackled through housing-specific action alone. Given the fact that indoor spaces accumulate the smoke and thus lead to the exposure of non-smoking persons, especially children, occupiers (and particularly parents) should be made aware of the related threats to health and programmes should be put in place to discourage smoking in dwellings and other indoor spaces.



Health effects of lead in housing

The evidence on the link between health and lead in housing is discussed by Jacobs and, as no detailed country-specific estimates are available for Europe, a summary of the evidence is given. Even low-level exposure to lead has cognitive, developmental, neurological, behavioural, cardiovascular and other effects, and higher



exposure levels can result in acute poisoning. The association with childhood lead poisoning of lead-based paint, lead-contaminated dust and soil and lead in drinking-water is now well-established. Exposure to lead in housing in the European Region is calculated to result in at least 694 980 DALYs (79.2 per 100 000 population) per year.

Controlling exposures to lead in housing is known to be effective, including a combination of cleaning, covering and/or removing lead painted surfaces and removing lead-contaminated dust and soil. New housing should not use any materials containing lead.



Household carbon monoxide poisoning

Kales, Islam and Kim show that carbon monoxide poisoning is a major cause of home poisoning related to the combustion of carbon-based fuels such as gas and solid fuels. Carbon monoxide exposure in indoor settings can quickly reach lethal levels but reliable, measured data on domestic exposure are rare. Thus, the assessment provides only the potential range of health outcomes expected for countries of the Euro A subregion for which relevant data are available. Kales and colleagues estimate that within this subregion there are between 114 and 1545 persons suffering from carbon-monoxide-related delayed or persistent neurological sequelae, corresponding to between 0.03 and 0.4 per 100 000 population. Based on the household energy sources in the Euro B and Euro C subregions, it can be assumed that the EBD may even be higher there, but lack of data restricts the assessment to Euro A.

Actions to prevent carbon monoxide poisoning include the regular maintenance of appliances burning gas, oil and solid fuel, ensuring an adequate supply of air for combustion for such equipment, making occupiers aware of the dangers of using inappropriate forms of heating (such as flueless gas or oil heaters) and the installation of carbon monoxide detectors in homes with gas, oil or solid fuel appliances (which is already mandatory in some countries).



Formaldehyde and respiratory symptoms in children

Because indoor concentrations of formaldehyde are poorly characterized in Europe, Gilbert and Guay provide a summary of the evidence that focuses on indoor exposure and increased prevalence of lower respiratory tract symptoms in children. They estimate that formaldehyde is associated with up to 1% of wheezing in children.

Formaldehyde is commonly used in many adhesives, pressed wood products and other building materials, and could be better regulated and controlled. High indoor levels are also associated with an inadequate supply of fresh air. Methods of controlling exposure include proper ventilation and use of materials that are free of (or contain low levels of) formaldehyde.



Indoor smoke from solid fuel use

The use of solid fuel for cooking or heating in open fires or inadequately vented stoves and ovens and in dwellings with poor ventilation produces high concentrations of air pollutants such as particulate matter and carbon monoxide.



These pollutants have been linked to chronic obstructive pulmonary disease and lung cancer in adults and to pneumonia in children. As the disease burden from indoor smoke from solid fuel use has been fully assessed and reported, an evidence summary is provided by Desai, Rehfuess, Mehta and Smith. They calculate that, for the Euro B and Euro C subregions, 14 280 deaths and 394 600 DALYs per year are related to exposure to indoor pollutants from solid fuel use. The largest health impact is



reported for acute lower respiratory tract infections in children under 5 years of age, which are estimated to cause 16.7 deaths per 100 000 children per year. There are effective means of reducing the production of combustion-related indoor pollutants, including technological improvements to stoves and ovens, improved housing ventilation and the use of cleaner fuels.



Housing quality and mental health

Evans reviews the evidence of the relationship between housing quality and mental health. Inadequate housing is stressful in several respects, including concerns about hazards and safety, financial worries about mortgage or rent payments, and concerns about meeting running (operating) costs, such as maintenance and utility bills. The design of some types of housing (such as high-rise buildings) may encourage social isolation. Those with a low income may feel a greater lack of control over their environment.



One finding in this work is that there is a need to recognize fully the effects on mental health of inadequate housing, which is difficult to assess based on the EBD approach. While it is unlikely that housing alone will precipitate serious mental disorder, it can induce chronic stress with symptoms of anxiety, depression, hostility and frustration. Poor-quality housing is also associated with poverty, and both are related to mental stress.



Housing improvements and their health effects

Poverty, poor housing and poor health are usually linked, and this means that it is difficult to measure health gains from improvements in housing conditions alone. Thomson provides a synthesis of data on the health impact of energy efficiency improvements and the effects of neighbourhood renewal or regeneration, showing that various interventions have had a positive impact on health.



The economic cost of inadequate housing

Nicol, Roys, Davidson, Ormandy and Ambrose report on the development of a methodology to quantify the annual cost of inadequate housing conditions to the health sector compared with the one-off (single) cost of remediation action. In England alone, this cost is estimated to be at least £600 million (some €717 million) per year. This cost to the health sector is estimated to be around 40% of the total cost to society, as it does e.g. not include costs associated with educational underachievement (through days off school) and time away from work.



Policy implications

While additional data and evidence can be expected to strengthen the finding that the EBD from poor housing is substantial, the conclusion of the report is clear:

Ensuring housing is as safe and healthy as possible will provide large benefits to public health and society generally.

Achieving this objective will involve policies and actions of a wide range of individuals, bodies and agencies concerned with housing, construction, architecture, urban planning, and building financing, equipment and maintenance.

The EBD attributable to inadequate housing in Europe thus more than justifies the introduction of health-based housing policies and actions as a means of achieving better housing and provides clear evidence that housing is an important public health issue. The conclusions given in the report indicate that adequate housing could make a major contribution to the primary prevention of noncommunicable diseases and reduce the spread of communicable diseases.

The findings presented in the report will be of interest to a wide range of individuals and bodies involved in housing. They will be useful to those involved in the design and construction of housing and to those involved in the renovation and improvement of existing housing. The findings will inform policy-makers at local and national levels and those responsible for setting health-based housing standards and requirements. For researchers and other academics, it is hoped that the report will encourage the collection of relevant data on these and other potential housing-related health risks, so as to provide a greater understanding of the health burden that can be attributed to inadequate housing.

Housing strategies and policies are complex as they include planning and construction as well as occupation and residential use, followed by improvement, renovation and reconstruction. This means that

strategies and policies for healthy housing need to be comprehensive and involve a wide range of disciplines. A summary of the most important professions and action areas is given below, suggesting ways forward for action and regulations on adequate and healthy housing.

Control of new housing

The control of the design and construction of new dwellings should ensure that the necessary and appropriate precautions are incorporated to protect against the identified potential threats to health and safety.

Particularly, the design and construction of buildings should include:

- adequate damp-proofing;
- radon protection measures (where necessary);
- prohibition of products associated with off-gassing of compounds (e.g. formaldehyde or similar volatile organic compounds) or release of other harmful material (e.g. lead or asbestos);
- provision to maintain effective controllable ventilation;
- effective protection against noise penetration;
- energy efficiency (thermal insulation, efficient provision of heating and draught-proofing);
- mandatory installation of smoke and carbon monoxide detectors/alarms;
- fencing-off of pools and ponds;
- safety catches and restrictors on windows;
- guarding to stairs and balconies (such as balustrades, handrails etc.) and other fall protection measures; and
- safe design and layout of kitchens, bathrooms, other rooms and exits.

The matters mentioned above are those covered by the various report chapters, but clearly the control of housing should ensure the full range of safe and healthy conditions, with all necessary facilities and



amenities. Aspects not covered in the report include water supply and sanitation, asbestos and other building-related pollutants, heat exposure, ventilation, pest infestation, fine particles, hygiene requirements, the location of settlements in safe areas, avoiding potential natural disasters (flooding, landslides etc.) and avoiding potential pollution from waste sites, incineration plants and industries with harmful emissions.

To be effective, the controls should be in the form of legislative and regulatory codes, capable of being properly applied and enforced and backed by effective sanctions in the case of non-compliance. In addition to controls on the design and construction of individual dwellings, there should be effective planning. These measures should include ensuring that housing is protected from noise sources, either by separation from roads and other potential sources or by the provision of barriers.

There should be programmes directed to the provision of affordable housing. The number and size of housing units should take account of local and national demands and trends. This can limit crowding and the associated risks to health that are not caused by the building itself but by a mismatch between the size of the building and the characteristics of the household.

Control of conditions in existing housing

New dwellings make up only a very small proportion of the housing stock; the vast majority of the stock already exists and some of it is old and built to standards unacceptable today. It is the existing housing, therefore, where health-based policies and actions will have the biggest impact, and guidance should be developed for its improvement and rehabilitation.

Clearly, it will not be possible to improve all the housing stock at once. There should be national and local policies and programmes with defined, prioritized target areas where the most serious conditions are likely to exist.

One obvious problem associated with renovation and improvement programmes is that of funding. Research findings demonstrate that there is a large cost to society from the health outcomes attributable to inadequate housing, particularly to the health sector, but also to other sectors such as energy, housing, financial institutions and the environment. This means that the one-off (single) cost of remedying or at least reducing potential threats to health from inadequate housing will produce a continuing benefit to society. While it should be the owner of the dwelling who pays for the maintenance and improvement of that dwelling (the owner's asset), where the owner cannot afford the cost of works there is good reason for some form of state subsidy: a grant or a loan or an option to release equity through the purchase of a share in the property. Many countries are increasingly struggling with the rising costs of medical care, and improved investment in housing will help to contain and reduce those costs.



Housing designers, constructors and managers

While it may be considered necessary to have in place effective controls on new and existing dwellings, all those involved in the design, construction, management, maintenance and repair/rehabilitation of housing and building-related equipment should be made aware of and educated on the links between housing conditions and health. As well as



understanding the links, these housing professionals have in the past and can in the future contribute to making housing safer and healthier. By involving different sectors and approaches, it is likely that new and innovative ways of avoiding housing conditions that threaten health and safety will be developed and implemented.

Policy-makers and regulators

While many housing standards and codes may have originally been based on health principles, in most cases there has been a lack of continued input from the health community. The result is that, over the years, housing providers and other housing professionals have increasingly concentrated on the buildings and equipment, with limited ability to take into account health-based evidence.

Policies and regulations affecting the construction and management of housing can be found on different levels and with varying legal status. Examples are Article 25(1) of the Universal Declaration of Human Rights (United Nations, 1948), the Istanbul Declaration on Human Settlements (United Nations Habitat, 1996) and the European Social Charter on the right to adequate housing under article 31 (Council of Europe, 2008).

Article 25(1) of the Universal Declaration of Human Rights

“Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control”.

Istanbul Declaration on Human Settlements

Member States are committed to “endorse the universal goals of ensuring adequate shelter for all and making human settlements safer, healthier and more liveable, equitable, sustainable and productive”.

European Social Charter on the right to adequate housing under Article 31

“With a view to ensuring the effective exercise of the right to housing, the Parties undertake to take measures designed:

1. to promote access to housing of an adequate standard;
2. to prevent and reduce homelessness with a view to its gradual elimination;
3. to make the price of housing accessible to those without adequate resources”.

The European Commission issues directives, including ones that directly and indirectly affect housing, such as the Construction Product Directive 1989 and the Energy Performance of Building Directive 2003. At national level, governments have adopted a variety of regulations covering such matters as energy, safety, personal hygiene, food safety, design and layout and so on.

There is a wide range of disciplines and professionals who have or should have an interest in housing standards and conditions, but these are not always brought together. Ideally, current building and housing codes and regulations should be regularly reviewed and critically evaluated against modern construction techniques, the use of the buildings and the available health evidence.

Housing occupants

How a dwelling is used can contribute to (or even cause) unhealthy conditions. Yet many occupants are rarely informed about housing-related health hazards. When moving into a home, most occupants receive





little or no advice about how to manage what is likely to be their single largest investment and what will become their home. To enable occupiers to make wise and informed decisions, there should be public campaigns to inform them of dangers (such as carbon monoxide and the threats to others from SHS) and of important precautions (such as effective ventilation). Occupiers should also be made aware of any subsidies that may be available, such as financial assistance towards energy efficiency improvements.

Health professionals

The health sector must become more involved in the development and implementation of policies and programmes directed at dealing with inadequate housing, which is a major environmental context for any individual and especially for more vulnerable groups such as children, elderly people and those who are sick. Inadequate housing results in additional costs to society, particularly costs to the health sector. Because of this relationship between housing conditions and health, health data can and should be used to monitor the effectiveness of housing programmes and policies.



Systems should be put in place enabling doctors and accident and emergency departments to refer patients (with their consent) for housing advice where they present with health conditions and injuries that could be related to housing conditions. There are examples of such systems, including *Conseiller Médical en Environnement Intérieur* in France or the *Green Ambulance* in Brussels (and various other places), where a referral is made when a patient presents with a certain health condition that could be associated with the housing environment.

Such a referral then triggers an investigation of possible exposures and risks in the home environment as a potential cause of the respective health effects.

Local authorities/municipalities

There are several functions and activities of local authorities that can promote healthier housing and alleviate conditions that could threaten health and safety.



First, urban planning in general should take account of the housing environment in the widest sense. Housing should be protected from sources of noise and air pollution. The immediate environment should facilitate walking and other physical activities and give easy access to open spaces.

Second, local authorities usually have the responsibility for reviewing the housing needs of their areas and for developing and implementing housing strategies. Such strategies will cover the provision of new housing, schemes for the replacement of obsolete housing and the application and enforcement of standards. The health relevance of housing means that there should be input from public health professionals into the local strategies, and an intense cooperation among the health, social and housing departments at both the municipal and regional levels.

Third, public housing agencies are in a position to directly support and provide adequate housing conditions for the benefit of the health and quality of life of their tenants, often including some of the most vulnerable population groups.



Conclusion

Research

The contributions to this work are limited to those areas where sufficient data are available. However, because of insufficient evidence, many potential health-threatening housing conditions are currently difficult to quantify. Additional research will improve and enhance the existing evidence base, particularly if it goes beyond the infrastructure-, engineering- or finance-related aspects of housing to consider its main function – the provision of a safe and healthy residential environment for the occupiers. The lack of evidence is particularly high in relation to the health and cost benefits of housing interventions. Systems should be developed to evaluate and monitor the effects of housing improvements in both the short and long term. These systems will provide valuable evidence to inform policies and practices, helping to ensure effective targeting of resources, better housing and improved health for all.

The report provides evidence that the health consequences of inadequate housing are substantial. Improving housing in a way that removes or at least minimizes the negative impact on health and safety and promotes a healthier living environment is good for the residents and beneficial for society. Reducing the burden of responding to the demands on the health system attributable to inadequate housing should therefore be seen as an obvious public health priority, but also as something that makes economic sense.

The findings set out in the report provide ample justification for the principle that health should be at the centre of housing policy. Making housing healthy, affordable and sustainable should be a prime objective of all professionals and policy-makers involved in any aspect of housing and of health, and the significant contribution of adequate housing to a healthy lifestyle should be more widely recognized.

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Summary of exposure, population-attributable fraction (PAF) and EBD from inadequate housing conditions

	Exposure	Health outcome	Exposure–risk relationship	PAF	EBD from housing per year
	Mould	Asthma deaths and DALYs in children (0–14 years)	RR = 2.4	12.3%	45 countries of the European Region: 83 deaths (0.06 per 100 000) 55 842 DALYs (40 per 100 000)
	Dampness	Asthma deaths and DALYs in children (0–14 years)	RR = 2.2	15.3%	45 countries of the European Region: 103 deaths (0.07 per 100 000) 69 462 DALYs (50 per 100 000)
	Lack of window guards	Injury deaths and DALYs (0–14 years)	RR = 2.0	33–47%	European Region: ~10 deaths (0.007 per 100 000) ~3310 DALYs (2.0 per 100 000)
	Lack of smoke detectors	Injury deaths and DALYs (all ages)	RR = 2.0	2–50%	European Region: 7523 deaths (0.9 per 100 000) 197 565 DALYs (22.4 per 100 000)
	Crowding	Tuberculosis	RR = 1.5	4.8%	EURO B and EURO C subregions: ^a 15 351 cases (3.3 per 100 000) 3518 deaths (0.8 per 100 000) 81 210 DALYs (17.6 per 100 000)
	Indoor cold	Excess winter mortality	0.15% increased mortality per °C	30%	11 European countries: 38 203 excess winter deaths (12.8 per 100 000)
	Traffic noise	Ischaemic heart disease including myocardial infarction	RR = 1.17 per 10 dB(A)	2.9%	Germany only: 3900 myocardial infarcts (4.8 per 100 000) 24 700 ischaemic heart disease cases (30.1 per 100 000) 25 300 DALYs (30.8 per 100 000)
	Radon	Lung cancer	RR = 1.08 per 100 Bq/m ³	2–12%	Three western European countries: France: 1234 deaths (2.1 per 100 000) Germany: 1896 deaths (2.3 per 100 000) Switzerland: 231 deaths (3.2 per 100 000)
	Residential SHS	Lower respiratory infections, asthma, heart disease and lung cancer	Risk estimates range from 1.2 to 2.0 OR = 4.4	PAF estimates range from 0.6% to 23%	European Region: 64 700 deaths (7.3 per 100 000) 713 000 DALYs (80.7 per 100 000)
	Lead	Mental retardation, cardiovascular disease, behavioural problems	Case fatality rate 3%;	66%	European Region: 694 980 DALYs (79.2 per 100 000)
	Indoor carbon monoxide	Headache, nausea, cardiovascular ischaemia/insufficiency, seizures, coma, loss of consciousness, death	DNS/PNS incidence 3–40%	50–64%	EURO A subregion: ^a 114–1545 persons with DNS/PNS (0.03–0.4 per 100 000) 114 ± 97 deaths (0.03 ± 0.02 per 100 000)
	Formaldehyde	Lower respiratory symptoms in children	OR = 1.4	3.7%	EURO A subregion: ^a 0.3–0.6% of wheezing in children
	Indoor solid fuel use	COPD, ALRI, lung cancer	RR = 1.5–3.2	6–15%	European Region: 8490 ALRI deaths in children < 5 years (16.7 per 100 000) 293 600 ALRI DALYs in children < 5 years (577 per 100 000) 5800 COPD deaths in adults ≥ 30 years (1.1 per 100 000) 100 700 COPD DALYs in adults ≥ 30 years (19.3 per 100 000)

Note: OR = odds ratio; RR = relative risk; DALYs = disability-adjusted life years; N/A = not available; COPD = chronic obstructive pulmonary disease; ALRI = acute lower respiratory infections; DNS/PNS = delayed or persistent neurological sequelae.
^aThe lists of countries in the WHO European subregions are provided on page 4.

This summary report presents key findings of the report *Environmental burden of disease associated with inadequate housing* published by the WHO Regional Office for Europe in 2011. It provides evidence that the health consequences of inadequate housing are substantial. Improving housing in a way that removes or at least minimizes the negative impact on health and safety and promotes a healthier living environment is good for the residents and beneficial for society. Reducing the burden of responding to the demands on the health system attributable to inadequate housing should therefore be seen as an obvious public health priority, but also as something that makes economic sense.

The findings set out in the full report provide ample justification for the principle that health should be at the centre of housing policy. Making housing healthy, affordable and sustainable should be a prime objective of all professionals and policy-makers involved in any aspect of housing and of health, and the significant contribution of adequate housing to a healthy lifestyle should be more widely recognized.

The full report *Environmental burden of disease associated with inadequate housing*, which provides all evidence and background information, is available on the WHO Regional Office for Europe web site (http://www.euro.who.int/__data/assets/pdf_file/0003/142077/e95004.pdf).

