
Inadequate housing and health: an overview

Xavier Bonnefoy

Environment and Health Consultant, Paris, France
E-mail: xbo@env-and-health.com

Abstract: For many years, the housing environment has been acknowledged as one of the main settings that affect human health. Living and housing conditions are the basis of many factors influencing residential health. Still, to date there is no commonly agreed upon definition of 'healthy housing', and there are still major gaps in the knowledge on how housing conditions may affect health. Epidemiological findings suggest strong associations between housing conditions and health effects. This paper explores the relevance of housing conditions as a key factor influencing mental health, sleep quality, indoor air, home safety, accessibility, obesity, mould growth, hygrothermal conditions and energy consumption, perception of crime, and residential quality.

Keywords: housing conditions; inadequate housing; health; evidence.

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Biographical notes: Xavier Bonnefoy is a Civil Engineer, Sanitary Engineer and has Post Graduate Degree from the Faculty of Medicine of Nancy in Public Health (CES de santé publique). Currently, he is working as an Environment and Health Consultant. Until July 2006, he served as Regional Adviser and head of the noise and health and housing and health programmes at the European Center for Environment and Health, Bonn office, of the WHO Regional Office for Europe. As WHO staff, he was coordinating the team in charge of the implementation of the Budapest conference declaration aspects related to housing and health in the European Region of WHO.

1 Introduction

For many years, the housing environment has been acknowledged as one of the main settings that affect human health. Living and housing conditions are the basis of many factors influencing residential health (Jackson, 2003). Indoor air quality, home safety, noise, humidity and mould growth, indoor temperatures, asbestos, lead, radon, volatile organic compounds (VOC), lack of hygiene and sanitation equipment, and crowding are some of the most relevant possible health threats to be found in dwellings. Physical, mental, and social health is affected by the living conditions, but no straightforward mechanisms have yet been established. Furthermore, the immediate housing environment and the neighbourhood represent an everyday-landscape, which can either support or limit the physical, mental, and social well-being of the residents. Although such impacts are broadly accepted, the concrete relationship between environmental quality and health/well-being has so far not been fully understood.

The quality of housing conditions plays a decisive role in the health status of the residents. Many health problems are either directly or indirectly related to the building itself, because of the construction materials that were used and the equipment installed, or the size or design of the individual dwellings. Representing the spatial point of reference for each individual, the home also has a broad influence on the psychosocial and mental well-being by providing the basis for place attachment and identity as well as a last refuge from daily life. However, especially, for this mental dimension of housing satisfaction and the meaning of home to the resident, not much data on the relation between health and well-being, and subjective satisfaction, and housing perception are available.

To date, there is still no commonly agreed upon definition of 'healthy housing', and there are still major gaps in the knowledge on how housing conditions may affect health and which mitigation strategies may show the best results. Furthermore, responsibilities for housing issues are mostly out of reach for many ministries of health, as housing is a traditional work field for ministries of construction or housing, or falls under the mandate of the ministry of environment. Because of this allocation of authority, a large amount of health-relevant decisions are assumed by the development and enforcement of urban planning guidelines, building regulations, and other relevant legal frameworks and policies directed at the various actors and stakeholders in the field of housing construction and maintenance.

The past decade has brought an increasing amount of research and numerous publications on the influence of living conditions on the health of occupants, the evidence base for the complex effects of housing conditions on health is growing (e.g., Lowry, 1991; Ranson, 1991; Ineichen, 1993; Burrige and Ormandy, 1993; Raw and Hamilton, 1995; Fiedler, 1997; Dunn and Hayes, 2000; Fuller-Thomson et al., 2000; Mackenbach and Howden-Chapman, 2002; Bonnefoy et al., 2003a, 2003b; Evans, 2003; Thomson et al., 2001; Shaw, 2004; WHO Regional Office for Europe, 2004a). There is a lack of fundamental research on housing and health in the context of current urbanisation trends, which have "not been well understood in terms of both the positive and the negative impacts on health and well-being (Lawrence, 2000, p.1). However, reviews of literature on housing and health show" that most studies deal with sectoral research, focusing on specific parameters of the diverse housing-health-relationship. A recent review concluded that a majority of such studies was too focused, unbalanced, or of low practical relevance (Fuller-Thomson et al., 2000).

What has been known for decades is that in the case of substandard housing conditions, residents may be the subject of several housing threats. Evidence has shown that those who have the least resources at their disposal suffer the worst housing conditions. Dealing with poverty will thus remain a most important element in any housing policy, either through specific housing programmes, or through specific economic policies.

Looking into the available knowledge in housing-health relationships, the WHO Regional Office for Europe established a programme on housing and health in 2001 and carried out a review of evidence on selected housing and health issues. The Regional Office's European Centre for Environment and Health, Bonn (ECEH) offers scientific support to identify effective, evidence-based policies on the environment and health, and provides recommendations for decision-making and legislation. Under the overarching theme of the urban environment and health, housing and health has been defined as a priority issue. Through global responsibility or global leadership in these

fields, ECEH, Bonn provides all WHO regions with guidelines for work related to environmental and health conditions. Following these objectives, the housing and health programme seeks to:

- assess and quantify the health impact of housing conditions
- identify health priorities in housing
- develop methodologies for a cost-benefit analysis for housing rehabilitation for health gain
- focus on specific priority technical topics.

2 The WHO approach to housing and health

To live in an adequate shelter means more than a roof over one's head: It means to have a home, a place which protects privacy, contributes to physical and psychological well-being, and supports the development and social integration of its inhabitants – a central place for human life.

'Healthy housing' must, therefore, be a comprehensive concept taking into consideration a variety of factors contributing to the quality of housing and housing environment. A healthy home is not a specially designed house, it is also a residential setting that is capable of fulfilling the expectations of the residents. For the provision of these benefits, housing standards and good practice examples have been gained and accumulated over centuries of housing production, showing that the construction of a 'healthy home' is mostly a question of applying existing knowledge and validated principles.

During the 2nd HABITAT Conference in Istanbul (1996), United Nations Member States defined housing in the following terms:

Adequate shelter means more than a roof over one's head. It also means adequate privacy; adequate space; physical accessibility; adequate security; security of tenure; structural stability and durability; adequate lighting, heating and ventilation; adequate basic infrastructure, such as water-supply, sanitation and waste-management facilities; suitable environmental quality and health-related factors; and adequate and accessible location with regard to work and basic facilities: all of which should be available at an affordable cost. Adequacy should be determined together with the people concerned, bearing in mind the prospect for gradual development. Adequacy often varies from country to country, since it depends on specific cultural, social, environmental, and economic factors. Gender-specific and age-specific factors, such as the exposure of children and women to toxic substances, should be considered in this context ...

This shows that the relationship between housing and health is obviously a complex mix. It is also an area where national authorities, local authorities, and individuals can work intensively to achieve health gains through improving housing conditions, be it the physical housing or the social environment of the house.

Housing is a complex construct that cannot be represented merely by the physical structure of the home. The WHO understanding of 'housing' is, therefore, based on a four-layer model of housing, taking into consideration the physical structure of the dwelling as well as the meaning of home (for a family and each individual), and

the external dimension of the immediate housing environment, and the community with all neighbours (see Figure 1).

Figure 1 The four dimensions of housing



3 The health relevance of the four housing dimensions

For each individual dimension, there is an array of effects that can be expressed as direct or indirect health effects, or as a limitation of the quality of life of the residents.

A home perceived as safe and intimate provides major psychosocial benefits. It represents a protected refuge from the outside world, enables the development of a sense of identity and attachment – as an individual or as a part of a family, and provides a space to be oneself. Any intrusion of external factors or stressors strongly limits this feeling of safety, intimacy, and control, thereby reducing the mental and social function of the home (Kearns et al., 2000; Relph, 1976).

Inadequate *dwelling conditions* may trigger many of the direct health effects. Mould growth, indoor air pollution, and emissions from building materials are as relevant issues as the occurrence of infestations, inefficiency of heating systems and insulation measures, or lack of hygiene and sanitation amenities. On the structural side, the quality and the design of the dwelling are responsible for potential safety threats, the social functionality of the dwelling, and the degree of limitation for residents with physical handicaps. In addition, to being influenced by other non-housing factors, crowding and noise exposure are also related to the design and layout of the dwelling (Fuller-Thomson et al., 2000; Mackenbach and Howden-Chapman, 2002; Bonnefoy et al., 2003a; Evans, 2003; Thomson et al., 2003; Shaw, 2004, WHO Regional Office for Europe, 2004a).

Within the *community*, a range of health-relevant aspects depends on factors that seem independent of housing conditions. Examples are the health effects with social etiology, which strongly depend on education, socioeconomic characteristics, or ethnic compositions of the people building a community within a neighbourhood or a city quarter. Still, a large number of studies provide sufficient evidence that the social cohesion of the community, and the sense of trust and collective efficacy is to some extent depending on the quality of a neighbourhood, which can promote or impede the social interactions through the provision of diverse public places and facilities for social life (Altgeld, 2004; Stafford and Marmot, 2003; Basolo and Strong, 2002; Cattell, 2001; Morrow, 2001).

Finally, the *immediate housing environment* has an impact on health through the quality of urban design. Poorly planned or deteriorated residential areas often lacking public services, greenery, parks, playgrounds, and walking areas, have been associated with lack of physical exercise, increased prevalence of obesity, cognitive problems in

children, and a loss of the ability to socialise. Symptoms of neighbourhood decline affect residents through both visual mechanisms (litter, pollution, graffiti, etc.) and social mechanisms (segregation, loitering, increased insecurity). In addition, current urban planning trends, such as urban sprawl, may lead to an increased dependence on individual transportation, triggering increased pollution and noise exposure, and endangering or isolating the most vulnerable population groups such as children, the elderly, or people with functional limitations (Cohen et al., 2003; Latkin and Curry 2003; Ellaway et al., 2001; WHO Regional Office for Europe, 1999; van Poll, 1997).

It is important to realise that each of the four dimensions of housing has the capacity to affect individual health status through physical, mental, or social mechanisms and that the four dimensions are interlinked with each other. Adequate housing, therefore, depends on the sufficient provision of services and conditions on all four domains. If this requirement is accomplished, housing provides human beings with satisfaction of physical and mental health needs. Therefore, it is clear that housing conditions play a relevant role for individual as well as for public health:

- health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity
- housing is the conjunction of the dwelling, the home, the immediate environment, and the community
- the role of public health is to provide the circumstances under which people can be healthy.

In summary, the consequence of these three statements is that housing is a topic for consideration to ministries of health, as well as for ministries of environment, social affairs, and construction.

4 Housing and health: a collection of evidence

Housing and health research looks back on a long history. In Victorian times, the relationship between housing conditions, such as overcrowding or poor hygiene and diseases like tuberculosis was studied in the UK by, e.g., Edwin Chadwick (Ineichen, 1993). Florence Nightingale (1820–1910) recognised that: “*The connection between health and the dwellings of the population is one of the most important that exists.*” (Lowry, 1991, p.9) and epidemics such as the plague were based on inadequate sanitation and high living density in rapidly growing cities (Foster, 1992).

Poor hygiene and sanitation as well as crowding are still typical basic problems of growing settlements and megacities, most of which are located in developing countries. However, in developed countries, there are many relevant housing and health challenges still to be tackled – noise exposure, thermal conditions, ventilation, mould, home safety, to name a few.

The largest challenge in the field of housing and health seems to be the collection of clear and straightforward evidence. As housing and health is always affected by a variety of factors, disentangling and assessing the impact of housing conditions on health is not an easy subject. “Housing and health is not and never will be an exact science.” (Ranson, 1991 preface)

Establishing the role of a specific housing factor such as overcrowding, in the face of many other possible contributing factors, is difficult even when the associated disease or injury is well defined. In many situations (e.g., the investigation of noise as a causal factor in ill health), neither the possible disease nor the probable exposure is fully defined, and any effect is likely to be exerted in combination with other contributory factors. In this case, it is important to recognise that direct evidence is unlikely to be produced, no matter how strong the effect (Raw et al., 2000, p.13)

In recent decades, two categories for building-related health outcomes have been proposed on the basis of strength and causality of the various observed health effects:

- Building Related Illness (BRI)
- Sick Building Syndrome (SBS).

BRI represents the health effects that have a clear etiology and can be traced back to the building. Specific health symptoms that enable the exact identification of causal factors are an implicit requirement for the categorisation as BRI. Examples of typical BRI that feature building-related factors are: Legionellosis, asbestos-related mesothelioma, or house dust mite allergy (Petrovitch, 1996).

SBS is defined as a complex of several unspecific health symptoms, such as the irritation of eyes, skin, nose and throat, or fatigue, headache, and decreased concentration capacity (Fiedler, 1998). In some cases, annoyance owing to odours and smells are possible. These health symptoms usually cannot be traced back to a specific cause, although it is widely accepted that heating, ventilation, and air-conditioning systems (HVAC), thermal discomfort, draught, or chemical emissions are closely related to the expression of SBS. It has also been established that SBS symptoms immediately decrease after the incriminated building has been vacated. However, the symptoms are unspecific; they can be triggered by many other causes and do not lead to the manifestation of a classic disease (Petrovitch, 1996). SBS occurrence is mainly limited to new-built and refurbished buildings, or buildings with sophisticated HVAC systems. Thus, SBS is mostly a concern for occupational buildings as offices, but similar aspects can also be observed in modern residential buildings (WHO Regional Office for Europe, 1995b).

Still, these two categories are insufficient to cover the relationship between housing and health. There are many more housing threats to health other than the ones described by BRI and SBS, all of which are related to the indoor quality and the pollution of the indoor air. With housing being a complex construct, it is necessary to consider architectural, social, and mental aspects of housing as well (Table 1).

In some areas, the housing-health relationship provides accepted and scientifically proven evidence. Because of their clear causal relationship, these areas fall close together with BRI. Examples in the housing and health area are: the impact of lead in paints and pipes on lead poisoning and loss of IQ in children (WHO Regional Office for Europe, 1995a; Jacobs et al., 2007), or the increased risk for lung cancer caused by radon exposure (and strongly aggravated by tobacco smoke) (WHO Regional Office for Europe, 1996).

Table 1 Selected working areas of housing and health

Radon, asbestos, lead	Mould and dampness
Electromagnetic fields	Thermal comfort/energy consumption
Lighting/illumination	Hygiene and sanitation
Home safety and accidents	Pests and infestations
Noise exposure/quality of sleep	Building products/emissions
Housing and mental health	Accessibility and usability
Ventilation, air exchange rate, and indoor air quality	Housing environment and neighbourhood services
Environmental tobacco smoke	Perception of safety/fear of crime
Density and crowding	Residential lifestyles

In addition to the very few ‘accepted’ relationships between housing and health, there is an increasing amount of epidemiological findings suggesting an association between housing conditions and health effects. Because of the fact that many studies find similar results, it seems justified to label these associations as ‘emerging evidence’, although much of this knowledge is based on cross-sectional studies only. Still, it is worthwhile exploring some selected examples of the emerging evidence on housing and health so as to provide the big picture on the same.

4.1 Housing accessibility and usability

In many countries of the WHO European Region, societies face the challenge of ageing populations. Today, the prevalence of handicaps and functional limitations is in the range of 10% of the total population, and it is likely to increase in the near future. In this context, the accessibility and usability of housing is of importance for enhancing the abilities of older and/or disabled persons to live independently in their own home. This includes the concept of complete use of the dwelling and its immediate environment: it is not sufficient for a person to merely have access to the building, dwelling, or environment. The person has to be able to make complete use of the building and residential environment regardless of age or physical condition (Steinfeld and Danford, 1999).

Research on housing accessibility as well as valid official statistics on such issues are scarce. However, there is some evidence that most elderly people live in dwellings with environmental barriers (such as steps, stairs, narrow doors, etc.), and that the magnitude of accessibility problems increases with age. For instance in Germany, one-third of the persons above 80 years have problems climbing staircases (German Ministry for families, elderly, women, and youth, 1996) and the WHO LARES (Large Analysis and Review of European Housing and Health Status) survey brought evidence that 90% of all persons with some kind of functional limitation cannot make normal use of their dwelling. Stairs and thresholds are present in the majority of European homes and in total only 27% of all residential dwellings were assessed as ‘easily accessible’ by their residents.

4.2 Housing environments, physical exercise, and obesity

In virtually all parts of Europe for which comparable data are available, there is a consistent trend showing that the number of overweight children is increasing rapidly, showing all characteristics of a pandemic. There are three major determinants for obesity: biological, behavioural, and environmental. The environmental causality, a suggested link between neighbourhood design and physical activity, has been one of the most recent findings of neighbourhood research, indicating that current trends of obesity are not only because of nutrition and lifestyle, but also depend on the urban structure and the housing environment (Saelens et al., 2003). It is argued that urban layouts that favour car transport, reduce opportunities for physical exercise (e.g., sport facilities, playgrounds, parks, or other open spaces), and limit walking or cycling (lack of sidewalks/bike tracks, low connectivity, unattractive outdoor designs) are important determinants for physical fitness and body mass index (BMI) of residents. Empirical evidence from the recent years has shown that such an influence of physical environment does exist, and can be equally important as social or individual factors (Giles-Corti and Donovan, 2003).

An ecological approach to the problem regards obesity as a normal response to an abnormal environment, rather than vice versa. This statement is supported by the results of the WHO LARES study, showing that residential areas with much greenery and low level of incivilities are associated with the lowest ratio of obese residents (Ellaway et al., 2005).

4.3 Energy consumption, heating, and excess winter deaths

Some housing studies point at indoor thermal comfort as one major factor for cardiovascular health problems. For the UK, five determinants of cold indoor temperatures have been identified (Wilkinson et al., 2001):

- age of dwelling (the older, the colder)
- absence of/dissatisfaction with the heating system
- cost of heating the dwelling (highest is colder)
- low household income (less is colder)
- household size (smaller is colder).

In the UK alone, the number of excess winter deaths is on average in the range of 40,000–50,000 a year (Wilkinson et al., 2001), partially caused by low indoor temperatures owing to fuel poverty phenomena and a structural dysfunction of the dwelling. Similar cases of excess winter mortality can be found in the Baltic countries, in Eastern Europe, in Central Asia and even in countries such as France, Germany, or Portugal.

In parallel, extreme heat can also lead to strongly increased morbidity and mortality patterns. The heat wave in Western Europe in summer 2003 resulted in tens of thousands of excess deaths in France, Germany, and Portugal and reviews have shown that many of these deaths were related to the social isolation of single elderly living in their dwelling without anyone to take care of them. These data show that housing conditions, as well as the social integration within the neighbourhood are more than relevant.

The provision of adequate heating and ventilation equipment, as well as functional thermal insulation, often depends on the socioeconomic means of households. The WHO LARES study showed that large parts of the poorer population groups in Europe might be affected by fuel poverty as well as inadequate heating and insulation standards. Cold temperatures in winter were reported by one third of all households, showing a clear socioeconomic gradient and being associated with decreased prevalence of various health effects, such as bronchitis or cold and throat illnesses.

With energy prices expected to rise in the near future, fuel poverty and indoor thermal comfort is becoming a major issue of housing and health as well as of social equity in many European countries, with eastern and central European as well as central Asian countries at highest risk.

4.4 Housing and mental health

To live somewhere means to develop a special relationship to space, time, luminosity, self, and others. A house, in its concrete reality, brings support to certain aspects of individual psychological structuring – it is the “central reference point of human existence.” (Relph, 1976, p.20)

One of the primary functions of housing is to provide a shelter from outside aggression. Beyond that function, however, a dwelling is defined as a holding space, a physical and psychological envelope within which intimacy will appear and develop and where each and every individual will find an opportunity to be himself or herself. Thus, what was just a house will become a home. Integrity of body and mind are dependant upon this possibility of living in intimacy.

The need for a private space differs from one individual to another and varies according to culture, but the pathogenic effects of homelessness, lack of control, deportation, being uprooted, and intrusion are indications of the real importance of this need. A house loses its protective value when troubles from the outside break in and intrude on an individual. The concept of private space is akin to that of private property. Poor quality housing, providing insufficient protection from the outside, from noise, from scrutiny, and intrusion can be the source of major suffering. Such events may generate pathological manifestations such as anxiety, depression, insomnia, paranoid feelings, and social dysfunction.

Bad circumstances in neighbourhood relations may generate social pathologies: aggressiveness, vandalism, depression, anxiety, somatic complaints, and even paranoid feelings and ideas. Social tensions arise when common spaces fail to act as buffer zones between private and public space or when neighbours try to use them as private spaces, encumbering them with personal items such as prams or bicycles, using them as private meeting places (groups of noisy adolescents), and so forth. Feeling safe in the intimacy of one's home, good neighbourhood relations, respect for the boundaries provided by those parts of buildings common to all, are all essential to the feeling of well-being in housing.

Loss of control over the residential environment or difficulties in appropriating space will unsettle individuals and groups. Disorderly, reactive, and transgressive appropriations will appear in overly impersonal places under the form of vandalism, tagging, damaging common property, and so forth (Freeman, 1993; Green et al., 2002).

Several studies, particularly in the field of social and environmental psychology have shown the influence of environmental factors such as pollution, level of noise and crowding on mental health, depression symptoms, and social well-being (Halpern, 1995;

Leventhal and Brooks-Gunn, 2003; Gomez-Jacinto and Hombrados-Mendieta, 2002). In addition, symptoms of stress, anxiety, irritability, depression, even social misconduct (violence, vandalism), and alteration of attention capacities at school in children may be related to noise exposure in relation to the housing conditions. It is also accepted that stressful housing conditions can aggravate pre-existing psychiatric pathologies (Evans, 2003).

The WHO LARES study has confirmed such findings by identifying increased prevalence of mental health symptoms in relation to selected housing problems such as (a) missing daylight, (b) bad view from buildings, (c) noise disturbance, and (d) inadequate privacy perception.

4.5 Home safety and accidents

Unintentional home injuries are a serious public health problem. Each year in the European Union (EU), there are around 25 million home and leisure injuries requiring medical attention. About three million of these lead to hospital admissions and around 70,000 result in death (DG Sanco, 2004). Over half of these accidents occurred in or around the home. In the UK in 1999, there were 2.8 million home accidents requiring medical attention for an estimated cost to the society around €35.5 billion (UK DTI, 1999), the home has seen more people dying from accidents (4006) than the road (3598) (RoSPA, 2000). In Italy during 2000, 4,380,000 home accidents have led to 6,000 casualties and 7,300,000 working days have been lost.

On the causal side, there are two factors relevant to home accidents – human behaviour and dwelling design and maintenance.

Behaviour can contribute, to a greater or lesser extent, to a home accident or it can be the sole cause. Young children lack the knowledge and experience to recognise danger, but are inquisitive by nature. The mobility and sight of the elderly may be impaired. A person may be distracted by something, such as an unexpected noise. Some people, perhaps in a rush, will take risks while others may be maladroit or just careless. In addition, occupants or residents can create hazards by leaving obstacles on stairs, having loose carpets, and leaving medicines and cleaning products easily accessible to young children.

Because of their design and function, dwellings contain physical dangers, many of which society considers necessary or desirable, such as gas and electricity supplies, steps and stairs, and balconies. Most of these can be made relatively safe, but perhaps not completely. However, some structural features may increase the risk of an accident. For example, horizontal bars in balcony guarding will provide a climbing frame for small children, a small change in floor levels in unexpected locations can be a trip hazard, and non-safety glass at the base of stairs will increase the severity of an injury, if there is a fall.

Also, age is regularly identified as the major risk factor for the occurrence of home accidents, the WHO LARES survey identified a variety of housing hazards and characteristics that are related to an increased occurrence of home accidents. Among these are, for example, badly designed staircases, slippery floor materials and unfixed carpets, electrical installations, poor lighting, crowding and too little work space, and noise exposure leading to tiredness and decreased attention.

4.6 *Noise exposure and sleep disturbance*

Sleep is an essential condition for humans and can be severely disturbed by noise. Acute sleep disturbances affect qualitative or quantitative performance. More than 10% of the adults in Europe suffer from chronic sleep disturbances in need of treatment, at least another 10% with sleep problems or occasional disturbances of the night's rest (Billard, 1993; Fischer et al., 2001; Peter et al., 1995). Environmental noise is the leader of the exogenous causes, with traffic noise usually being the major problem followed by neighbourhood noise and aircraft noise.

The non-auditory effects of environmental noise appear to occur at levels far below those required to damage the hearing system. Environmental noise acts as a stressor at night by disturbing sleep and via strong annoyance (or bothering) during the day and may impair the cardiovascular and the mental health in the long run (Babisch, 2000; van Kempen et al., 2002; Lercher et al., 2002; Maschke et al., 2003; Rosenlund et al., 2001).

The results of the LARES study confirmed the findings of recent studies by defining noise exposure as a major urban problem and also as one of the major causes of annoyance and reduced quality of life. Health effects were identified for the mental health area, as well as for selected physical and stress-related symptoms, such as hypertension and migraine, which showed significantly increased relative risks. The results also indicated that particular attention must be paid to night time noise exposure in the homes.

4.7 *Indoor air quality*

As people in European countries spend a majority of their time indoors, indoor air quality is a major determinant of health. For a number of air pollutants originating from various indoor sources, it is not only the duration of exposure, but also the concentration levels that might strongly exceed the ones encountered outdoors which is health relevant. Depending on the specific situation, a number of harmful substances can be found in indoor air.

Exposure to elevated levels of the radioactive gas radon may cause lung cancer (Field et al., 2000). Radon is formed by the natural radioactive decay of uranium in rock and soil. Once produced, radon moves through the ground to the air above and may be 'captured' and concentrated in indoor air. It has been estimated that exposure to indoor radon (radon decay products) is on average the most important source of ionising radiation from any natural or man-made source (WHO Regional Office for Europe, 1996).

Environmental Tobacco Smoke (ETS) can be harmful to human health, in particular for children. Effects include asthma, sudden infant death syndrome (SIDS), bronchitis and pneumonia, and other respiratory diseases (WHO Regional Office for Europe, 2000). It has also been suggested that ETS also has an adverse effect on the developing foetus (Dejmek et al., 2002). Exposure to ETS may also cause lung cancer, eye, nose, and throat irritation, and may affect the cardiovascular system. According to a new study from the UK, each year passive smoking at home might account for approximately 2700 deaths in persons aged 20–64 years and 8000 deaths among people aged ≥ 65 (Jamrozik, 2005).

Emissions of pollutants from cooking and heating with gas or solid fuels have been found to affect respiratory illnesses in children. Observed effects were an increase in respiratory diseases (Burr, 1999) and respiratory infections (Chauhan et al., 2003), an increase in the susceptibility to asthma, and changes in lung function (Corbo et al., 2001).

Owing to specific sources (cleaning materials, solvents, etc.), the concentration of VOC measured in indoor air is often significantly higher than outdoors. Some VOC are known to cause harmful effects to health: several are known carcinogens.

Formerly, asbestos was widely used as fireproof material indoors and in consumer products such as fireplace gloves, ironing board covers, etc. When asbestos-containing material is damaged or disintegrates with age, microscopic fibres may be dispersed into the air. The presence of these fibres within the lungs over longer periods may result in asbestosis (asbestos-caused fibrosis of the lung), lung cancer, and pleural or peritoneal cancer or mesothelioma (US EPA, 1986).

The LARES survey provided additional evidence that adequate indoor air quality is not common in many European homes, and is still affected by a variety of pollutants and problems such as insufficient ventilation, leading to the above-mentioned health effects.

4.8 Mould growth

There is increasing evidence that mould growth in damp buildings is an important risk factor for respiratory illness. Mould-related symptoms are likely as a result of irritation, allergy, or infection (Chapman et al., 2003).

Mould spores are present in all kinds of indoor environment. Normal building materials and furnishings provide ample nutrition for many species of moulds, but they can grow and amplify indoors only when there is an adequate supply of moisture. Older houses with recent water damage are frequently the favourite sites for mould growth. Poor social conditions (large household size, state rental housing, and financial difficulty with housing costs) were also found to be significant predictors of damp, mouldy homes (Butler et al., 2003).

Though in most cases a dose-response relationship cannot be derived between the measured concentration of fungi and the registered health problems (Moriske et al., 2003), irritations of the throat and eyes, allergies (most frequently allergic rhinitis), lower respiratory symptoms (dry or productive cough, wheeze), and asthma, as well as increased incidence of respiratory infections have been repeatedly observed. Some studies show a relation between dampness and mould and objective measures of lung function. Apart from respiratory symptoms, depression and the presence of general symptoms like fatigue, headache, dizziness, and difficulties in concentration were also reported (Rylander and Etzel, 1999; Moriske et al., 2003; WHO Regional Office for Europe, 2004b).

The WHO LARES survey showed that there is a considerable amount of European homes that may be affected because of mould growth and dampness. Substantial mould growth was detected in 32% of all surveyed homes associated with health effects such as asthma, bronchitis, migraine, and also with depression.

4.9 Perception of safety and fear of crime

There are two relevant concepts for public safety issues, which strongly overlap:

- the more general perception of safety
- the more specific fear of crime (Austin et al., 2002).

Looking at the subjective perception of safety, it is especially the occurrence of physical or environmental cues in the residential environment that leads to insecurity and feelings of not being safe (Mozingo, 1995). Such cues that raise concerns about safety issues can, for example, be physical incivilities, such as deterioration of neighbourhoods, trash, or graffiti (indicating a low community spirit, and in effect, a low social control) and social incivilities such as conspicuous youth groups or persons with strange behaviour (questioning the degree to which social norms and customs may be kept) (Halpern, 1995).

Looking at fear of crime, the 2002–2003 British Crime Survey estimates that fear of crime has a major impact on the quality of life of 7% of the population, with a lesser impact on an additional third of people. Important housing-related factors affecting feelings of safety and fear of crime include having windows that close properly, being able to escape in case of fire, having adequate and working lights in the common areas, and being able to overlook the street from some part of the dwelling.

The LARES survey identified similar patterns of increased fear perception in relation to social and physical incivilities such as dog droppings, litter, and vandalism. In general terms, the most severe expression of this problem was found in badly maintained housing estates with large housing blocks, little maintenance, and large public open spaces with unclear management responsibilities.

4.10 Housing and residential environment

Research indicates that residents' perceptions of urban environmental quality and satisfaction with their residential situation are determined by a large number of different physical and social aspects. The most important residential quality aspects appearing in the literature are social ties in the neighbourhood, safety risks (e.g., crime, traffic), environmental hygiene (e.g., noise, air pollution), and the presence of facilities (e.g., shops, greenery) (Kaplan and Kaplan, 2003; Austin et al., 2002; Stansfeld et al., 2000; Macintyre and Ellaway, 2000; van Poll, 1997; Bistrup, 1991). Personal characteristics studied (age, gender, and socioeconomic status) appear to influence quality judgements only marginally. It is not only the measurable 'objective' aspects of the living environment that determine whether people are satisfied, but also the perception of these. These do not always parallel each other. Seldom objective and subjective aspects are studied in combination. Empirical evidence is still limited and there is no integrated model available yet (van Kamp et al., 2003). However, consensus exists that the field requires an interdisciplinary approach that integrates physical, spatial, social, and environmental aspects.

The LARES survey, collecting both subjective and objective assessments of residential conditions, showed that the residential satisfaction as well as self-rated health are closely related to the existence of neighbourhood problems such as noise, social problems, litter, and lack of green and open spaces. The results highlight an especially strong impact of social problems and fear of crime on the quality of life and the residential satisfaction.

4.11 Pests and infestations

The invasion of the home by harmful insects and pests is a direct threat to health, as pests can function as carrier of pathogens, diverse diseases, and allergens (Ranson, 1991, p.67).

Once pests have entered into one household, they may lead to an infestation of the whole building and can become a small-scale epidemic if no counter-measures are taken. Next to the influence on hygiene conditions in general, many of these pests may have a parasitic relationship with humans that will enable them in affecting their health (Howard, 1993).

For the occurrence of pests, the environmental conditions in the dwelling are of high importance. Mites, for example, multiply best in conditions of high relative humidity (minimum around 40–45%, optimum at 80%) and with average to warm room temperatures with an optimum of 25°C (Raw and Hamilton, 1995).

In accordance to the different categories of pests, there are also different health effects. Blood parasites and biting insects perforate the skin of humans. As a result, allergic reactions, inflammations, and secondary skin infections can occur, while bigger threat of blood parasites lies in their vector function for parasitic or viral diseases such as malaria or dengue (Howard, 1993). Hygiene pests do not exert a direct harm to humans, but their ability to act as a disease carrier or vector can result in severe health effects. The main threat of hygiene pests is the contamination of food and water through imported pathogens, infected food particles, or excrements (Ranson, 1991).

Allergies nowadays represent the most common health effect related to pests. For sensitive and allergic people, allergens from pest infestations are a major problem (WHO Regional Office for Europe, 1990). Allergic reactions can be because of (a) body particles (hair, skin, etc.) and (b) excretions and emissions of the animals. House dust mite and cockroaches are among the most relevant pests triggering adverse reactions and allergies. It has been estimated that 10–20% of the normal population are potentially allergic to dust mites; while up to 70% of asthmatic people are likely to show allergic reactions (Howard, 1993; WHO Regional Office for Europe, 1998).

In the WHO LARES, it was indicated that the existence of cockroaches strongly depended on the housing characteristics and was favoured by, for example, inadequate bathroom installations, problems with the water drainage system, dirty waste chutes located outside the dwelling, leaky roofs, kitchen windows that do not close tightly, poor bathroom ventilation, litter, graffiti, and poorly-kept open spaces between buildings. Regular and adequate maintenance work of the building was, therefore, identified as one of the major control mechanisms for the prevention of infestations.

5 Housing and health: a cross-sectional and multidisciplinary challenge

Housing and health are a complex construct, and require complex approaches. Given the variety of issues that may eventually limit the health condition of the residents, it is clearly necessary to approach housing and health in a cross-sectional and multidisciplinary way. Any research on housing and health, therefore, needs to place itself in the holistic concept of housing and evaluate the impact of individual housing factors such as noise, air quality, or temperature against the reality of housing conditions. It is, therefore, clear that laboratory studies – though necessary and useful – can only provide one part of the evidence on the housing and health relationship. Their validity in real life, however, will always be influenced and modified by the large number of interacting housing conditions.

Facing this challenge, the WHO housing and health programme of the Regional Office for Europe, located at ECEH, Bonn is, therefore, determined to carry out further work on housing and health in various selected areas. Current priorities of the programme, based on recent literature reviews and expert consultations, are, for example:

- thermal comfort, energy and fuel poverty
- quality of sleep
- housing and mental health
- the challenge of ageing populations
- home safety and accidents
- construction and home materials
- indoor air quality and indoor comfort.

Working on these issues, the WHO housing and health programme will aim at collecting and initiating the production of further scientific evidence needed to close the currently existing knowledge gap and identify better the relationship between housing and health.

Next to the scientific work, the WHO will work on an increased application and implementation of the existing knowledge. For this objective, best practice cases will be identified to demonstrate the effectiveness and implementability of sustainable and healthy housing solutions.

The coordination and monitoring of housing projects and housing interventions, if undertaken on a longitudinal time frame, will provide additional knowledge on the effects of housing improvements on health and well-being, and may also provide the necessary data for undertaking cost-benefit studies, and for quantifying the global burden of disease attributable to inadequate housing conditions.

The generation of such policy-relevant data will be the ultimate objective of the programme to provide policy-makers, housing, and public health professionals with a better knowledge of (a) their housing policy choices, (b) the health-related consequences, and (c) the economic and health-related effects.

WHO strongly believes that more transparent and evidence-based data will provide clear and convincing arguments for an increased consideration of housing and health issues within a public health framework, and bring about a new recognition of housing problems for local, regional, and national policy-making.

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