

# Social inequities in environmental risks associated with housing and residential location—a review of evidence

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**Background:** Housing conditions and environmental quality of residential areas are differentially distributed in the population. Less affluent population groups are more often affected by inadequate housing conditions and higher environmental burden in their residential neighbourhoods. A synthesis of the dispersed evidence on health-related housing characteristics and social status is needed to provide support for housing policies addressing social inequities. **Methods:** The literature on social inequities and environmental risks related to housing and residential location was searched in health, environmental and geographical databases and reviewed to summarize the evidence. Household-level socio-economic status and income were considered as indicators of social status. The review was limited to European evidence. **Results:** Adequate studies were only available for few countries. Most studies identified the less affluent population groups as most exposed to environmental risks in the place of residence. Inequities were reported for risks experienced within the dwelling (such as exposure to dampness, chemical contamination, noise, temperature problems and poor sanitation) and related to residential location (neighbourhood quality, traffic-related pollution, proximity to pollution sites). Increased exposure to environmental risks within more affluent population groups was rarely identified. **Conclusions:** The review indicates that social status and especially low income are strongly associated with increased exposure to environmental risks in the private home or related to residential location. However, due to the methodological variety of the available studies and the lack of data for many countries, it is not possible to provide a general assessment of the magnitude of inequity in Europe at the present time.

**Keywords:** environmental inequities, health inequities, housing, neighbourhood, social determinants

## Introduction

Housing is a fundamental human right and has been identified as one of the determinants for health and quality of life. Different housing conditions lead to different levels of exposure and therefore different levels of environmental risk. Health effects of housing and residential conditions can for example be triggered by lack of thermal comfort, dampness, indoor air pollution, lack of sanitary equipment, noise and environmental pollution in the neighbourhood.<sup>1–4</sup> The strength of the identified associations between housing conditions and health outcomes varies significantly. Many studies find a strong link between housing characteristics and health, while the evidence for links between residential location and health is much more difficult to establish and at this time tends to be mostly indicative.

Housing—including its spatial context which is referred to as ‘residential location’ in this review—is a good offered in the free market. With varying quality, the price for housing differs and consequently the quality of housing and residential location is directly and indirectly associated with income and socio-economic status (SES).<sup>1,5,6</sup> Similar concerns exist for social housing which often is of lower quality and clustered in deprived neighbourhoods.<sup>7</sup>

Studies from many countries show that it is often the most vulnerable or disadvantaged part of the population that is located in housing with poorer environmental quality.<sup>8–12</sup> However; there is no review available that describes the link between the exposure to housing-related health risks and the social status on a disaggregated level such as dwellings or households. This paper therefore aims at compiling the available evidence on the impact of social inequities on environmental risks related to housing and residential conditions. It includes associations between social status and (i) housing conditions or housing-related exposure conditions directly affected by social status (such as fuel poverty or passive smoke exposure) and (ii) independent housing risks such as exposure to pollution. Only exposure variables that have been confirmed as risk factors for health were considered. However, as this review did focus on the exposure differentials, studies presenting evidence on the housing-related health outcomes were not included. Due to the large international variation of housing parameters and social factors, the review was limited to evidence from European countries.

The results of the review could support the development of housing policies as a means to reduce inequities in health between social groups,<sup>13</sup> and help improving the daily living conditions as a major strategy to tackle social inequities as recently proposed by the World Health Organization (WHO) Commission on Social Determinants of Health.<sup>14</sup>

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## Methods

Evidence on income and SES-related inequities in environmental risks related to housing and residential location has been searched. In parallel, reports of national and international organizations were identified to gather

**Table 1** Examples of search terms and identified publications in PubMed

Combination of search terms	Total publications identified	Publications matching criteria
'inequalities'	225 196	Not assessed
'inequities'	1159	Not assessed
'environmental', 'inequalities'	26 510	Not assessed
'environmental inequalities'	7	1
'environmental', 'inequities'	162	5
'environmental inequities'	12	1
'housing', 'inequalities'	3984	Not assessed
'housing inequalities'	0	–
'housing', 'inequalities', 'social'	1971	Not assessed
'housing', 'social inequalities'	32	7
'housing', 'inequities', 'social'	22	0
'housing', 'social inequities'	0	–
'neighbourhood', 'social inequalities'	58	9
'neighbourhood', 'social inequities'	3	0
'residential', 'social inequalities'	13	1
'residential', 'social inequities'	0	–

Note: The search was restricted to articles on 'humans' only.

evidence beyond scientifically published articles. The review was limited to European evidence.

The identification of relevant publications used a systematic approach to search in a variety of databases (PubMed, Web of Science, SWETSWISE, Annual Reviews, Google Scholar). Key words used in varying combinations were 'housing', 'home', 'indoor' and 'residential' to describe the spatial component, and 'income', 'socio(-)economic status', 'inequality/ies', 'inequity/ies', 'environmental' and 'risk' to describe the social gradient. However, the combination of keywords to focus on housing or residential location together with terms such as inequalities/inequities quickly reduced the number of matching studies (see table 1).

The most frequent reasons for not including studies in the review were: (i) the evidence was based on non-European data; (ii) the study only referred to 'deprived' housing and did not indicate specific housing or residential risk factors; (iii) the study did not report on the distributions of risk by income or SES categories.

It is likely that this review fails to cover some of the existing evidence. Some papers known to the authors and used in this review were actually not identified during the literature search at all as they were not primarily published as inequity-driven papers. The same accounts for reports by governments or international organizations which provide a significant share of the evidence, but are not accessible through literature search programmes.

## Results

The review showed that many studies dealing with social inequities related to housing and residential conditions focus on ecological level analysis of neighbourhoods by social deprivation level and often fail to deeper investigate environmental inequities—especially those related to the dwelling. For each environmental risk factor related to housing and residential location, only few studies or reports were identified that provided insight into the social gradient of risk exposure. Such evidence is available only for few countries, with Germany and UK being the main contributors. In parallel, there is a scarcity of evidence on specific environmental risks such as, e.g., sanitation (no peer-reviewed publication matching the criteria was identified), while for home safety and injuries no data were actually identified at all.

## Housing and indoor environments

The European Foundation for the Improvement of Living and Working Conditions<sup>15</sup> states that there is an association between household income and inadequate housing, which is stronger in the new EU member states than in the EU15. WHO data based on eight European cities further confirms that inadequate housing conditions are associated with risk factors such as mould, crowding, indoor pollution and noise especially for low-income households.<sup>1,16</sup>

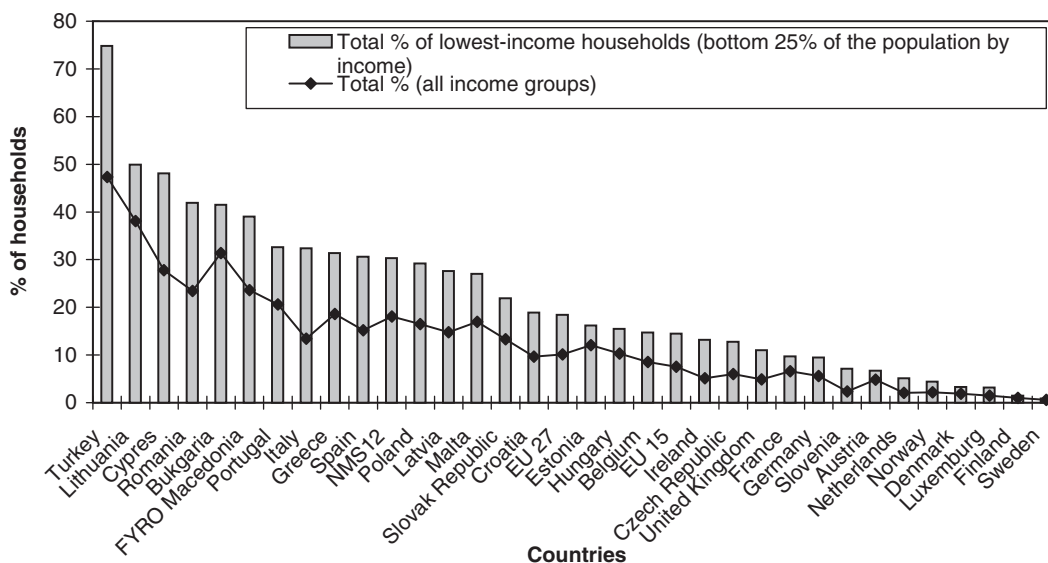
## Fuel poverty and thermal comfort

Excess winter deaths are responsible for premature deaths of ten thousands of EU citizens each year.<sup>17</sup> Healy<sup>18</sup> examined excess winter deaths in 14 EU countries and demonstrated that countries with the poorest housing in terms of thermal efficiency showed the highest level of excess winter mortality (Portugal: 33% mortality increase; Spain: 21%, Ireland: 21%, UK: 19%). In-depth research undertaken in the UK showed that excess winter mortality is stronger expressed in residents of cold homes than warm homes,<sup>19</sup> linking excess winter deaths to fuel poverty and thereby the less affluent population groups.

The European Quality of Life Survey<sup>20</sup> shows that for the affordability of heating, large income-related inequities exist: in 9 out of 31 countries—old and new EU members—this problem is twice as often reported by households in relative poverty (defined as below 60% of national median income) (figure 1).

In general terms, affordability of heating is a major problem in Eastern European cities, affecting >40% of all low-SES households.<sup>1</sup> Buzar<sup>21</sup> describes the frequent problems of fuel poverty in the Czech Republic (4–11% of population affected) and the Former Yugoslav Republic of Macedonia (up to 60%), noting that income-poor households are also the most energy-poor. Similarly, a report by the United Nations Development Programme (UNDP)<sup>22</sup> on energy, environment and poverty in Serbia and Montenegro indicated that the burden of cold is disproportionately affecting the low-income households, 27% of which are limiting the heating use to only a reduced number of rooms.

Thermal risks also arise from heat waves when houses accumulate the heat and cannot cool down during night. Data from the 2003 heat wave in Paris showed that the highest heat exposure categories were found in the most deprived areas while similar results were not found for the rest of the country due to less heterogeneity in



**Figure 1** Households that cannot afford to keep their homes adequately warm (2007). Source: European Foundation for the improvement of living and working conditions

deprivation.<sup>23</sup> Further studies indicate that elderly residents of low-quality housing were most vulnerable and that building age (before 1975), location of dwelling under the roof and low insulation quality doubled the risk of heat-related mortality.<sup>24</sup>

### Indoor environmental exposures and crowding

Studies from various European countries identified significant social inequities for environmental tobacco smoke (ETS) exposure,<sup>11,25–28</sup> with children in low-income households being exposed about twice as much<sup>11</sup> (higher exposure rates are even found for low education status of parents<sup>25</sup>).

In the EU15, 18% of households in the lowest income quartile have damp or leaks compared with 9% in the highest quartile; in the 12 new member states, the figures are 29% in the lowest quartile and 8% in the highest quartile.<sup>15</sup> Low-income households are more often exposed in all countries except Sweden, Norway and Finland and the biggest problems of dampness are faced by low-income households in Poland (57% reporting dampness or leaks) and Romania (45%). For Serbia and Montenegro,<sup>22</sup> the problem of dampness is strongly related to affordability of heating: 48% of households using coal and wood for heating-reported dampness problems versus 14% of households benefitting from district heating systems. Poortinga *et al.*<sup>29</sup> in Wales found that lower socio-economic households were more exposed to heavy condensation, damp, cold or mould.

German data<sup>11</sup> indicate inequities for benzene exposure in indoor air of children's bedrooms, and for child blood lead levels. However, a number of exposures were more frequently found in well-off households, such as polychlorinated biphenyl in children's blood, terpene concentrations in indoor air and dichlor-diphenyl-trichlorethylene (DDT) levels in house dust samples. Household chemicals which pose potential health threats (e.g. disinfectants, indoor sprays, detergents, etc.) are more often and more frequently used by households with low social status.<sup>30</sup> However, chemical compounds for pest control (moths, ants, etc.) are more often applied by households with high social status.

A rising concern is the use of solid fuels for heating and cooking, which is especially frequent in the Eastern countries

and also is an alternative energy source for low-income households in more developed countries.<sup>31</sup> The UNDP<sup>22</sup> report on energy use in Serbia and Montenegro identified the use of lignite coal—known as a serious risk factor for indoor air pollution—as more common in the housing stock inhabited by less affluent population groups. In homes heated with coal and wood, increased exposure to carbon monoxide, benzene, particulate matter and formaldehyde were identified.

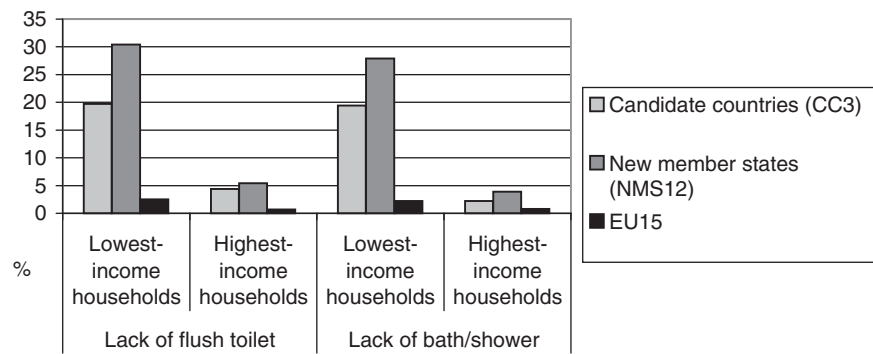
Problems with crowding were more than three times more frequent for households in relative poverty in Bavaria.<sup>32</sup> According to data from the European Quality of Life Survey<sup>33</sup>, 21.7% of the EU15 households in the lowest income quartile report problems with shortage of space in their dwelling, while this is only reported by 12.2% of the highest income households. In the new EU member states, the problem of shortage of space is found even more frequently (22% in high-income and 28% in lowest income households).

### Water and sanitation

Water and sanitation are key requirements for healthy housing, but for European countries there is little information available on inequities in water supply. Therefore, data were almost exclusively found in relation to international databases and monitoring programmes. The lack of a flush toilet for the private use of the household is still an issue for the lowest income population groups in the EU (figure 2).<sup>33</sup> The biggest problems are faced by Romania, where already 11.2% of the highest income group reports such a problem, and 68.8% of the lowest income group is affected. However, for the EU15, the problem rate for the lowest income groups can also go as high as 3.9% (UK), 4% (the Netherlands) and 5.3% (Greece) and thereby reach unexpected levels for highly developed countries as well.

### Outdoor environments and residential location

The strongest link found in terms of residential location is between deprivation and ambient air quality (see review by Deguen and Zmirou-Navier in this issue). However, studies from various countries have looked at the link between



**Figure 2** Lack of sanitary equipment by household income in the EU (2007). Source: European Foundation for the improvement of living and working conditions. The lowest/highest income is defined as bottom/top 25% of the households by income

social status and residential location for other environmental factors. Whilst the number of such studies is small, their results presented below provide evidence that quite stark inequities exist in the countries that have been studied so far.

### Neighbourhood deprivation, safety and physical activity

Studies from England, Scotland and Wales found that those from a lower socioeconomic background were more likely to report litter and poor neighbourhood quality and found a clear association between neighbourhood deprivation and exposure to poor environments.<sup>29,34,35</sup>

A housing survey undertaken in eight European cities showed that the level and frequency of physical activity in the residing population were affected by perceived safety in deprived neighbourhoods (associated with litter, graffiti, etc.)<sup>36</sup> as well as by a lack of greenery.<sup>37</sup> Although respondents in more deprived areas in the UK may live closer to green spaces, they still report poorer perceived accessibility, poorer safety and less frequent use of these areas which may also relate with the quality of the green spaces.<sup>38</sup> Finally, lower levels of public green areas have been found for low-income neighbourhoods in the Rijnmond region in the Netherlands (five times less than for highest income groups)<sup>39</sup> and for low-income households in Bavaria in Germany.<sup>32</sup>

### Noise

German studies examined perceived exposure to noise pollution amongst a range of different social characteristics and found increased exposure to traffic-related noise particularly for low socio-economic groups.<sup>32,40</sup> This result confirmed earlier work which found that people with lower socio-economic status often lived nearer to main roads with high traffic noise.<sup>41</sup> Similar results are obtained for Switzerland,<sup>31</sup> stating that noise exposure is highest in lower social classes and regularly exceeds the Swiss limit value of 65 dB(A). In addition, Swiss data show that 65% of the households with lowest SES live in areas with industrial activities where background noise levels are around 7 dB(A) higher than in residential areas. A Dutch case study reported that lower levels of income reduced the chance of noise exposure levels < 50 dB(A) in the Dutch Rijnmond region<sup>9</sup> but an exception was found for aircraft noise for which high income was associated with increased exposure.<sup>39</sup> Brainard *et al.*<sup>42</sup> studying Birmingham, England, found that night time noise was significantly elevated in deprived communities and

Poortinga *et al.*<sup>29</sup> found for Wales that persons with lower socioeconomic status were more likely to report noise exposure.

### Industrial pollution and environmental deprivation

The siting of Integrated Pollution Control (IPC) sites has been examined for England<sup>10,43</sup> using the national Index of Multiple Deprivation 2000 at ward level. The results indicate a strong inequity as 20.1% of the population living in the most deprived wards were living within 500 m distance to an IPC site versus 3.8% of the population in the least deprived wards.

From 1991 to 2001, there were five times as many authorizations in the most deprived decile wards, compared to the least deprived. Furthermore, IPC sites in deprived areas on average produced greater numbers of emissions and presented a greater potential pollution hazard, as indicated by the Agency in authorization scores. Levels of particulate matter (PM<sub>10</sub>) emissions from IPC sites were disproportionately high in more deprived wards and to a lesser extent also emissions of nitrogen dioxide (NO<sub>2</sub>), the latter also being confirmed for the Netherlands when looking at low-income groups.<sup>39</sup> In 2007, the Environment Agency<sup>44</sup> carried out a more detailed analysis, confirming that such sites were concentrated in the most deprived areas with the exception of landfills.

In Scotland, Fairburn *et al.*<sup>45</sup> found a strong social gradient in the siting of IPC sites as well, while Laurian<sup>46</sup> found that towns in France with high proportions of immigrants were more likely to host hazardous sites even after controlling for size and income. In the Dutch Rijnmond region, waste sites were more frequently built in neighbourhoods populated by low-income groups.<sup>9,39</sup> Specific concern has been voiced for Eastern European countries where thousands of abandoned and in-use landfills—and many more illegal and unlocated dump sites—cannot be sufficiently monitored by the responsible agencies and toxic leakages may occur.<sup>47</sup>

Fairburn *et al.*<sup>45</sup> reported on Scotland using individual household location classified according to the Scottish Index of Multiple Deprivation covering ambient air quality, industrial pollution, derelict land, river water quality, landfill sites, quarry and open cast sites and woodlands. For industrial pollution, derelict land and low river water quality, there was a strong relationship with socio-economic deprivation indicating increased exposure in more deprived datazones (~1500 residents per datazone) (see table 2).



**Table 2** Scottish population living close to derelict land, IPC sites and polluted rivers

Decile	Total Population	Population within 600 m of derelict land	Percentage	Population within 500 m of IPC sites	Percentage	Population within 600 m of rivers classified as C or D	Percentage
1 (most deprived)	505 775	340 045	67.2	422 564	83.5	129 752	25.7
2	506 808	267 125	52.7	387 929	76.5	88 247	17.4
3	506 064	219 564	43.4	336 369	66.5	83 760	16.6
4	506 082	170 656	33.7	277 154	54.8	79 393	15.7
5	506 596	155 380	30.7	251 672	49.7	70 623	13.9
6	505 966	144 472	28.6	218 421	43.2	67 010	13.2
7	505 930	135 568	26.8	208 505	41.2	61 453	12.1
8	506 157	125 781	24.9	219 250	43.3	57 022	11.3
9	506 485	93 659	18.5	200 501	39.6	61 778	12.2
10 (least deprived)	506 148	70 180	13.9	150 251	29.7	67 799	13.4
Scotland	5062 011	1722 431	34.0	2672 615	52.8	766 839	15.1

Source: Fairburn *et al.*<sup>45</sup>

## Discussion

A large part of the identified studies focused on data analysis on aggregated (mostly neighbourhood) level and did not enable the identification of specific risks or a social gradient in exposure. This review therefore relied on studies that provided data on specific housing and residential risks, and the distribution of these risks by income or SES. Drawing from published evidence, the review confirmed the existence of a social gradient in exposure to housing and residential risks. The environmental disadvantages are—with very few exceptions—faced by the less affluent population subgroups. Examples are housing and housing-related exposure conditions directly associated with social status such as fuel poverty, lack of sanitary amenities, damp buildings and ETS exposure and independent risk factors such as noise exposure, lack of green spaces and distance to polluted or polluting sites in the residential environment. In contrast, no evidence for social gradients was found for safety threats although injuries are widely considered a major housing-related health outcome.

A major caveat to the presented results is that the evidence is based on studies from few countries with only fragmented contributions from other countries. International data covering several countries are almost exclusively available from international agencies, the United Nations network, or the European Commission and its bodies (Eurostat, Eurofound). Due to the lack of data for many countries, it is not possible to provide a general assessment of the magnitude of housing-related inequity in a European context at the present time.

There is an obvious lack of indicators of multiple environmental risks as studies tend to look at various exposures separately. A few studies only offer evidence on risk indices compiling several risk factors,<sup>9,16,48</sup> all indicating that less affluent population groups are often facing accumulated environmental disadvantages. However, based on the marginal evidence, no assessment is possible on the social distribution of multiple risk.

Key challenges for further work on environmental quality in the field of living conditions will be to (i) develop consistent methodologies to allow comparison of data on international scale (especially regarding use and definition of social determinants such as age, gender, income, employment, ethnicity, etc.), (ii) better integrate social determinants into data collection systems such as national or EU-based surveys and monitoring projects, (iii) make available spatial or geographical data allowing application of Geographic Information Systems, (iv) develop and apply multiple exposure indices to assess inequities more holistically and (v)

promote health and environmental inequities as a major working field for health, social and environmental actors.

The results of this review support the recommendation of the WHO Commission on the Social Determinants of Health<sup>14</sup> to improve daily living conditions and address the unfair distribution of resources and power. This position advocates not only that poverty and social gradients need to be tackled but it also very clearly identifies the need to disconnect the current association between being poor and being disadvantaged in terms of environmental conditions.

To address the housing risks directly related to social status and building quality, rehabilitation of the existing housing stock and neighbourhood renewal will be a main target for action by public actors, but increases in supply of public housing need to be considered as well as healthy standards for new construction. However, a major challenge will be to offer quality housing affordable for low-income population groups.

For independent risks, mostly related to pollution and residential quality, greater use needs to be made of spatial planning to avoid the build up of multiple exposures to poor environments and ghettoization of neighbourhoods. This would be accompanied by integrated regional planning to consider the impacts of new facilities and infrastructural developments on inequities. Publication of multiple impact maps should be used to stimulate discussion amongst the general public particularly around the issue of local unwanted land uses (LULUs).

There need to be much stronger links between local municipalities and the health service providers to tackle residential conditions together. National governments may want to consider switching resources from health service providers to local municipalities to provide more of a focus on preventative as opposed to curative policy measures. In that context, municipal services could be developed to further support housing and local neighbourhoods especially for low-income families and elderly.

Overall, national policies should consider housing as a determinant of health as well as social stability, and thus an asset to the society.

## Acknowledgements

An extensive version of this review was provided as a background document to the WHO expert meeting on “Environment and health risks: the influence and effects of social inequalities” (Bonn, Germany, 9–10 September 2009)

and will be published in the context of the Fifth Ministerial Conference on Environment and Health.

## Funding

This work was partly supported by the WHO Regional office for Europe in the framework of preparatory work towards the Fifth Ministerial Conference on Environment and Health.

*Conflicts of interest.* None declared.

## Key points

- This is the first published review of European evidence on the impact of social inequities on health-related housing and residential risks that specifically addresses the disaggregated level of households or dwellings.
- The review confirms that strong social inequities exist in both quality of housing and the residential location. Largest inequities have been found for less affluent population groups and are most often related to risks due to material deprivation.
- Evidence and national data broken down by social categories is rare, especially on household or person-level. Almost no information is available on the parallel exposure to multiple risks.
- Public health work needs to further address the dimension of health and environmental inequity as a major policy focus.

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Received 3 September 2009, accepted 4 December 2009