Thermal discomfort and health: protect the susceptible (part 2)

Abstract. In this second part of our paper, we review human and building factors that increase the risks of health impact of exposure to excess cold and excess heat in housing and the range of responses to reduce these risks. This shows that most human factors and some building characteristics that increase susceptibility are common to low and to high temperatures. The human factors include age, gender, some physical and mental health conditions, isolation, low social-economic status, people with mobility problems, and being unaware of precautionary actions. The building factors include inadequate thermal insulation, and inappropriate provision for heating and for ventilation.

These observations should encourage social, building and health sectors to adopt a more integrated approach to provide protection for those most at risk from exposure to low and high temperatures.

Key words: air pollution, indoor; cold temperatures; health; hot temperatures; housing.

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To reduce the risk of exposure to either low or high temperatures (i.e., temperatures outside the thermal comfort range of 18°C to 24°C) it is necessary first to identify factors that could increase the threat to health and then to look at options to eliminate or at least minimise them. Here we discuss the human including socio-economic and behaviour aspects and the building factors that increase or reduce the possibility of exposure to temperatures outside the recommended thermal comfort range that could increase the threat to health [1].

The susceptibility of individuals to exposure to low or high temperatures depends on personal characteristics (age, health status, etc.), duration of exposure [1] and adaptive capacity of each individual. Dwelling characteristics that influence the potential risk of exposure include the design and construction, and the orientation. Location is another factor, as the urban heat island effect can increase temperatures, and those in hard to heat dwellings in rural areas may suffer low temperatures [2, 3]. At the macro level, whatever the geographical location, populations will suffer heat and cold related mortalities [4]. Here, we concentrate on countries with a temperate climate.

**Excess cold**

**Human factors increasing the threat to health**

Unavoidable human factors include age, female gender, and chronic physical and mental conditions [5, 6]. The elderly (over 65) and very young (under 5) are more at risk from exposure to low temperatures physically, and are likely to spend most of their time at home.

Those suffering from chronic physical or mental illnesses, or on particular medication are also at risk. The physical conditions include cardio-vascular and respiratory conditions (e.g., asthma, and Chronic Obstructive Pulmonary Disease), diabetes, and arthritis. It has also been suggested that older women with a history of respiratory illness may be more susceptible than other older individuals [7]. Mental health conditions such as dementia, and depression, may mean the individual is less likely to take appropriate precautions [8-12].

Isolation, for whatever reason, will also increase the threat to health. The elderly can be isolated, perhaps separated from relatives, and unable to keep physical contact with friends. Such isolation of elders may increase the severity of the outcome from exposure, because a susceptible individual may be left undiscovered for longer. Households in cold, damp dwellings, conditions linked to energy inefficiency, are likely to be reluctant to invite in others and so become isolated [5]. Similarly, not being able to afford to heat more than one room could increase the risk of spreading infectious diseases through crowding [13].

Limited income and resources can mean households may only afford to live in old and energy inefficient dwellings, with the consequential inability to afford sufficient energy for normal domestic living (i.e., in Fuel Poverty). While this seems logical, findings on low socio-economic status and exposure to excess cold are inconsistent and may be influenced by dwelling characteristics. One study found that socioeconomic factors were not strongly associated with winter deaths in older people [7] and one found that people in the lowest socioeconomic groups may occupy more energy efficient public sector housing which could reduce risks [14]. Fuel poverty and smoking contributed to adverse winter health and social outcomes [15]. Also, a study in Scotland found a significant positive correlation between excess winter mortality and the (Scottish) Index of Multiple Deprivation [16], and another found socio-economic factors were associated with excess winter mortality across Europe [17].

Under-occupation (e.g., where parents remain in a largish dwelling after children have left home) can also result in high heating costs or low indoor temperatures.

The UK has higher winter mortality rates than other European countries that have colder and more severe winters, and several studies found that people from temperate regions tended to have cooler homes and take less precautions against the cold [17], including wearing inadequate protective clothing when going outdoors [18, 19].

**Human responses to reduce the threat to health**

Many human factors that may increase susceptibility cannot be avoided, but it is possible to recognise them and take some precautionary measures. As susceptibility increases with age, the presence of serious chronic health conditions and reduced mobility mean that more precautions are needed [5].

The ability to distinguish thermal discomfort diminishes in old age, but a simple thermometer can give an indication that room temperatures are at a safe level. Other precautions include wearing layers of warm clothing, preparing warm food and drinks (non-alcoholic), and closing windows and curtains at night to conserve heat. In readiness for the colder periods of the year, the heating system should be checked and serviced. Also, it may be useful to check if the energy efficiency of the dwelling can be improved. However, these precau-
tions need an awareness of the potential threats and the need for protective behaviour.

Some of these actions may involve costs. Inadequate financial resources for low income households – the heat-or-eat dilemma [20] – may result from a household being unaware of grants or supplementary state benefits, or even reluctant to apply for available help (and the perceived associated stigmatising). However, grants and benefits may not compensate for other personal and behavioural characteristics [7].

**Building factors increasing the threat to health**

Building factors include the age (ie, when the dwelling was constructed), the insulation provided by the structure, the efficiency and effectiveness of the heating system, the rate of ventilation, and the location of the dwelling within a building and geographically.

The design and construction of a dwelling affect whether it gives adequate protection for the occupants against cold periods. Although it is possible to design new dwellings (those yet to be built) to incorporate protection, the majority of dwellings already exist – in England, at least 50% of the housing stock is 50 years old [21] and this is probably true for most developed countries. It is this majority of the housing stock which is unlikely to provide adequate protection. It has been shown that there is an increased risk of exposure to excess cold in older dwellings [7], the risk being greatest in dwellings built before 1850, and lowest in those built after 1980. It also appears that an absence of central (whole house) heating and dissatisfaction with the heating system are associated with increased risk of winter mortality [22].

Similar findings about the link between energy inefficiency and excess winter deaths have been found in a large cross-European study [17]. This study found that four countries with poor standards of housing, Portugal, Greece, Ireland, and the UK, all recorded high numbers of excess winter deaths (EWDs).

Energy inefficiency depends on whether the dwelling allows too much heat to escape because of poor structural thermal insulation, on the type of fuel used for space and water heating, and the size and design of the means of heating and ventilation.

Disrepair or dampness to the dwelling and any disrepair to the heating system may affect their energy efficiency. Also, the exposure of the dwelling will increase heat loss, but this may be compensated by the orientation which may give some solar heat gain (even in the colder seasons).

Some forms of insulation will settle over a period and become less effective as a result. In addition, as water readily conducts heat, excess moisture content (dampness) in the structure will reduce the thermal insulation it provides. This means that the effectiveness of some forms of insulating material can be compromised by moisture.

While ventilation is necessary to maintain indoor air quality and remove pollutants, excess and uncontrollable ventilation (rate of air exchange and draughts) wastes heat and reduces air temperatures as warmed air is replaced by cold air from outside. Excess and uncontrolled or uncontrollable ventilation that may be caused by too large or inappropriately sited means of ventilation (such as windows) permanent openings (such as air bricks and vents), ill-fitting butt-jointed wooden floor boarding, or ill-fitting doors or windows.

**Building responses to reduce the threat to health**

For new dwellings (those yet to be built) there is a range of options that can be covered by Building Codes. To minimise risks from low temperatures, these Codes can ensure high levels of energy efficiency such as design to take account of exposure and orientation, high levels of thermal insulation, efficient and effective heating system, and air-tightness (while ensuring ventilation is sufficient to maintain air quality). However, dealing with existing dwellings is more problematic and it is these that we concentrate on here.

The prime long-term and sustainable response is to improve the energy efficiency of the dwelling. This has been shown to benefit both physical and mental health, to increase spatial use of the dwelling, and to have socioeconomic benefits [23]. Appropriate and sufficient structural thermal insulation will minimise or at least reduce heat loss. The level of insulation necessary is in part dependent on geographical location and exposure, the position in relation to other dwellings and buildings, and the orientation. South facing glazing can be used to increase solar heat gain during daytime and so save energy (but it should not create overheating problems during summer, perhaps by the provision of shading or shutters, on which see Building responses to reduce the threat to health below).

Heating should be appropriate to the design, layout and construction, such that the whole of the dwelling can be adequately and efficiently heated. It should be safely and properly installed and maintained, and, importantly, should be controllable by the occupants.

There should be means for ensuring low level background ventilation without excessive heat loss or draughts. It should be properly installed and maintained, and should be controllable and understandable by occupiers [24]. There should be means for rapid ventilation at times of high moisture production in kitchens and bathrooms.

It is important to note that improving air-tightness, without appropriately designed ventilation, can increase mean indoor radon levels [25]. And, while there have been
some concerns, particularly about indoor air quality, a recent meta-analysis found no negative health effects from energy efficiency interventions [26].

**Excess heat**

**Human factors Increasing the threat to health**

Heat-related health impacts can be especially severe for certain population groups. These include the elderly and very young [27], those with chronic physical conditions (such as obesity, diabetes, renal, and cardiovascular diseases) and/or mental health conditions, and those on certain medications [28, 29]. Impaired mobility or being bed-ridden increases the risk [30]. It is also suggested that women are more likely to be at risk [31].

Individuals who are living alone were found to be more at risk in some studies [28, 31], but not in a study in Britain [14]. While one study found those isolated or with lower socioeconomic background are at risk [32] another did not find an association with low socioeconomic status [33]. Studies have found an association between mortality and low socioeconomic status during heat waves, in the US where it could be linked to the lack of access to air conditioning [34]. Some specific ethnic groups may be more at risk [35].

**Human responses to reduce the threat to health**

The active participation of the occupiers is necessary for limiting heat gain and reducing indoor temperatures, which means an awareness and knowledge of appropriate precautionary measures. However, the behaviour of occupiers is both difficult to assess and to influence. A review on window opening behaviour found that while it is possible to identify what drives behaviour, it is difficult to understand how to influence it [36]. Also, there have been only a few studies evaluating occupier behaviour during extreme heat [37, 38].

Shading from the sun to reduce solar heat gain can avoid overheating, and this can include closing curtains where other means are not available. More important is understanding and controlling day and night ventilation. Opening windows during the day is only useful where the outdoor temperature is lower than that indoors. Purge ventilation at night with high air change rates, to replace warm indoor air with cooler air from outdoors is important to ensure residents can sleep and that the heat built up over the preceding day is released [39]. Installing air conditioning is really a building solution, but using it is a human factor, which may not be an option for those on low income.

As well as air temperature, the risk from overheating is affected by other factors, including air movement. Air movement helps the body cool down, principally by evaporation (however, see Building responses to reduce the threat to health below on the use of mechanical fans to increase air movement).

Relief from high temperatures can be achieved within a dwelling where there is a cool room (such as a North facing room) or cool area available in the building. Where this is not available, going to a cool (air-conditioned) public space, such as a library or shopping mall, can give relief. However, this is not possible for those who may be the most susceptible including the bed-ridden or those with physical (mobility) impairments.

**Building factors increasing the threat to health**

Factors affecting the risk of exposure to overheating include the location, orientation, structural insulation, and ventilation.

Risks from high temperatures can be increased in dwellings in urban areas [40], and those in areas with a low prevalence of air conditioning [34]. One study found that there was a higher heat threshold (the temperature above which mortality risk clearly begins to increase) in cities that normally have hotter summers, reflecting the adaptation of the population [4].

In dense built-up areas there are Urban Heat Islands (UHIs), where the local ambient temperature may be several degrees higher than that in a rural location a relatively short distance away [41, 42]. Such UHIs are a result of reflected heat, heat emitted from refrigeration and air conditioning equipment, heat emitted by people and vehicles, and heat emitted overnight by the thermal mass of buildings and roads that absorbed heat during the day. This is compounded by the lack of protective greenery. The UHI effect can mean that the night-time temperature remains as much as 4°C higher than in the rural areas. Even in less dense urban areas with green spaces and trees, the temperature may still be around 2°C higher than rural areas at night. This means that there is less variation between day and night temperatures limiting the dwelling, and more importantly the residents, from cooling down.

Moreover, living in a noisy location – adjacent to busy roads, railway lines, industrial plants, airports, or other noise sources – will affect whether occupants open windows at night. Similarly, a dwelling on the ground floor of a block will influence whether occupants open windows at night for security reasons. As open windows could give access to attacking insects, screens (preferably moveable) can be fitted.

The direct heat gains through glazing can also be very significant, particularly where windows face South through to West [43]. Solar radiation through windows...
will heat the internal surfaces and that heat will be given off into dwelling causing internal temperatures to remain high over the following night. While internal blinds or curtains may reflect some heat, there will still be warming of the room air.

Design and construction practice often means that the same or similar house typography will be adopted irrespective of orientation. In the case of single aspect dwellings and apartment blocks, dwellings facing one direction may be more prone to overheating than those facing the other.

The amount of heat conducted through the opaque elements of the building fabric when the temperature of external surfaces is higher than the internal is relatively small in modern buildings. However, this may not be the case for older buildings and in some cases (where dwelling or rooms are directly under the roof) heat gains can be very significant.

Investigations into the Paris heat wave of 2003 found that elderly residents of dwellings sited immediately under an inadequately insulated roof were more likely to suffer overheating and had an increased risk of mortality than those in other apartments [30].

Independent of heat waves, there are also several sources of heat within dwellings that can contribute to overheating. Depending on activity, the human body will give off between 65 to 80 Watts per person per hour. In addition, activities such as cooking, bathing, etc. all release heat, and almost all of the electricity used in a dwelling is converted into heat. The generation and distribution throughout a dwelling of hot water is also a source of heat liberated into the dwelling, and, depending on the type of system this may be significant.

While thermal insulation is good and necessary, for some modern, highly insulated and relatively air-tight dwellings, the problem of overheating can be magnified. Such energy efficient dwellings limit the heat loss through the fabric and air changes, and so retain even more of internal and solar heat gains within the dwelling [44].

### Building responses to reduce the threat to health

Again, Building Codes can be geared to reduce the possibilities of overheating, and can require including design to take account of orientation, high levels of thermal insulation, controllable heating system, and controllable ventilation (while ensuring good air quality). Neighbourhood planning can ensure more green spaces (to reduce the UHI effect) [2,45].

In existing dwellings, solar heat gain through the structure can be reduced by increasing the thermal insulation provided by the external walls and windows, and the loft (roof). However, without adequate and appropriate means of ventilation, this may trap heat inside the dwelling. Providing additional thermal insulation to dwellings with solid external walls is challenging, particularly where the dwelling abuts the pavement (as is often the case in urban areas).

Curtains, internal blinds or shutters can limit solar heat gain through windows facing South through to West, but external shading or shutters are more effective. External shutters can also provide additional security, and, depending on the type, can allow for natural ventilation. In England, most modern openable windows are designed to open outwards, making the fitting of external shutters problematic.

Shading of windows can also be provided by brise-soleil or awning and are particularly suited for South facing windows and walls, giving protection from high level sun. External shutters or roller-blinds, providing vertical shading and protection from low level sun, are more suited to windows facing East or West, giving protection when the sun is at a lower level. (But, such vertical shading has the disadvantage of restricting daylight and views of the outdoors [46]).

A light-coloured finish to walls and flat roofs can reflect sunlight, so reducing solar gain. Also, it may be that some protection will be given by photovoltaic devices fitted to roofs, as these will help reduce the amount of solar gain through the roof (and provide a source of useable energy).

Other than homes for a specific population group (such as retirement homes), passive ventilation is a better option than air conditioning, and avoids another energy using appliance (which will also emit heat to the immediate outdoors and place an additional financial burden on the household). Electric fans also use energy and generate heat within the dwelling, and, while they ensure air movement, have limited usefulness when the relative humidity is over 35% and in high ambient temperatures (over 32.3°C) will not reduce body temperature [47-50].

For ground floor dwellings and those in apartment blocks with windows opening onto access balconies where there is a need for security and in noisy locations, opening windows may not be practical or appropriate. In such cases mechanical ventilation system may be necessary. Such systems should be able to achieve high air change rates to give purge ventilation without impacting the residents, ie, should be of appropriate size and not noisy. Where security alone is an issue an option is the installation of windows that incorporate controllable secure louvered panels (with protection against insect attack).

### Discussion

Avoiding thermal discomfort within dwellings is not just about residents’ satisfaction and comfort, it is about protecting health. Ambient temperatures below 18°C or
above 24°C are thresholds beyond which there are threats to health, particularly for those who are susceptible for whatever reason. Although accurate measurement or modeling of indoor temperatures is not really possible, precautions and actions to protect against the likelihood of exposure to excess low or high temperatures are known.

This paper shows that there are some human and some building factors that increase the threat to health and that are common to low and to high temperatures (tables 1 and 2). For the human factors these include age, most of the health related factors, social exclusion, mobility problems, and lack of awareness of precautionary actions. For the building factors they include inadequate thermal insulation, and inappropriate provision for heating and for ventilation.

The population groups already susceptible will be most at risk where they occupy dwellings that provide inadequate protection exposure to low and/or high temperatures. While it may not be possible to identify all those susceptible (such as those with health conditions), it may be possible to identify those at risk for social or financial reasons, although some households may not wish to be identified, perhaps fearing being stigmatised as ‘Fuel Poor’. Strategies and actions focusing on this most ‘at risk’ group are necessary for short-term plans, and many countries have Cold Weather, Heat Wave, and/or Extreme Weather Plans that trigger action targeting at risk groups when a cold or hot event is forecast.

However, long-term solutions, aimed at increasing the protection offered by all dwellings will complement and reduce the strain on reactive interventions. Such building focused solutions provide a more permanent solution as there is no guarantee that the current occupying household (whether at risk or not) will remain in occupation [51].

Some of these human and building solutions will involve adaptations against the impact of climate change. In addition, they will mean contributions to mitigating against climate change and the housing sector is a key target for reducing emissions of greenhouse gases.

It is important that any building interventions are carefully planned to ensure that the necessary benefits for health are not compromised by avoidable negative impacts on, for example, indoor air quality. Avoiding negative impacts, such as overheating, is also important in the design and construction of new buildings. When preventative measures are installed in the building, it is important to inform the occupiers on how to use them.

Table 1. Human factors increasing the risks to health of thermal discomfort.

<table>
<thead>
<tr>
<th>Unavoidable factors</th>
<th>Excess cold</th>
<th>Excess heat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The elderly, particularly those &gt; 75</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>The young, particularly those &lt; 5</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td><strong>Health</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>People with mental health problems</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>People taking particular medications</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>People with mobility problems</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>People with serious chronic diseases</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td><strong>Socio-economic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low socio-economic status</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>The isolated (social exclusion)</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Crowding</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td><strong>Factors probably avoidable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unaware of, or not claiming financial assistance</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td><strong>Behaviour</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol or drug abuse</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td><strong>Awareness</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unaware of precautionary behaviour</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>
Ventilation is necessary for indoor air quality, but relies on the behaviour and understanding of the occupants. For example, opening windows when the outside temperature is equal to or above the indoor temperature is at best of no benefit and may increase heat gain.

Table 2. Building factors increasing the risks to health of thermal discomfort.

<table>
<thead>
<tr>
<th>Location</th>
<th>Excess Cold</th>
<th>Excess Heat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediately below an uninsulated roof</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>In a rural or isolated location</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>In an exposed position</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>In a noisy environment (road, rail or other traffic)</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>In an urban environment (heat island effect)</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>On ground floor or off public balcony (security)</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Orientation</th>
<th></th>
<th>✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large glazed areas facing south, west, or southwest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-aspect dwelling facing south, west, or southwest</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shading</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No means of external shading to windows</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Thermal insulation</th>
<th></th>
<th>✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor structural insulation (walls, windows, roof)</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Dampness reducing effectiveness of insulation</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Compression/settling of insulating material</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Presence of cold bridges</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Uninsulated hot water system</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heating</th>
<th></th>
<th>✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faulty or inappropriate controls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inappropriate/inefficient provision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequate for size of dwelling</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>No whole house (central) provision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequately installed/maintained</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ventilation</th>
<th></th>
<th>✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient/ineffective/excessive provision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequate means of control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disrepair to provision or controls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ill-fitting doors/windows (draughts)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defective/inefficient air conditioning</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusion

What seems clear from our summaries of building factors is that there are common factors that mean some dwellings provide inadequate protection to both high and low temperatures and some create problems that threaten health. This also means that there are some building responses (adaptations) that will reduce the risk of exposure to both threats. This integrated approach has been pointed out in a recent report to the UK Parliament [52]. These building responses should be included in both Heat Wave Plans and Cold Weather Plans.

Ideally, there should be a co-ordinated approach involving all the various sectors, at local and national levels, with responsibilities related to both excess cold and overheating in dwellings. This would include collaborations between the building, housing, social and health sectors – a single comprehensive strategy to protect health in housing environment.

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References


