An assessment of indoor air quality and thermal comfort in sheltered accommodation in Belfast

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SUMMARY
Thermal comfort and indoor air quality is of growing concern in the current building industry. For more susceptible groups such as older people, the risks associated with inadequate interior environmental quality are more severe. This research focuses on the identification of current interior environmental conditions in sheltered accommodation in Belfast. The methodology adopted includes the measurement of interior relative humidity, carbon dioxide and temperature levels between the periods of 8.00am and 5.00pm. Interviews were also carried out to gain qualitative information on perceived comfort and indoor air quality. This research found that 83% of sheltered accommodations assessed failed to maintain an internal temperature within the WHO's recommended limits (20-24°C). Furthermore, 67% of buildings measured recorded relative humidities above ASHRAE's recommended limit of 60%RH. Thus this study argues the need for a review of interior environmental quality in sheltered accommodation and recommends further research to identify the extent of the problem.

KEYWORDS
Healthy homes and buildings, Thermal comfort, Perceived air quality, Residential

1 INTRODUCTION

The home is depicted as a shelter; a comfortable refuge providing protection from the elements and other external threats. People tend not to consider the need however, for protection from internal threats. The chronic cancer risks associated with exposure to pesticides, asbestos, radon and combustion by-products suggest that health concerns associated with internal air pollution dramatically exceed that of external air (Godish, 2004).

The fundamental importance of interior environmental quality has grown over the last few decades, as a result of an over-reliance on elaborate technologies in air-tight buildings, which are oblivious to the natural environment (Oliver, 2005). The drive towards energy efficiency is having a detrimental effect on indoor air quality through the increased airtightness of building envelopes. The lack of sufficient air changes in sealed buildings as a result of reduced air infiltrations leads to a build-up of harmful pollutants, which have a negative impact on human health (NHBC, 2009). In the context of this rapidly changing construction industry, further problems arise through the implementation of new construction methods and materials with unknown consequences.

For more susceptible groups, the risks associated with poor interior environments are more severe. Older people spend a disproportionate amount of time indoors, and are more vulnerable to interior conditions; such as temperature changes, drafts and poor indoor air quality. Older people have a reduced capacity to adapt to ambient temperature change as the human metabolic rate decreases with age (Hwang & Chen, 2010). Furthermore, research

suggests that older people's lifestyles and behaviour can subject them to increased levels of indoor air pollution, as a result of residential maintenance difficulties, increased time in the kitchen and extensive use of cleaning products (Coelho et al, 2005).

In order therefore to ensure that people grow old comfortably in an environment that protects human health and provides optimum levels of satisfaction, the current indoor air quality and levels of comfort in sheltered accommodation must be determined. As suggested by Coelho et al (2005), most studies related to indoor air quality have been carried out on working people, without the consideration of older people and their specific health risks. Furthermore, there is a lack of information on the current environmental quality of older people's homes, particularly within the UK.

2 MATERIALS/METHODS

An explorative and descriptive method was utilised through the combination of a literature review, field work measurements and interviews. A preliminary sample for investigation was selected using data from a previous study, where sheltered accommodation in Belfast were selected based on building type, size, age and comfort levels. Through telephone investigations and visits, this sample was reduced to three purpose built and three adapted sheltered accommodation.

Carbon dioxide, temperature and relative humidity levels were recorded in communal areas using an indoor air quality datalogger (Extech EasyView Model EA80) at fifteen minute intervals between 9.00am and 5.00pm. This provided greater degree of accuracy as measurements could run continuously throughout the day which reduced time needed for stabilisation. Communal areas were measured during normal occupancy, with measures taken to reduce interference. Outside readings were also taken at the beginning of the survey, at midday and at the end. The outdoor air samples were located near intake sources (e.g. windows) and away from direct sunlight.

A period of fifteen minutes was provided for stabilisation prior to the measurements. The sampling probes were placed at a height of 1.1m above floor level (according to standard ISO 7726:1998 for seated persons). Care was taken to ensure the probes were kept away from sources of direct air pollutants, and placed at an adequate distance from corners, windows, walls and other vertical surfaces (ORIA et al, 2003). Additional factors including occupancy rates, activities, window/door status and weather conditions were recorded during the measurement period, which provided fundamental information on the conditions affecting indoor air quality and thermal comfort.

Interviews were utilised to obtain subjective data, validate findings and increase the accuracy of the results. These were carried out with staff and visitors due to insufficient time to obtain the ethical approval required to interview residents. The interviews provided further information on perceived indoor air quality, perceived thermal comfort, building components and building related health/wellbeing issues, which could then be correlated with measurement results. The number of candidates interviewed depended on the availability of staff in each building, and ranged between one and two interviews per building. The interviews were intended to collect results of 'depth' and not 'breadth', therefore sample size was not considered of primary importance.

A semi-structured guide was created prior to the interview process, which provided some degree of flexibility, while ensuring the interview remained focused. Candidates received a

copy of this guide at the beginning of the interview, which offered further validation through providing ample time to consider questions thoroughly before formulating an answer. A recording device was used in some cases to clarify results.

3 RESULTS

Field measurements

Findings suggest inadequate internal temperatures in 83% of buildings measured. Five out of six buildings measured recorded internal temperatures outside of the WHO's recommended limits (minimum of 20°C for the elderly and maximum of 24°C for working in comfort). Two of these buildings (M1; M5) recorded average internal temperatures above the WHO's recommended maximum temperature for working in comfort. 50% of buildings measured temperatures below the WHO's recommended temperature for the elderly. There did not appear to be any significant differences between purpose built and adapted.

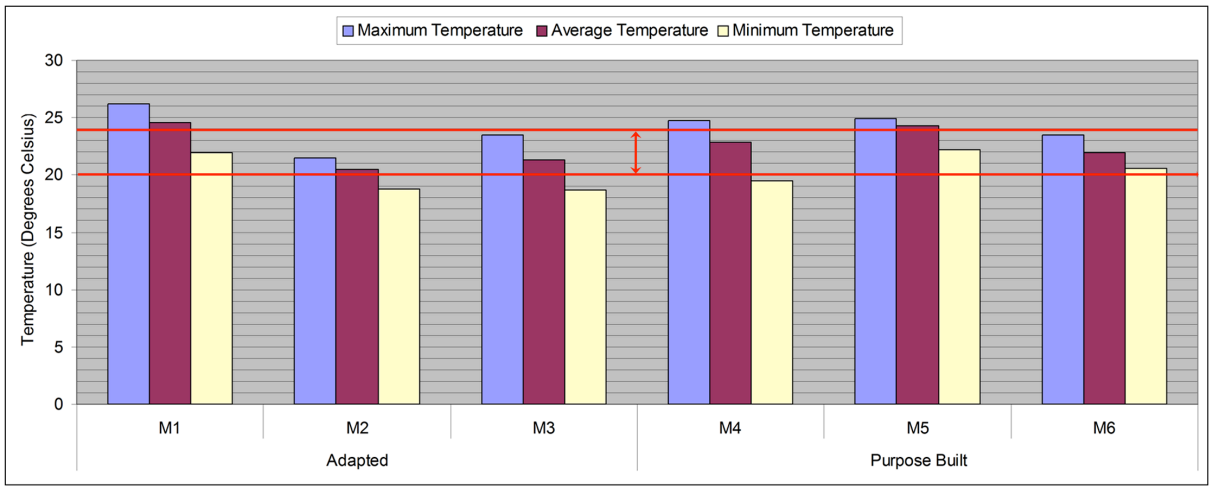

Figure 1. Maximum, minimum and average temperatures

Four out of six buildings recorded interior relative humidity levels above ASHRAE's recommended standards, with two out of six experiencing problems with mould. All average relative humidities however were within the recommended limits (30-60%RH).

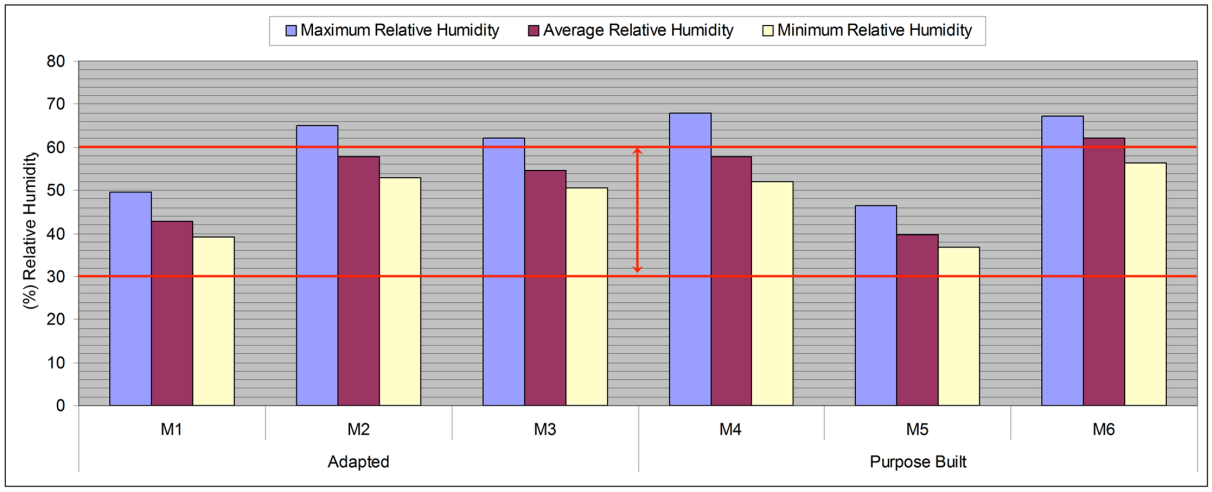

Figure 2. Maximum, minimum and average relative humidities

Only one building recorded levels above the ASHRAE recommended limit of 1,000ppm (M6) which occurred at peak occupancy levels (in this case during weekly tea/coffee morning).

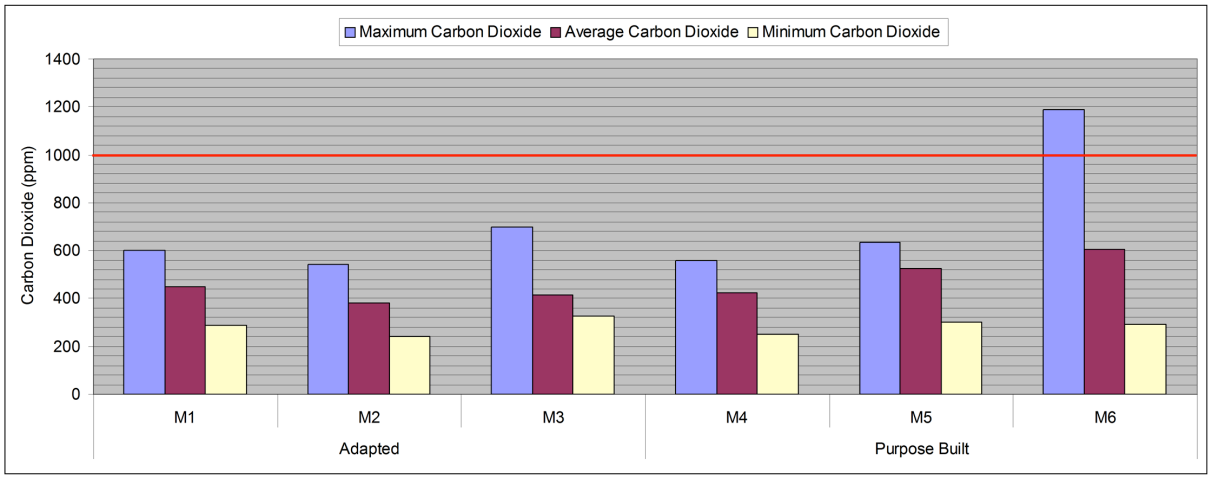

Figure 3. Maximum, minimum and average carbon dioxide levels

Interviews

Two staff members were interviewed from each sheltered accommodation, with the exception of M3 where only one member of staff was available to interview. The most prevalent comfort complaint was feeling thermally uncomfortable during the summer months. This was elaborated by some staff members who explained that the constant use of heating systems can lead to overheating in some areas. In addition, more than half of the staff members interviewed used portable fans during the summer months for additional cooling, which suggests a problem with over-heating.

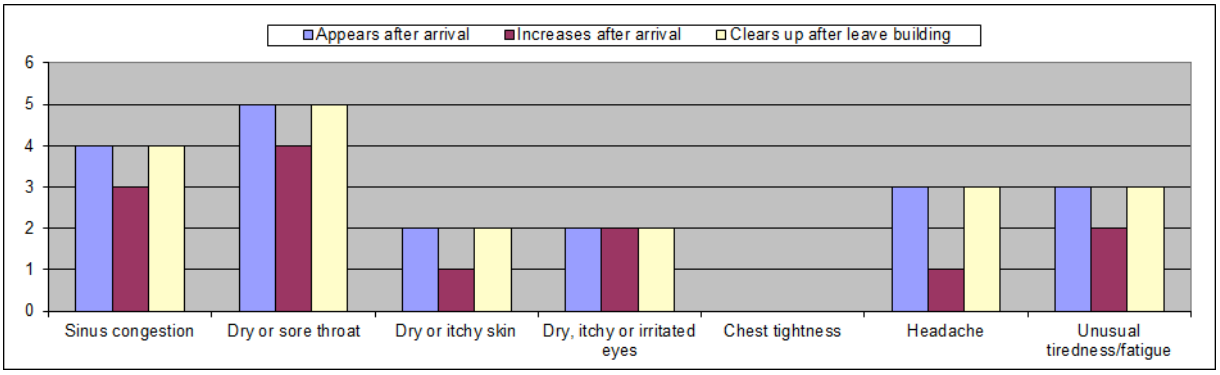

Figure 4. Prevalence of building related symptoms experienced in sheltered accommodation

Almost half of all staff members interviewed experienced unusual tiredness/fatigue in the workplace. Out of these, 60% stated that this symptom ‘appears after arrival’ and ‘clears up after leaving the building’. Fatigue is a common symptom of sick building syndrome; therefore it is possible that this related to the interior environmental quality. One explanation is that fatigue may be as a result of excessive internal temperatures. Furthermore, almost half of all staff members interviewed reported experiencing a dry or sore throat in the workplace which ‘appears after arrival’ and ‘clears up after leaving the building’. In addition, 36% of candidates experienced building related sinus congestion, suggesting the need for further research with a larger sample size to determine the extent of the problem.

4 DISCUSSION

Exposure to indoor pollutants poses greater risk to older populations, generally related to increased prevalence of underlying health problems, increased time spent indoors and lifestyle and behavioural choices (Brebbia & Longhurst, 2010; Makri & Stilianakis, 2008). The continuing rapid growth in the older population will further heighten this problem, with risks to health and wellbeing likely to become more prevalent in years to come. Current literature suggests a drastic need for further research in this area, particularly in Northern Ireland where very little studies have been cited so far.

The size of this study is not substantial enough to draw firm conclusions; however it does identify some interesting findings. The excessive interior temperatures suggest inadequate control over interior conditions and may increase the prevalence of headaches, fatigue and stuffiness (EPA, 1991). The use of portable fans by more than half of staff members indicates inefficient, uneconomical methods of thermal control and suggests the need for a review of internal heating strategies. The interview analysis also highlighted problems with the over-use of heating systems particularly in the summer months, often resulting in overheating in some rooms. The problem appears to be in maintaining a balance between energy efficiency, thermal comfort and indoor air quality. It is suggested that through our quest for greater levels of comfort, we are unconsciously creating progressively unhealthy environments (Saunders, 2002).

Availability of resources and time limited the scope of this study; however it did highlight future research needs. The frequency of building related symptoms from staff members suggests the possibility of sick building syndrome (SBS) in sheltered accommodation in Belfast. Further research is required to identify the extent of interior environmental problems and the health risks associated in residential buildings. Furthermore, the challenge of creating energy efficient, healthy and comfortable homes with adequate occupancy control will require further research, particularly from a design perspective.

5 CONCLUSIONS

This research provides an insight into the interior environmental conditions of sheltered accommodation in Belfast, which as far as the researcher is aware has never been done before. The findings suggest the need for greater monitoring and control of interior temperatures and relative humidities, and a revision of heating strategies used. In addition, the results from the interview analysis found that in five out of six sheltered accommodations, at least half of staff interviewed reported one or more building related symptom which appeared after arrival and cleared up after leaving the building.

This study highlights the fundamental importance of interior environmental conditions in the home, thus may be used to promote the monitoring and control of indoor air quality and thermal comfort. Furthermore, it highlights the importance of thermal comfort and indoor air quality in buildings occupied by older people. The findings from this research provide baseline data which can be used to inform the future design, construction, operation and maintenance of sheltered accommodation in the UK and Ireland.

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