WELLINE
Wellbeing and the Indoor Environment

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WELLINE Workshop I: Summary

'The Indoor Environment and Disorders of the Respiratory and Cardiovascular Systems across the Life Course'

University of Birmingham, 23 September 2009

Lifelong Health & Wellbeing
Research for Healthy Ageing

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WELLINE WORKSHOP 1:

THE INDOOR ENVIRONMENT AND DISORDERS OF THE RESPIRATORY AND CARDIOVASCULAR SYSTEMS ACROSS THE LIFE COURSE

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WORKSHOP SUMMARY

Introduction

Caring for an increasingly aged population carries with it an intense resource requirement; it is therefore important to try to keep individuals *out* of care. This may be partly achieved by addressing the factors that influence health throughout the life-course, and eliminating, ameliorating or mitigating those that have adverse impacts while enhancing those that have positive influences on health.

For most health conditions there is an element of genetic predisposition combined with exposure to environmental factor(s) that result in the causation and/or worsening of the disease. The home environment can be extremely relevant in this context, not least because it is where people spend an increasingly large proportion of time as they age. This workshop investigated, using a modified DPSEEA tool, possible linkages between the home and two specific health conditions affecting older people – chronic obstructive pulmonary disease (COPD) and cardiovascular disease (CVD). The workshop (see programme at Annex 1) included contributions from both experts and patients suffering from the diseases in question.

The environment may affect health in a number of ways throughout the life-course, including impacts on disease causation (initiation), incremental worsening of symptoms and/or more sudden exacerbation of symptoms. This workshop focused principally on the worsening and exacerbation of symptoms, but there is a wider context, not directly considered in this exercise, that includes impacts during early life (including therefore the school environment) and mid-life (including the work environment) that can affect disease causation. The manner in which home (and other) conditions influence disease *causation* through the life-course can be considered a knowledge gap that needs to be addressed.

As well as plotting linkages through application of the modified DPSEEA model (see Annex 2) the analysis undertaken during the workshop was aimed at identifying possible actions and principal gaps in knowledge. A key objective was to determine what individuals can do for themselves, or have done, in their own home. Notes captured during the meeting are presented in Annex 3.

In addition to formulating one or more key research questions, an anticipated outcome from the WELLINE project is the formulation of an answer to the question: “What is the ideal indoor housing condition for these [COPD & CVD] groups of patients?” i.e. production of a statement of best practice.

Background considerations

The workshop identified a number of background issues and facts that were considered relevant to the deliberations.

Although the focus was on the domestic (home) environment, it was acknowledged that care homes and communal indoor environments (public buildings) are also relevant. It was recognised that the published COMEAP guidance on indoor air quality was relevant and should be referenced, and that for some considerations it is likely to be necessary to differentiate between age groups. Evaluating the strength of evidence should lead also to the identification of knowledge gaps. It was considered that outputs from this exercise should include very practical guidance, for example for builders. Important sources of background information include the report on 'Health and Safety Risk Drivers' and also the Health and Housing Safety Rating System (HHSRS).

Dwelling characteristics

In considering how aspects of the home might influence COPD and CVD, the following dwelling characteristics were identified as being of potential importance:

- **Presence of stairs**
- **Heating systems amenable to control**
- **Building layout and ergonomics – including room, corridor and door size, toilet accessibility and storage/appliance reachability**
- **Communications**
- **Openable bedroom windows**
- Thermal efficiency (temperature)
- Ventilation (dwelling specific or building specific for multiple occupancy buildings)
- Moisture control and mould growth
- Indoor pollution from combustion products, consumer products and building products
- Presence of natural light
- Noise

Those shown in bold are considered to be specifically relevant to dwellings of individuals with COPD or CVD.

Priority topics

The topics identified as being of particular interest and/or importance were:

- **Building structure and design: presence of stairs, location of toilets, building modifications**
- **Factors for primary prevention: damp and cold housing, temperature extremes**
- **The health endpoints of breathlessness and dizziness**
- Factors causing incremental worsening of conditions: smoking, environmental tobacco smoke (ETS), occupational exposures
- Volatile organic compounds
- Exacerbation/destabilisation of condition: COPD, CVD (cold), climbing stairs, moving between rooms

Those shown in bold were considered further through application of the modified DPSEEA model, as detailed below.

Dwellings not suitable for life-long living

The DPSEEA *State* of 'Dwellings not suitable for life-long living' was taken as a starting point for identifying relevant linkages with COPD/CVD and indicating appropriate actions and gaps in knowledge. The context for considering these linkages included: changing age, health status, socioeconomic status, and use of air fresheners and other sources of VOCs.

A direct *Action* to address this *State* could be appropriate adaptation of the house or moving to other more suitable housing. An associated knowledge gap was the question whether the National House Condition Survey contained or enabled links with relevant health data. In addition there was considered to be an informational need relating to compatible space resolution within buildings and, more fundamentally, the need for a definition of the ideal living environment for people with COPD/CVD – i.e. a statement of best practice.

The principal *Pressure* that causes this State to exist was identified to be the original design of the building and subsequent modifications made to the dwelling. There was considered to be a lack of knowledge of the nature and impact of modifications made after dwellings are built.

The *Drivers* that affect building design and subsequent modifications making dwellings unsuitable for life-long living were deemed to include: planning policy (including housing density); lifestyle and expectations; changing age structures; changing household structure; current and historical building regulations; changing demand (e.g. multigenerational); energy efficiency policy; and the economic climate adversely affecting heating, maintenance and necessary building modifications (individual or grant funded). *Actions* that have been taken and were considered relevant include the Housing Act 2004 and the implementation of the Housing Health and Safety Rating System – however there was perceived to be a gap in enforcement.

Further in-depth analysis was conducted on factors including, but not necessarily limited to, those previously identified as dwelling characteristics and priority topics associated with the general state of 'Dwellings not suitable for life-long living' and specifically relevant to individuals with COPD or CVD, namely: Presence of stairs; House that cannot be adequately heated; Dwelling overheated; Inadequate ventilation/Poor indoor air quality; Internal natural light; Layout and ergonomics; Internal (and external) communications; Noise levels; Building materials; and Access to an external environment.

For each of these *States* the associated *Exposures* and *Effects* were identified, together with possible *Actions* and also any gaps in knowledge.

Presence of Stairs

The *Exposure* associated with the presence of stairs is overexertion in the context of impaired health (COPD and CVD).

Effects include breathlessness, fatigue and exhaustion with potentially long recovery times, and psychophysiological responses.

Actions to avoid or mitigate these effects include having help with the stairs, installing a stair-lift, reorganising the house and/or living arrangements to eliminate or reduce the use of the stairs, and obtaining grants (or loans or equity releases) to make appropriate modifications.

Inability to heat the dwelling adequately

Exposures here are considered to be temperatures less than 12°C, sudden changes in temperature (encountered, for example, when moving from a well heated room to an unheated one), excessive heating/cooling of hands, face and feet, dampness leading to mould growth and increased house dust mites, and viral transmission.

The *Effects* of low temperatures and sudden changes in temperature include cardiovascular impacts, changes in blood pressure and exacerbation of respiratory disease (COPD and asthma). Dampness and viral transmission are associated with asthma (the evidence for this being highest in children).

Identified *Actions* include installation of insulation (where grants may be available), application of building standards, and policy initiatives tackling fuel poverty (improving insulation and heating). Relevant sources of information include the National House Condition Survey and recommendations on energy efficiency measures.

A number of gaps in knowledge were identified including: whether physiological responses are primarily to changes in body temperature or air temperatures *per se*; profiles of thermal exposure; impact of cold homes on behaviour (e.g. going out); effects of climate change on older people; and how temperature affects individuals with specific diseases.

Overheating

The *State* of overheating of a dwelling, with no or limited control of the heating, was considered to apply particularly, but not necessarily exclusively, to shared/sheltered housing. The principal *Exposure* is dehydration and the *Effects* are on CVD by affecting cardiac output, with a possible link also to COPD.

Inadequate ventilation / Poor indoor air quality (IAQ)

This *State* is associated with the presence of indoor pollution sources.

The *Exposures* are the pollutant gases carbon monoxide, oxides of nitrogen, and possibly ozone - also particulate matter, VOCs, water vapour, and carbon dioxide (considered to be a proxy for poor IAQ).

The *Effects* of exposure are CVD and/or asthma.

Possible *Actions* include the control of VOC emissions from products (as done in France, for example), education and passing of information between residents, building control mechanisms, and production of a 'House Handbook'.

The context is behavioural modification and increased knowledge of the need for, and correct use of, ventilation systems. Identified knowledge gaps included the health impacts (effects and mechanisms) of VOCs, the health impacts of air movement (rather than just air exchange rate), personal exposures within a

building, the health impacts of high CO_2 levels, ventilation levels (rather than air tightness) in individual houses, age related behaviours such as opening of windows, the different ventilation rules/guidance in England, Scotland and Wales, and house condition reports (in Scotland) prepared on the sale of a house.

Natural light levels

The *Exposure* here is considered to be inadequate levels of blue light and altered photoperiod.

Effects include changes to the arousal cycle leading to changed sleep patterns and thence aging effects, changed inflammatory levels (affecting COPD and CVD), mood, and quality of life. There was considered to be limited understanding of the impact of quality of life and Vitamin D deficiency on the progression of chronic disease and general mobility.

Layout and Ergonomics

This *State* includes such factors as room, corridor and door size, and service, storage and appliance 'reachability' - and also (as a consequence of failings in the latter) loss of surface space.

The associated *Exposures* are exertion on access and reduced cleanliness and dust (in the context of health status), and use of diuretics.

Effects are breathlessness, fatigue and exhaustion, stress (associated with concern about incontinence) leading to elevated heart rate and CVD, and possibly asthma (associated with dust exposure). Suggested *Actions* include building control requirements, provision of building adaptation grants, and simply moving house to a more appropriately designed dwelling. A systematic review of evidence in this area was called for.

Internal and external communications

Exposures here are impaired access to alerts on (poor) air quality and the inability to summon help in the context of poor health status (COPD and CVD).

Effects include potentially more serious health outcomes, for instance individuals being unable to alert when an exacerbation occurs that limits their ability to move or undertake specific activities.

An identified *Action* was the installation of appropriate alarm systems. A systematic review of evidence in this area is required.

Noise levels (internal and external noise; sound transmission)

The associated *Exposures* are stress and altered arousal patterns; the *Effects* are sleep disturbance and, in the case of stress, CVD. Knowledge gaps include individual noise exposure levels and subjective thresholds.

Building materials

An important *Exposure* linked to this state is 'Dust Soup' – an indeterminate indoor mixture of organic and inorganic particles of various sizes, including in the nano range.

An *Effect* of such exposure is an asthma exacerbation, potentially contributing also to exacerbations of COPD.

Access to an external environment

Exposure here is considered to be mitigation of stress in the context of a state of being housebound. The *Effect* is a positive impact on wellbeing.

CONCLUSIONS

In considering possible associations between the indoor environment and disorders of the respiratory and cardiovascular systems in an aging population, the identified priority topics were: building structure and design (presence of stairs, location of toilets, building modifications); factors related to primary prevention (damp and cold housing, temperature extremes); and the health endpoints of breathlessness and dizziness. The most important building characteristics were considered to be: the presence of stairs; heating systems amenable to control; building layout and ergonomics (including room, corridor and door size, toilet accessibility and storage/appliance reachability); communications; and openable bedroom windows.

The following states were considered in detail: Dwelling not suitable for life-long living (overarching state), Presence of stairs, Inability to heat the dwelling adequately, Overheating, Inadequate ventilation/poor indoor air quality, Natural light levels, Layout and ergonomics, Internal and external communications, Noise levels, Building materials, Access to an external environment. Further analysis of these states led to a number of recommended actions and identified gaps in knowledge:

Dwelling not suitable for life-long living

Actions:

- Appropriate adaptation of the house;
- Move to other more suitable housing;
- Enforcement of the Housing Act 2004 and implementation of the Housing Health and Safety Rating System.

Knowledge Gaps:

- Whether the National House Condition Survey contains or enables links with relevant health data;
- Informational need relating to compatible space resolution within buildings;
- Need for a definition of the ideal living environment for people with COPD/CVD – i.e. a statement of best practice;
- Lack of knowledge of the nature and impact of modifications made after dwellings are built.

Presence of stairs

Actions:

- Have help with the stairs;
- Install a stair-lift;

- Reorganise the house and/or living arrangements to eliminate or reduce the use of the stairs;
- Obtain grants (or loans or equity releases) to make appropriate modifications.

Inability to heat the dwelling adequately

Actions:

- Installation of insulation (grants may be available);
- Application of building standards;
- Policy initiatives tackling fuel poverty (improving insulation and heating).

Knowledge Gaps:

- Whether physiological responses are primarily to changes in body temperature or air temperatures *per se*;
- Profiles of thermal exposure;
- Impact of cold homes on behaviour (e.g. going out);
- Effects of climate change on older people;
- How temperature affects individuals with specific diseases.

Inadequate ventilation / Poor indoor air quality (IAQ)

Actions:

- Control of VOC emissions from products (as in France, for example);
- Education and passing of information between residents;
- Building control mechanisms;
- Production of a 'House Handbook'.

Knowledge Gaps:

- Health impacts (effects and mechanisms) of VOCs;
- Health impacts of air movement (rather than air exchange rate);
- Personal exposures within a building;
- Health impacts of high CO_2 levels;
- Ventilation levels (rather than air tightness) in individual houses;
- Age related behaviours such as opening of windows;
- The different ventilation rules/guidance in England, Scotland and Wales;
- House condition reports (in Scotland) prepared on the sale of a house.

Natural light levels

Knowledge Gaps:

- The impact of quality of life and Vitamin D deficiency on the progression of chronic disease and general mobility.

Layout and Ergonomics

Actions:

- Building control requirements;
- Provision of building adaptation grants;
- Moving house to a more appropriately designed dwelling.

Knowledge Gaps:

- Systematic review of evidence required.

Internal and external communications

Actions:

- Installation of appropriate alarm systems

Knowledge Gaps:

- Systematic review of evidence required.

Noise levels

Knowledge Gaps:

- Individual noise exposure levels and subjective noise thresholds.

ANNEX 1: WORKSHOP PROGRAMME

WORKSHOP 1 (23rd Sept, Birmingham)

Indoor Environment and Chronic Disorders of the Cardiopulmonary System

8.30-9.00 Registration

Part 1: Introduction and Background

9.00-9.05 Jon Ayres

Introduction on Aims of the Project (emphasizing importance of lifelong prospective, role of indoor exposures on prevention and/or mitigation, discussing both “negative” and “positive” exposures)

9.05-9.25 George Morris

Introduction to the DPSEEA model

Part 2: Introduction on cardiopulmonary system and the indoor environment

9.25-09.30 Jon Ayres

Overview of chronic disorders affecting the respiratory system, with a focus on the possible interaction on indoor environment and potential for prevention/mitigation.

9.30-9.45 Patient with COPD on his/her experience of the condition

10.20-10.30 Overview of chronic disorders affecting the cardiovascular system, with a focus on the possible interaction on indoor environment and potential for prevention/mitigation.

10.30-10.40 CVD patient on his/her experience of the condition

10.40-11.15 Coffee break and voting

Part 3: DPSEEA mapping

11.15-12.15 Workshop on DPSEEA mapping for respiratory system and the indoor environment

12.15-13.30 Lunch

13.30-14.30 Workshop on DPSEEA mapping for cardiovascular system and the indoor environment

14.30-15.00 Coffee break

Part 4: Summary and the Next Steps

15.00-16.00 Summary, conclusions, next steps

ANNEX 2: THE MODIFIED DPSEEA MODEL

In Scotland, the Good Places, Better Health[1] policy recognised the need to make better connections between health and the physical environments in which people live, work, are educated, and take their leisure. The first phase of this new approach is to frame problems, gather intelligence and analyse relationships. In order to do this, a model has been identified and modified[2], which allows structured cross-sectoral discussion and reporting of the issues and current actions or those which could be considered in the future.

The model, (DPSEEA – which is an acronym of the elements within the model (described below)) was first conceived for work by the World Health Organisation[3;4] to develop indicators for a European environment and health initiative. DPSEEA provides a simple structure to consider the ways in which specific elements in the environment impact on health; the ways in which these environments are generated; and actions which can be taken to address the results chain which ends with health outcome(s). In addition the modified model (modified DPSEEA) considers the issues which determine whether people are exposed to particular environmental factors and whether these exposures subsequently lead to health effects (the contexts). The model has proved a useful tool in engaging people from a wide range of backgrounds in common discussion of the issues and in providing structured feedback on those discussions.

The modified DPSEEA has been provided as a diagram below (Figure 1), which gives the details of how the acronym is formed (the first letter of each element is underlined, starting at the top of the diagram).

The model can be read from any starting point. Starting from health effect, it considers the environmental exposures that may influence such an effect, and the contexts which determine exposure and the risk of an observable health effect. From there it considers the environmental states which lead to such exposures, the man made pressures on environments leading to such states and the social, political, economic, commercial, fiscal and other human activities which lead to these pressures. All points on the chain are then considered for possible action.

There is often no one single environmental factor which leads uniquely to a single health effect, and the model is often branched, with multiple chains leading to a number of different health impacts. Thus an action which has been envisaged to impact on one health state may result in impacts on a number of other health states or issues (some of which may be positive and others negative). DPSEEA modelling will establish the former, and the latter will be explored by other programmes within the Good Places, Better Health implementation.

Reference List

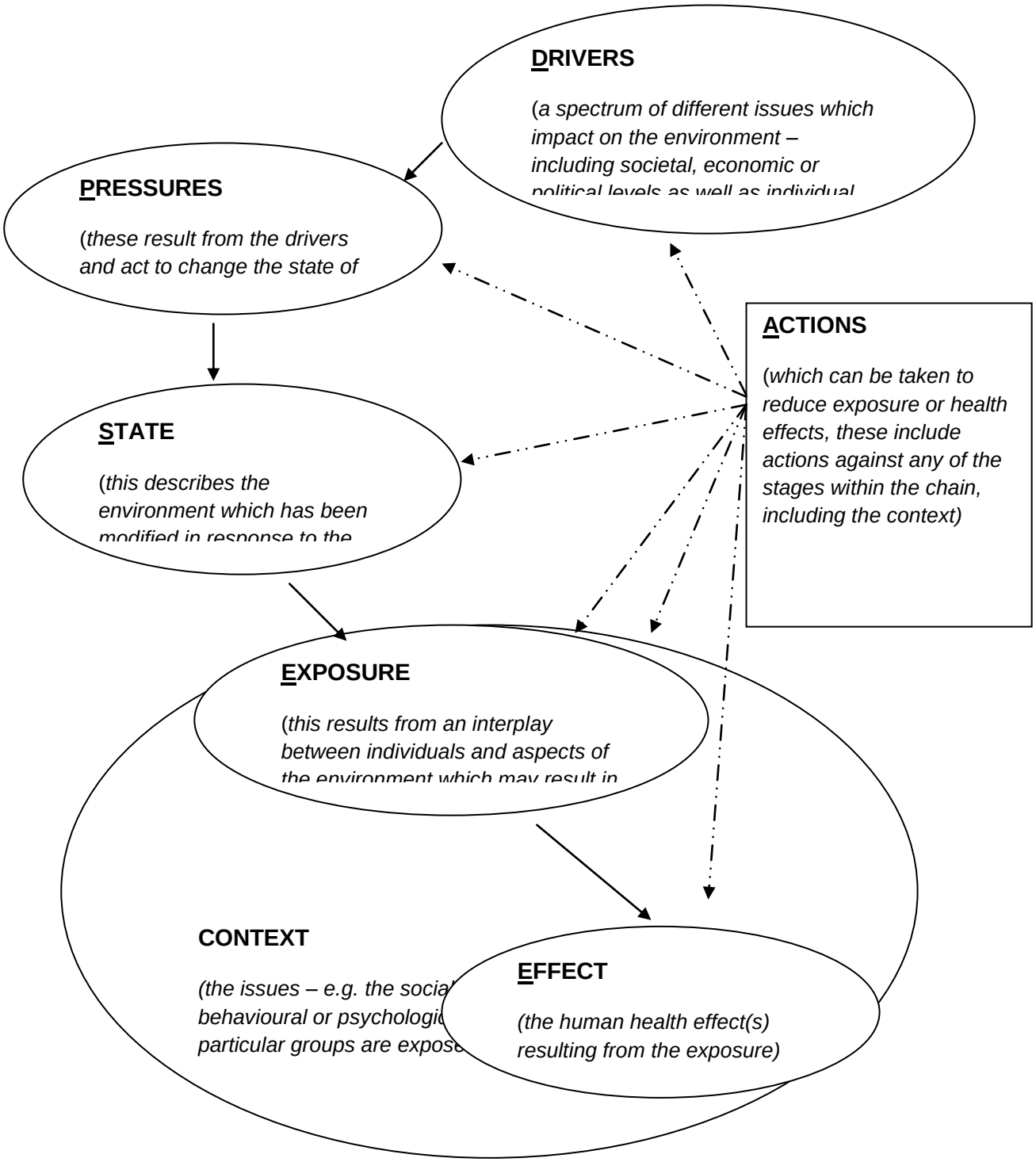
(1) Scottish Government. Good Places Better Health. http://www scotland gov.uk/Publications/2008/12/11090318/0

(2) Morris G, Beck S, Hanlon P, Robertson R. Getting strategic about environment and health. Public Health 2006; 120(10):889-903.

(3) WHO. Development of environment and health indicators for European Union Countries: results of a pilot study. http://www euro who int/eprise/main/WHO/Progs/EHI/Methodology/20040602_1 [2004 [cited 2004 Dec. 6]];

(4) WHO. Environmental health indicators for Europe: a pilot indicator-based report. www euro who int/document/eehc/ebakdoc04 pdf [2004 [cited 2004 Dec. 7]].

Figure 1 The modified DPSEEA model



ANNEX 3: FLIPCHART NOTES AND TABLES

FLIPCHART 1

ISSUES TO KEEP IN MIND

Need for a clear brief for builders

COMEAP Indoor Air Quality Guidance

Homes, Care Homes, Public Buildings

Differentiate between age groups

Background information: "Health and Safety Risk Drivers" report; "Health and Housing Safety Rating System"

Strength of evidence – Identify knowledge gaps

COPD consultation [??]

FLIPCHART 2

IMPORTANT DWELLING CHARACTERISTICS

Dwelling with stairs *

Thermal efficiency/inefficiency (temperature) → Comfort and health

Heating systems amenable to control *

Ventilation – dwelling specific; building specific (multiple occupancy)

Moisture control/Mould

Indoor Pollution – combustion products, consumer products, building products

Natural light in building

Building layout/ergonomics – room/corridor/door size, toilet accessibility, storage/appliance reachability *

Communications – internal, external *

Openable bedroom windows (bedroom fan) *

Noise [Effects knowledge gap?]

* Specifically relevant to buildings with COPD/CVD occupants

FLIPCHART 3

BRAINSTORM LIST OF 'TOPICS' [NUMBER OF VOTES]

Endpoints: Breathlessness [7]; Dizzy spells [1]

Primary prevention: Dampness & cold housing, temperature extremes [14]

Incremental worsening of conditions: COPD – smoking [1], ETS [3], occupational [1]

Volatile organic compounds [5]

Building structure/design [20] – toilets, stairs, modifications

Exacerbation/destabilisation of condition – COPD [1], cardiovascular (cold) [0], climbing stairs [1], moving between rooms [1]

FLIPCHART 4

DRIVERS	**ACTIONS**	**GAP**
Planning policy – building density	Housing Act 2004	Enforcement
Lifestyle and expectations	Housing Health and Safety Rating System (HHSRS)	
Changing age structures		
Changing household structures		
Current and historical building regulations		
Changing demand (e.g. multigenerations)		
Energy efficiency policy		
Economic climate (heating, maintenance, modifications – individual and grant funded)		
PRESSURES		
Original design and subsequent modifications		Knowledge of impact of adaptations
STATE		
Dwellings not suitable for life-long living	Adaptation of house Move to more suitable housing	National House Condition Survey links with health data? Need for compatible space resolution (informational need). Define the ideal living environment for people with COPD/CVD – statement of best practise.

EXPOSURE/EFFECT – SEE FOLLOWING TABLE

CONTEXT

Age (changing)

Health status

Use of air fresheners & other sources of VOCs

Socio-economic (ability to address exposure

FLIPCHART 5

STATE	EXPOSURE	EFFECT	ACTION	GAPS
Stairs	Overexertion *[Context: Health status - COPD, Heart disease]*	Fatigue/Exhaustion (long recovery) Breathlessness Psychophysical responses	Help with stairs Stairlift Reorganise house/living arrangements Move Grants for modifications; loans; equity release	
House that cannot be adequately heated	Temperatures <12°C Sudden changes in temperature (e.g. when moving between rooms) Heating/cooling of hands/feet/face Dampness →Mould growth and house dust mites Viral transmission	Cardiovascular impacts Exacerbation of respiratory disease (COPD and asthma) Changes in blood pressure Asthma *[Context: Evidence of health impacts strongest in children]* Asthma	Insulation (grants) Building standards Fuel poverty initiatives for insulation & heating *[Info: National House Condition Survey; energy efficiency measures]*	Body temperature or air temperature effects? Profiles of thermal exposure Impact of cold homes on behaviour (e.g. going out) Impacts of climate change on health of older people How does temperature affect people with specific diseases?
Dwelling overheated (e.g. sheltered housing) with no or limited climate control	Dehydration	Heart disease Link with COPD?		
Inadequate ventilation/ Poor indoor air quality/ Indoor pollution sources	CO_2 – proxy for poor IAQ PM, CO, NOx, VOCs, Water vapour, (O_3)	Cardiovascular disease and/or asthma	Control VOC emissions from products (e.g. as in France) Education and passing of information between residents. Building control mechanisms	Health impacts of VOCs – effects and mechanisms Health impacts of air movement Personal exposures within a building Health impacts of high CO2

			‘House Handbook’? *[Context: Behaviour and knowledge of use of ventilation systems]*	Little known about ventilation levels (cf. air tightness) in individual houses or about age-related behaviours such as opening of windows. Knowledge of differing ventilation rules/guidance in England, Scotland, Wales and NI. House condition reports on sale of house (Scotland)?
Natural light levels	Inadequate levels of blue light (photoperiod)	Arousal cycle → sleep patterns → aging effects Inflammatory levels (→COPD & CHD) Mood → Quality of life		Impact of quality of life and Vitamin D deficiency on progression of chronic disease and general mobility
Layout and ergonomics - e.g. room/corridor/door size, reachability (→ loss of surface space)	Access exertion Reduced hygiene; Dust *[Context: Health status; use of diuretics]*	Breathlessness; fatigue/exhaustion Stress (concern about incontinence) → elevated heart rate → CVD Asthma?	Building control requirements Building adaptation grants Move house	Systematic review of evidence
Internal and external communications	Access to alerts on air quality Unable to summon help *[Context: Health status (COPD/CVD)]*	More serious health outcomes	Alarm systems	Review of evidence

Noise levels in house: internal & external sources; sound transmission	Stress Arousal patterns	Sleep disturbance & Cardiovascular disease Sleep		Individual exposure levels; subjective thresholds
Building materials	'Dust soup'	Asthma exacerbation		
Access to an external environment	Mitigating effects on stress [Context: Function – Housebound]	Positive impacts on well-being		