Bureau of Energy Efficiency

सत्यमेव जयते
Government of India
Ministry of Power

german cooperation
DEUTSCHE ZUSAMMENARBEIT

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ANGAN

Augmenting Nature by Green Affordable New-habitat

A Courtyard for Revolutionary Change in Building Energy Efficiency

An International Conference on Building Energy Efficiency

9th-11th September, 2019 | Hotel The LaLiT, New Delhi

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THIS PRESENTATION WAS SHARED BY

Ian Hamilton

UCL Energy institute

FOR THE SESSION:

"Occupant Comfort: Thermal, Visual, Acoustic, Indoor Air Quality"

DURING ANGAN 2019

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Intersections of building energy efficiency and health and wellbeing

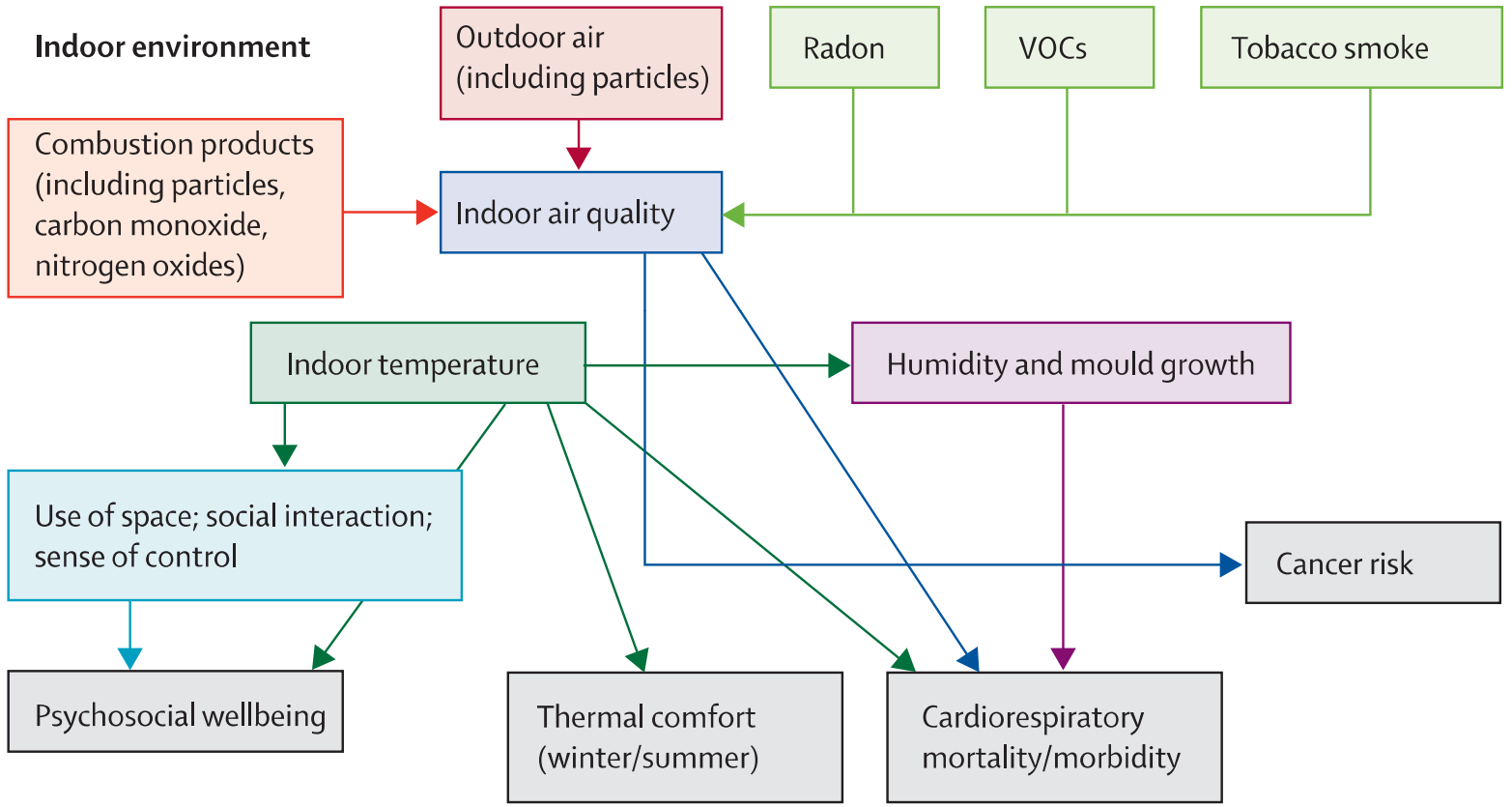
ANGAN Conference

9-11 September 2019

Ian Hamilton
Associate Professor
UCL Energy Institute

Buildings quality and health

Connections between building quality, energy and health



Source: Wilkinson, Lancet, 2009

Air pollution and health

Worldwide premature **deaths due to pollution were estimated to be 9 million** in 2015 (16% of the total) with the majority of this burden falling on low to upper middle income countries.

Two thirds of this burden is related to air pollution.

Air pollution and health

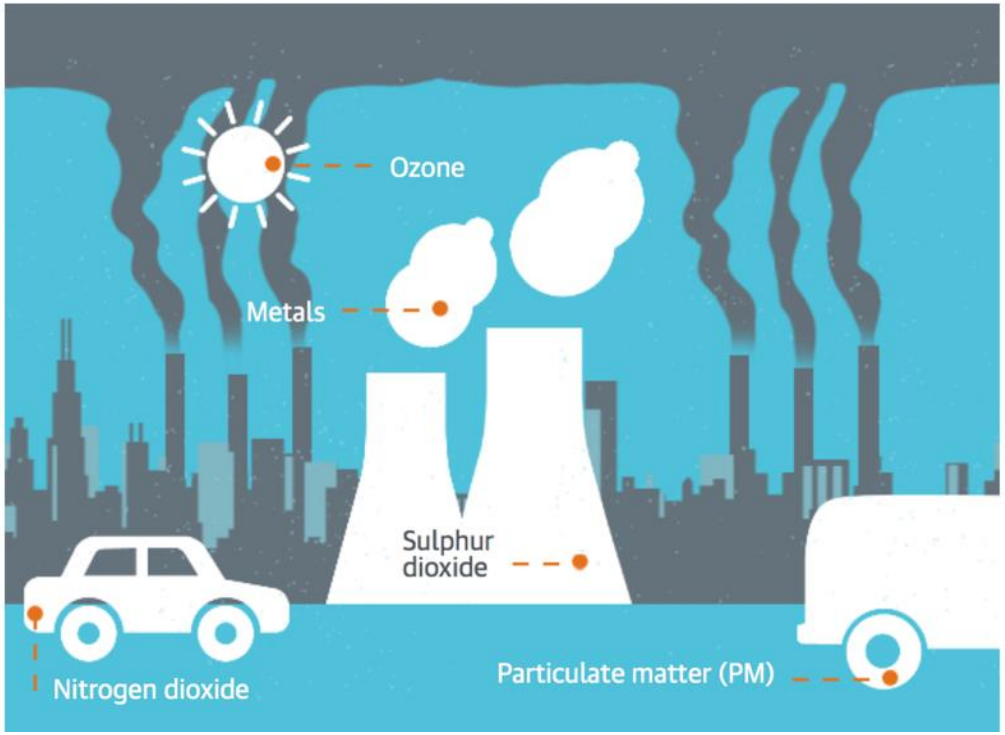
The evidence for adverse effects of urban air pollution clearly shows that **particle pollution in particular is responsible for a large global burden of mortality and morbidity.**

Transport of air masses means that air pollution is not a uniquely urban problem, but it is **predominantly urban because of the density of traffic and stationary sources** in cities.

Street canyons and other buildings in cities can also affect dispersal of pollutants and, thus, local pollutant concentrations.

Source: Wilkinson et al, 2007

Air pollution and health



RCP, 2016

Sulphur dioxide

From the burning of fossil fuels, mostly power stations.

Nitrogen dioxide

Highest levels found close to road traffic or indoor gas cookers.

Ozone (ground-level)

Caused by chemical reactions between natural, traffic and industrial pollution in strong sunlight.

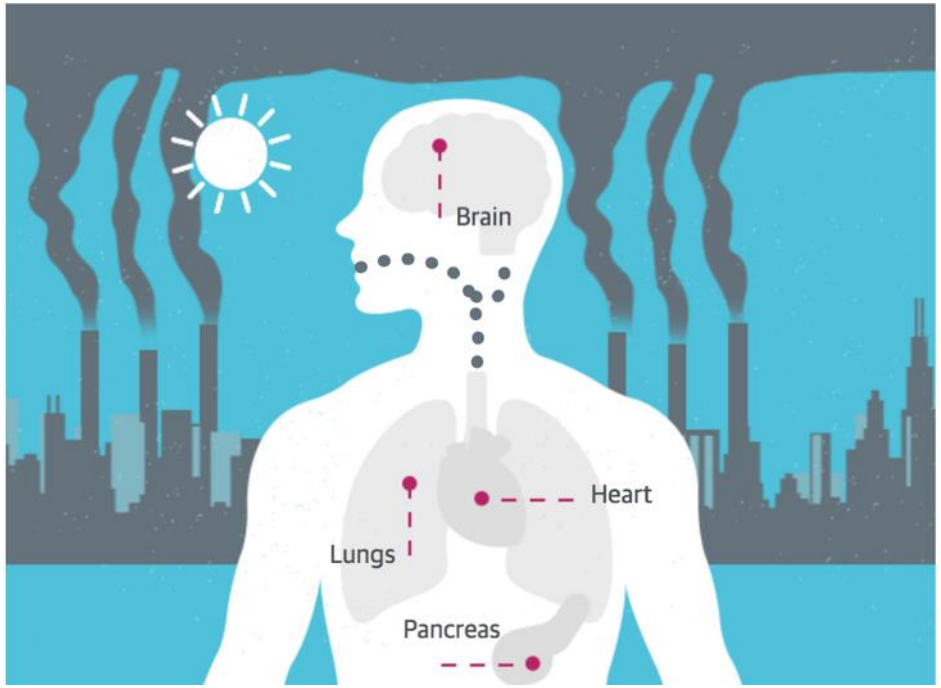
Particulate matter (PM)

Solid particles or liquid droplets in the air, primarily from road traffic. When smaller than 2.5 micrometers (that's 60 times thinner than a human hair), they are known as PM2.5. Larger particles, which could be dirt or dust stirred up from vehicles are known as PM10.

Metals, including lead, mercury, arsenic

Less of a problem in some countries due to controls on emissions. Iron and steel sectors dominate lead emissions, while disposal of treated wood by burning is source of arsenic.

Air pollution and health



RCP, 2016

Lungs

Suppresses normal lung growth in children. Accelerates lung function decline or an ageing lung in adults and a known cause of lung cancer. Also linked to onset of asthma.

Pancreas

Linked to onset of type 2 diabetes in adults.

Heart

Linked to the development of cardiovascular diseases, such as a stroke and heart disease, including atherosclerosis (furring of the arteries). Can also exacerbate existing conditions.

Brain

Exposure of pregnant women found to affect to fetal brain growth. Also impacts mental and physical development in children and cognition in adults.

Buildings quality and health

Buildings act as a modifier for health, exacerbating or protecting against exposure to thermal stresses and air pollution.

Indoor environmental quality

- Indoor air quality and exposure to internal & external pollutant sources
- Exposure to heat and cold

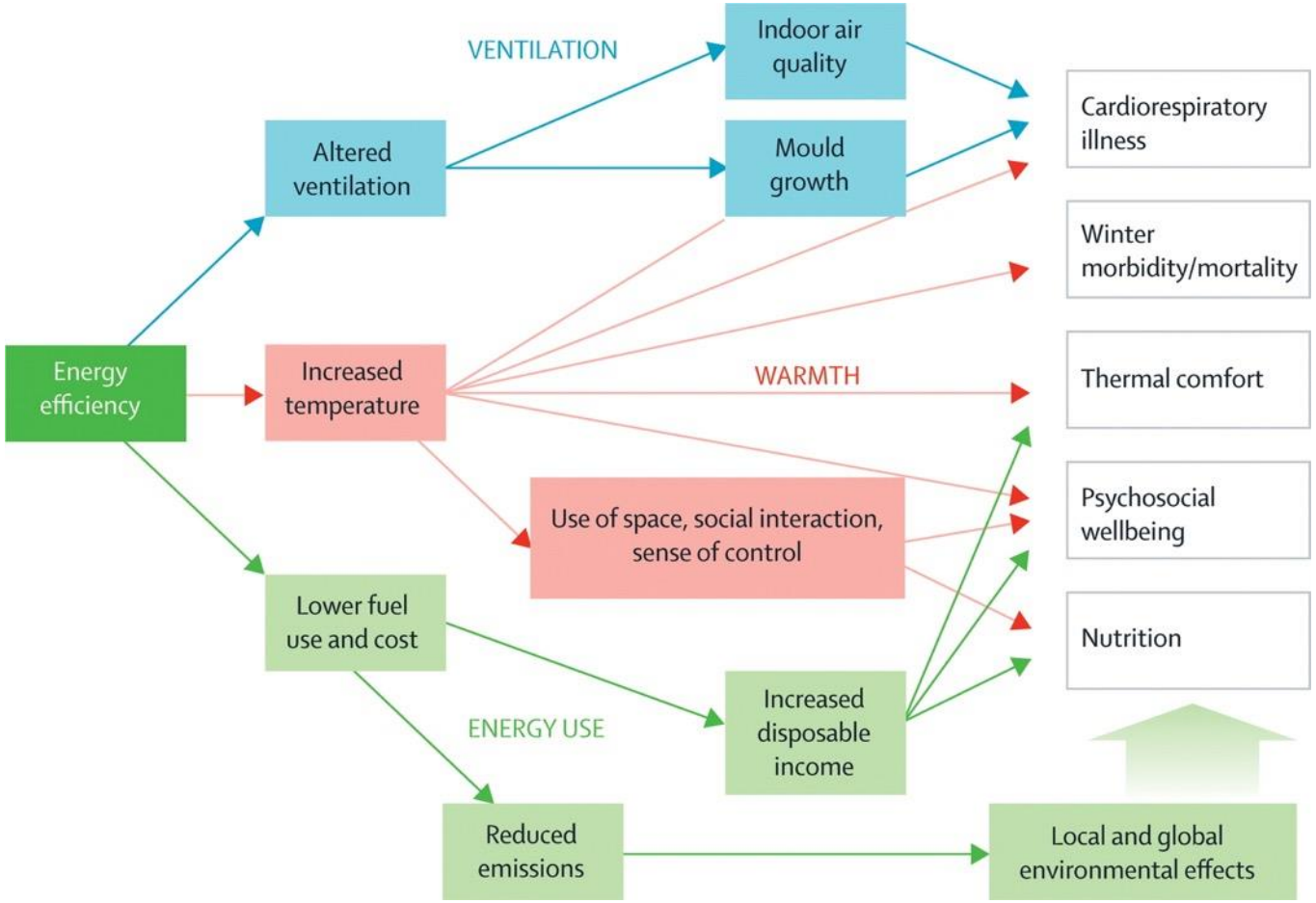
Energy use is a strong feature in modifying the indoor environment

- Energy for maintaining adequate indoor environment (ventilation, heating and cooling)

Population exposure to air pollution is typically evaluated using the outdoor concentration of pollutants and does not account for the fact that people spend a majority of their time indoors.

Buildings quality and health

Connections between building quality, energy and health



Energy, energy efficiency, and the built environment. Wilkinson et al 2007

Optihouse Project: Delhi

UCL

CENTRE FOR URBAN AND REGIONAL EXCELLENCE

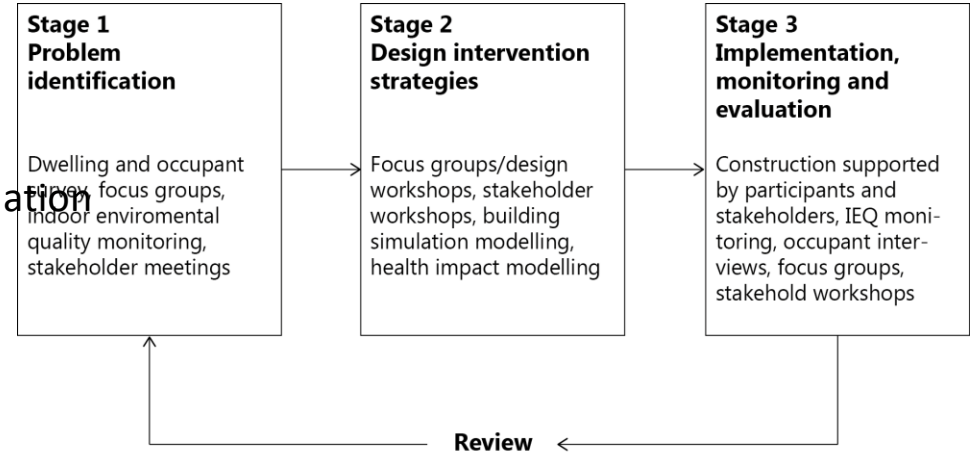
LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

wellcome trust

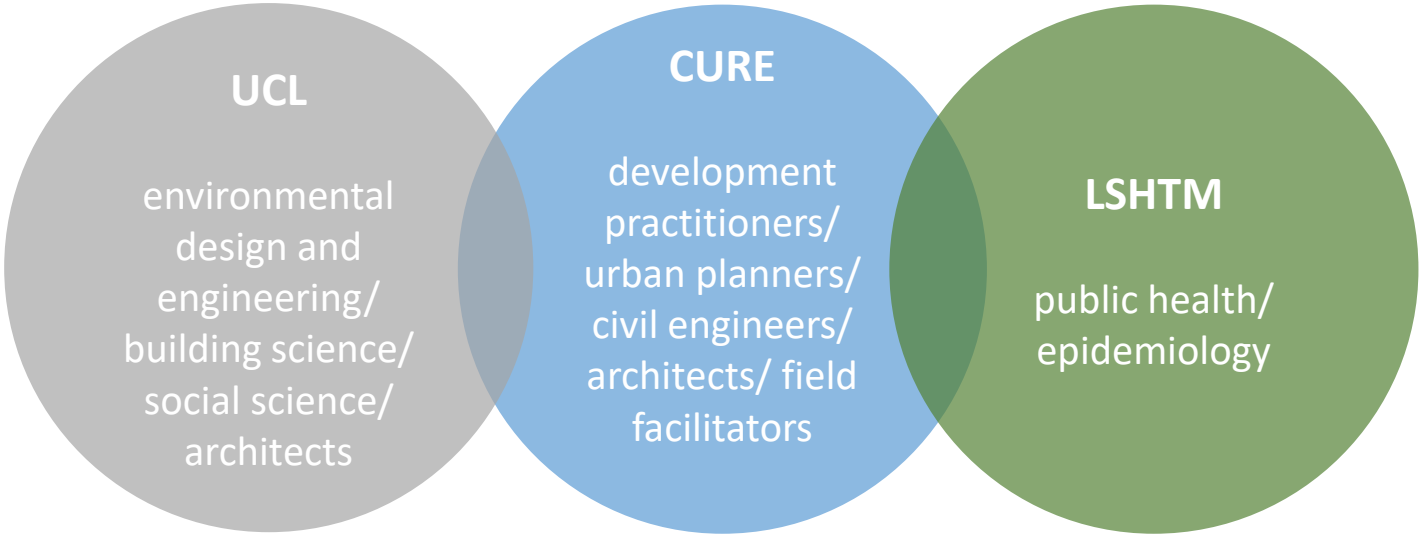
Project approach

Participatory action research approach:

- Using participatory techniques, led by the housing residents
- Three stages:
  - Problem identification
  - Design solutions
  - Implementation, monitoring and evaluation



Transdisciplinary research team



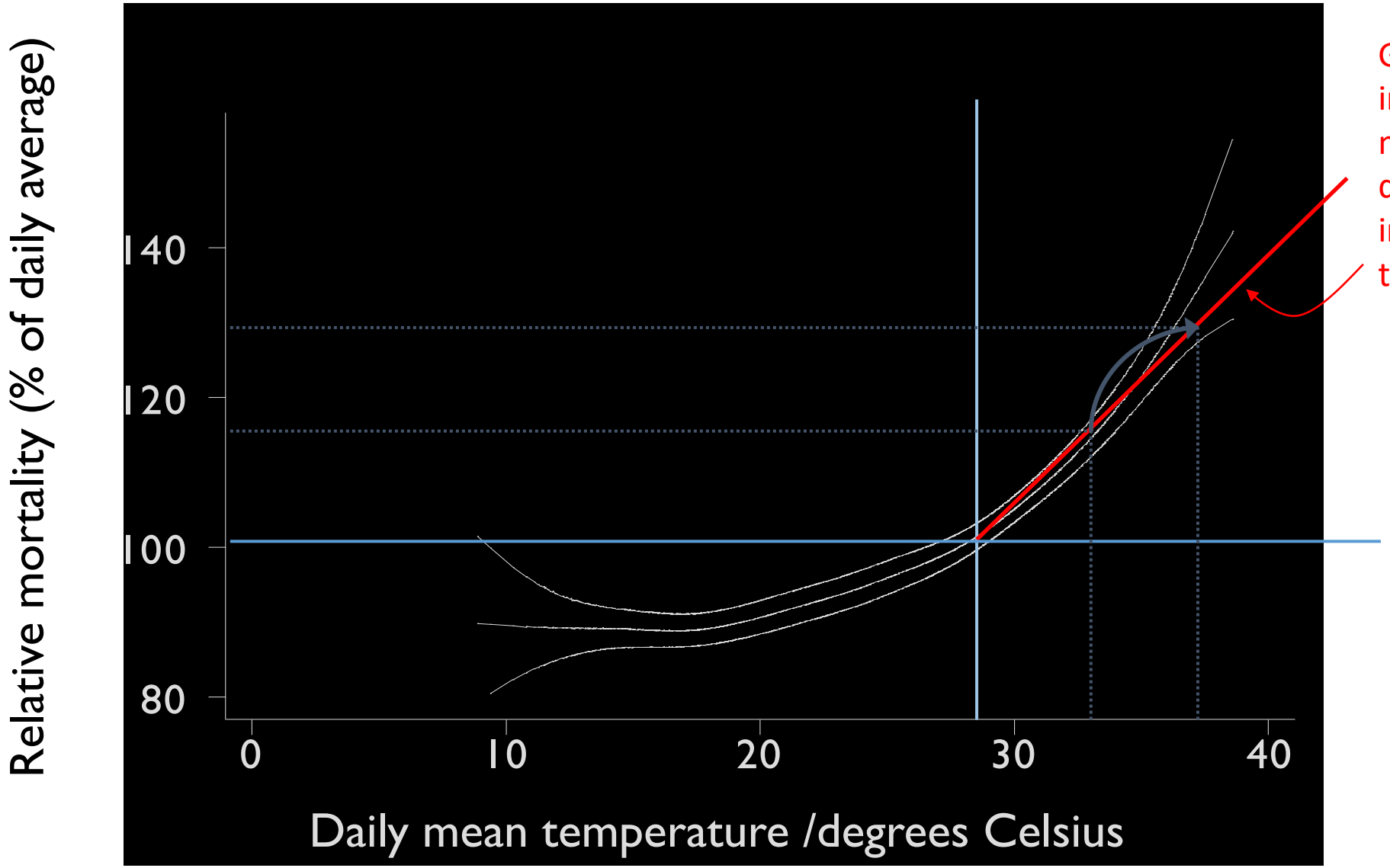
Optihouse: aim

To model, design and test housing and/or housing refurbishments for low income populations that optimize the fulfilment of health protection needs and environmental sustainability in the context of climate change and growing energy insecurity

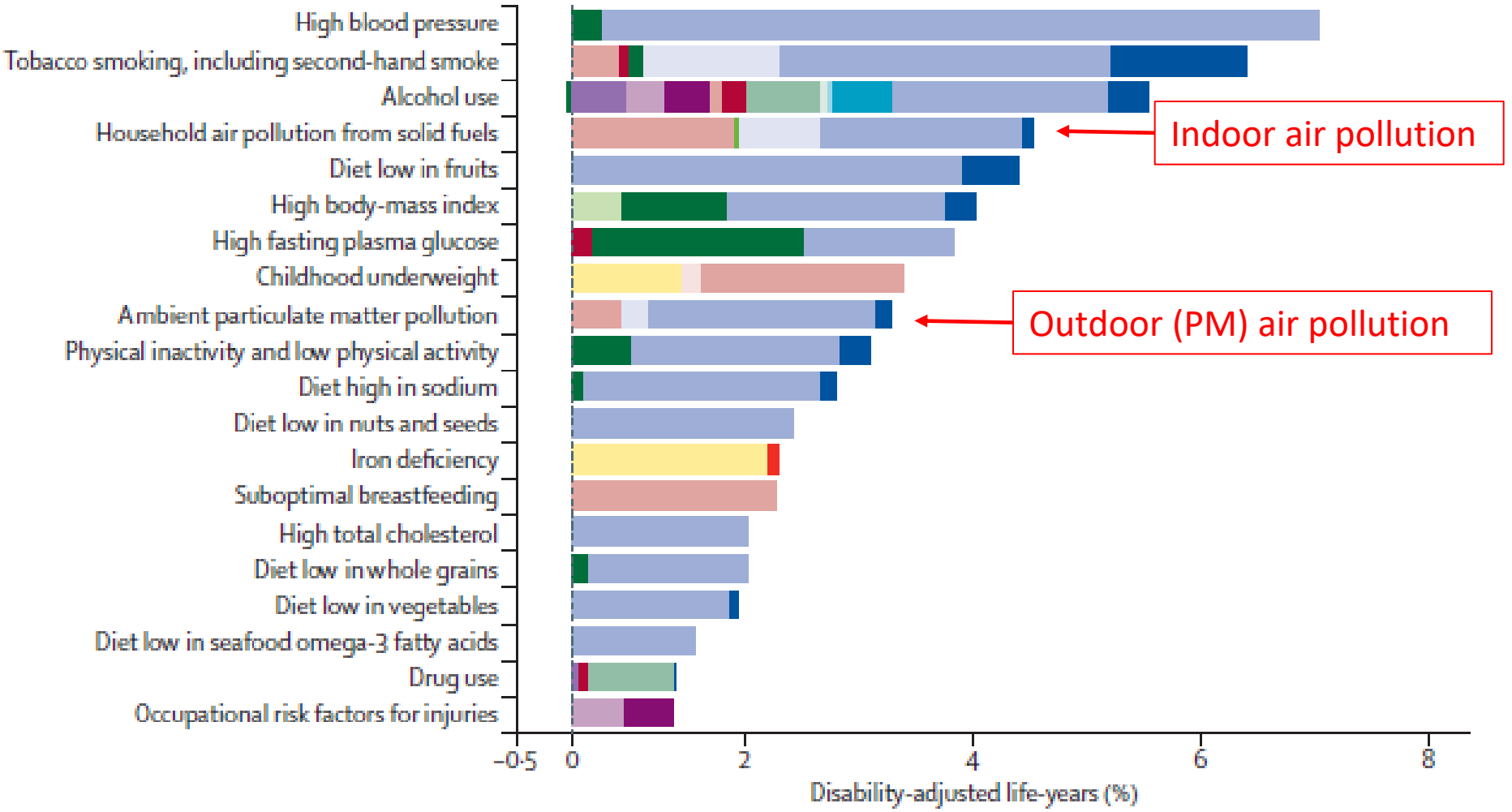
Some housing links to health

- Temperature (heat)
- Dampness and mould
- Household air pollution
- Water and sanitation
- Vector-borne disease
- Structural integrity

Heat-related mortality, Delhi



A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990—2010: a systematic analysis for the Global Burden of Disease Study 2010



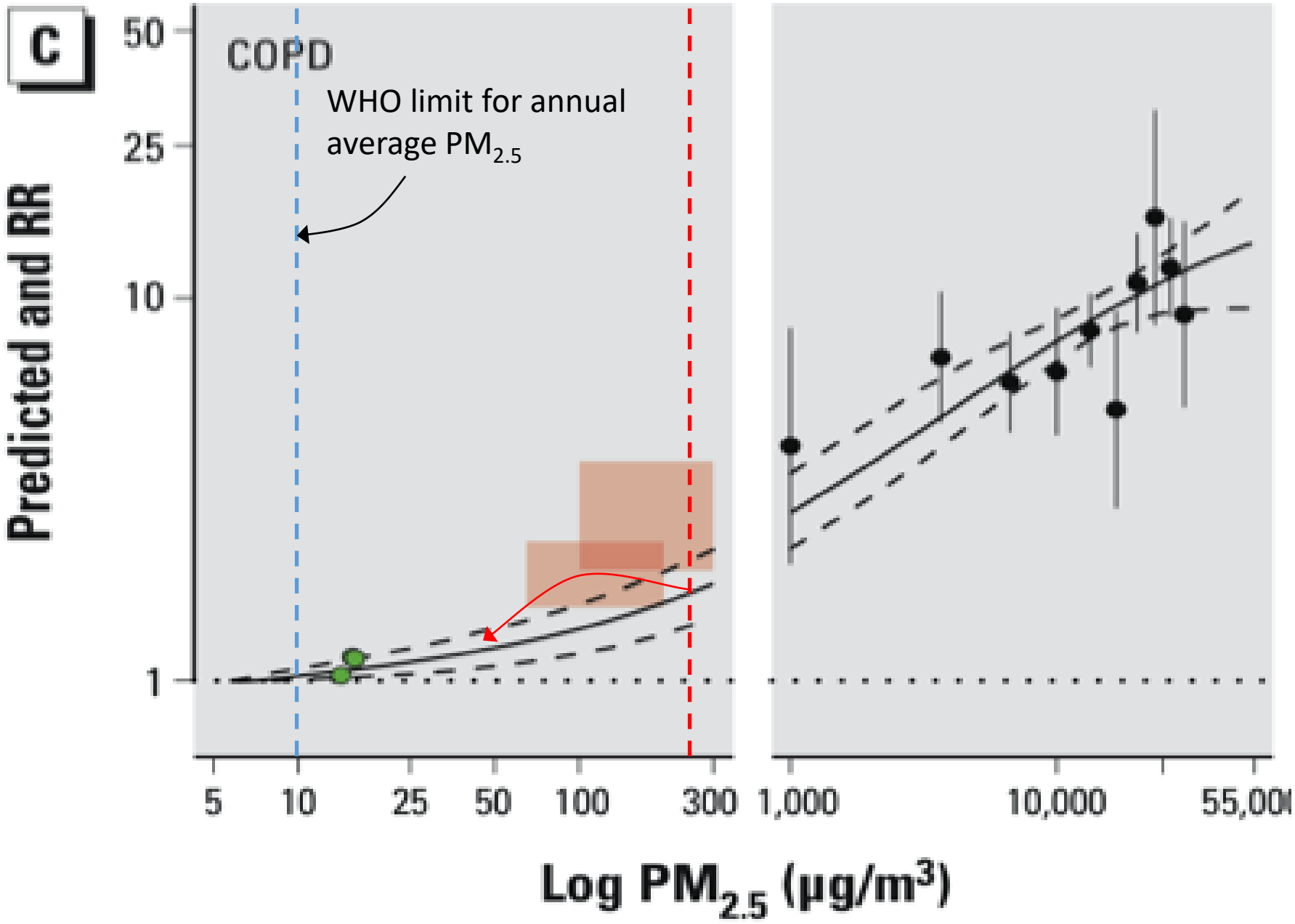
Source. Lim et al. The Lancet: 380(9859): 2224 - 2260

Dampness & mould

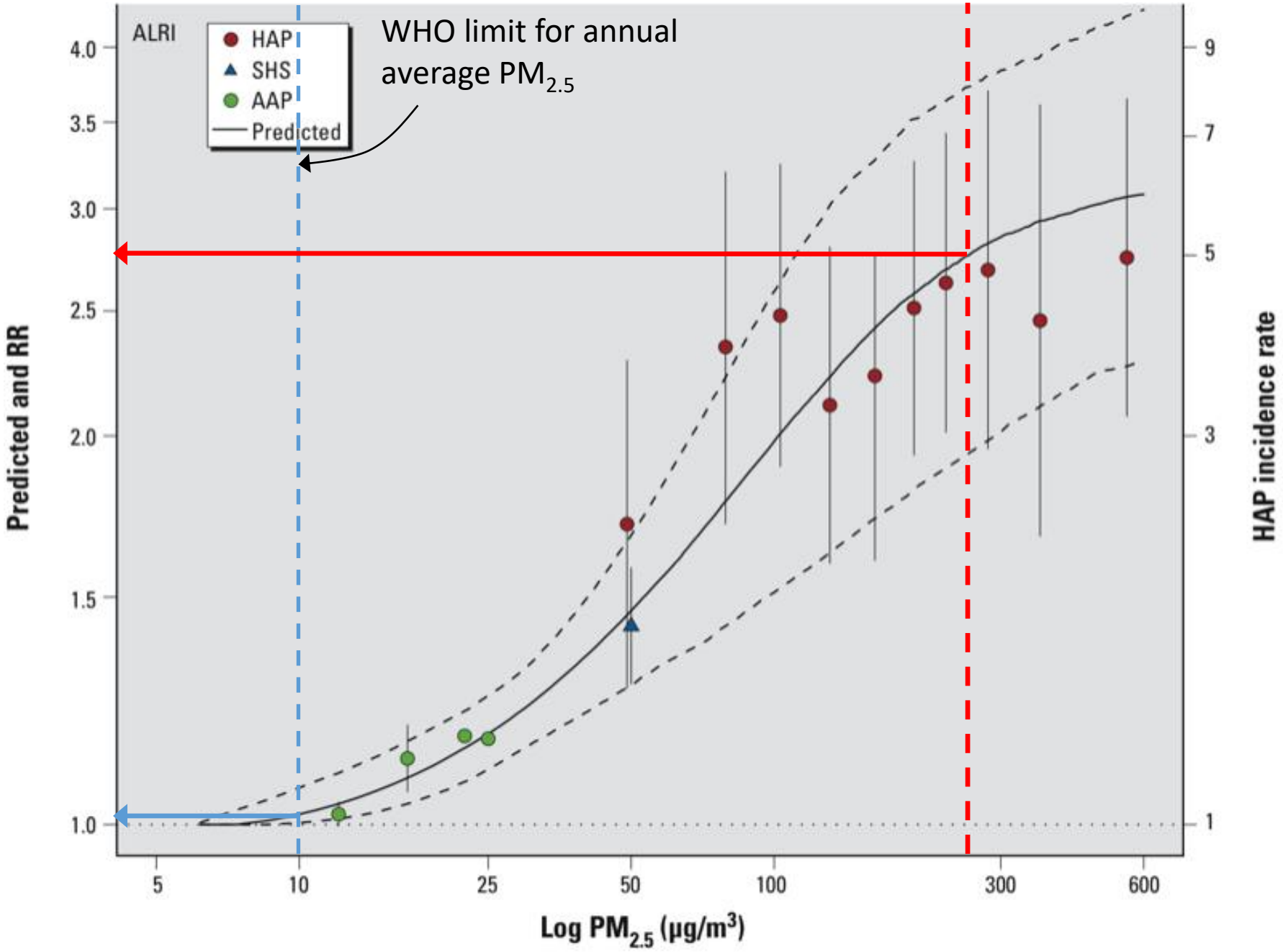
- Evidence from multiple studies suggest risk multiplier of 1.5 to 2 for respiratory illness in children

Air pollution

Simulation annual average $PM_{2.5}$: 260 µg.m^{-3}



Acute lower respiratory tract infection (ALRI), infants



Case study settlement

Savda Ghevra, JJ Resettlement colony:

- Settlement was initiated in 2006 in the North-West of Delhi
- Home to 20,000 families
- Families allocated empty small plots of 12.5m^2 or 18m^2
- Housing characterized by self-built incremental houses of varying quality

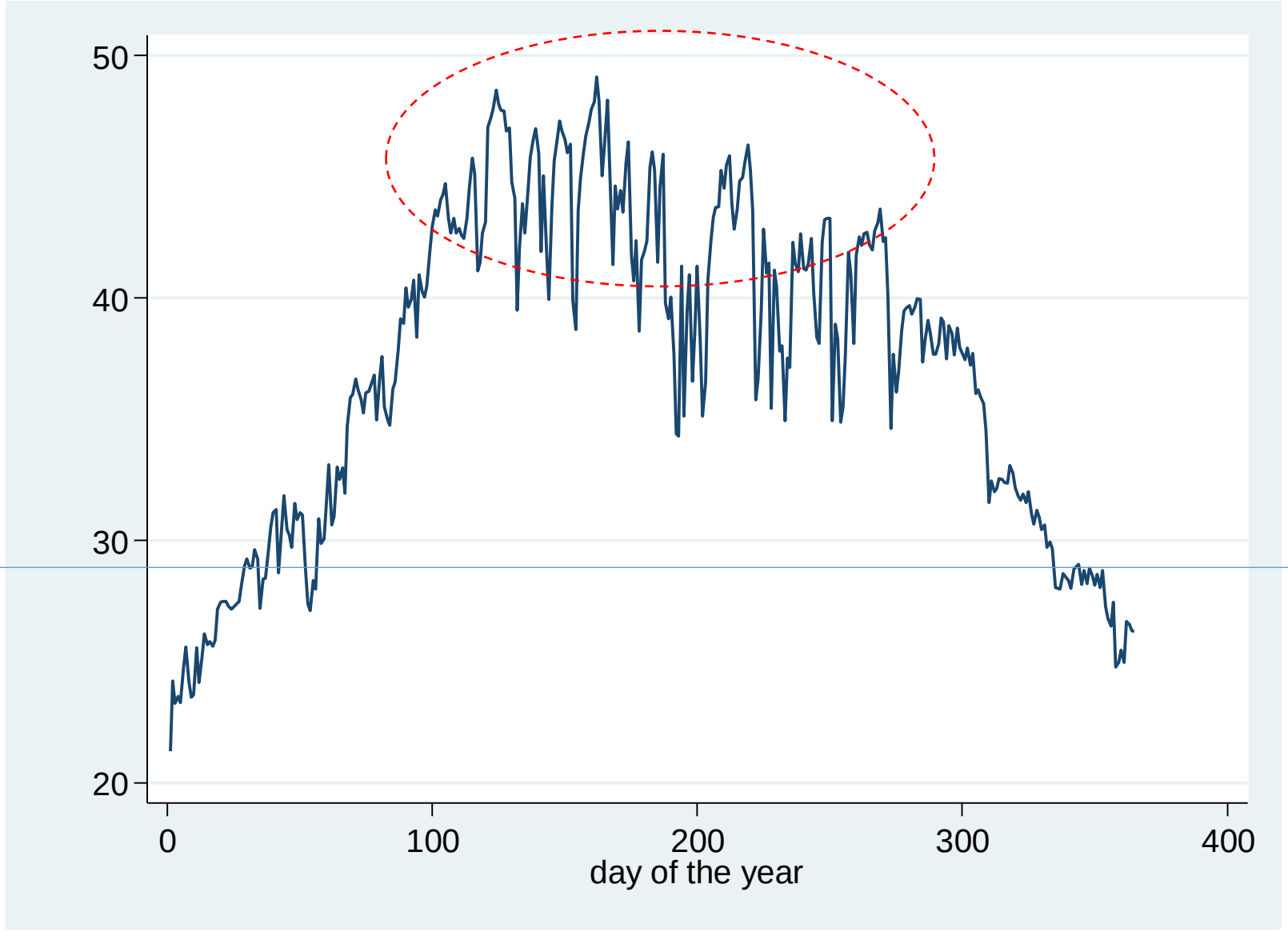

ISUZU

Housing risk assessment

Table 2. Comparison of hazard priority based on surveying by local researchers and self-assessment against those agreed upon by both after focus groups.

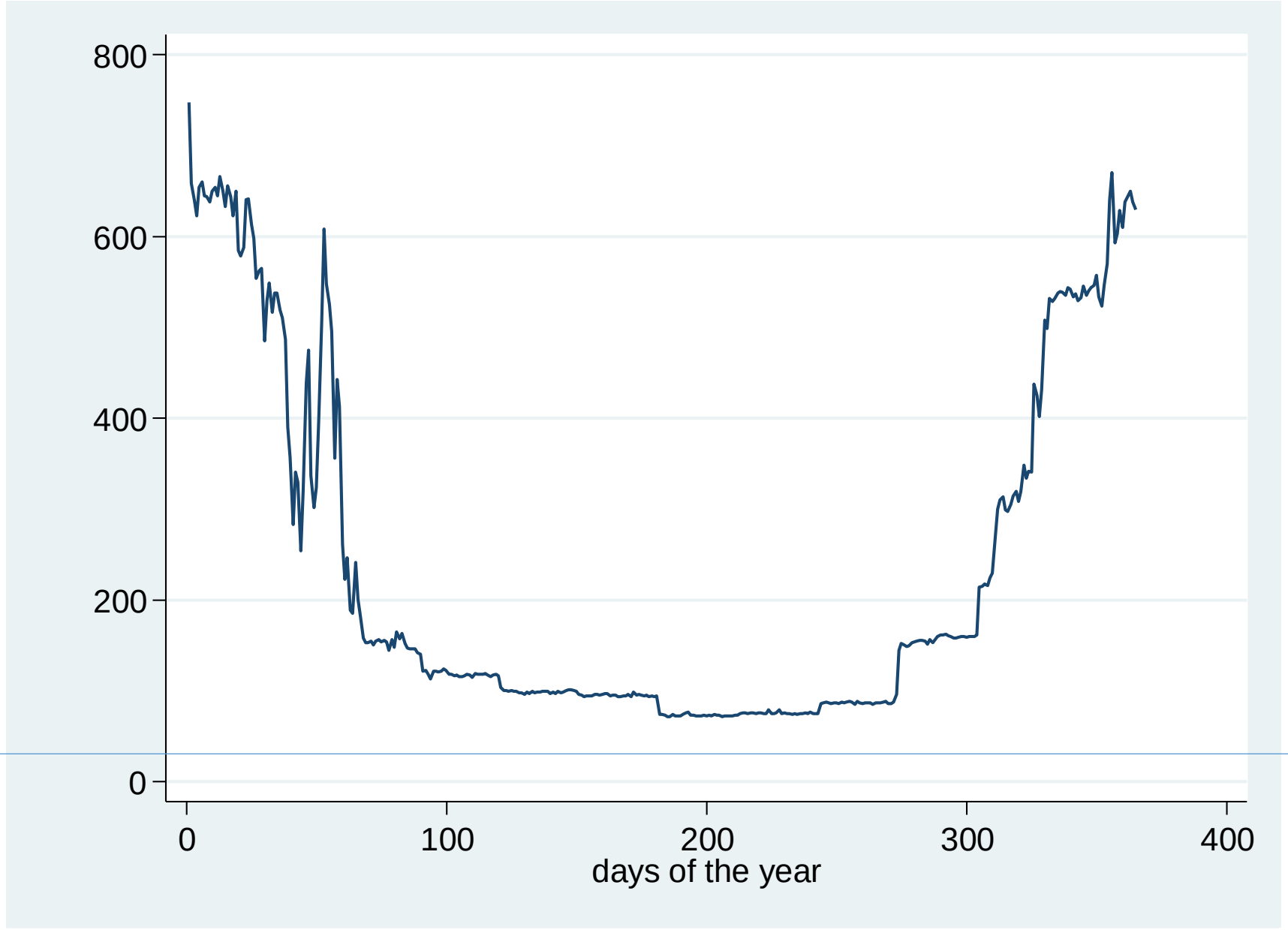
Rank no.	Survey-based risk assessment	Self-assessment	Consensus after focus groups
1	Heat	Damp	Damp
2	Cold	Mold	Mold
3	Indoor air pollution	Mosquitoes	Heat
4	Mosquitoes	Pest	Cold
5	Sanitation	Food infestation	Mosquitoes
6	Personal hygiene	Heat	Indoor air pollution

Measurements of indoor temperature: Savda Gehvra dwelling



Heat threshold
29 ºC

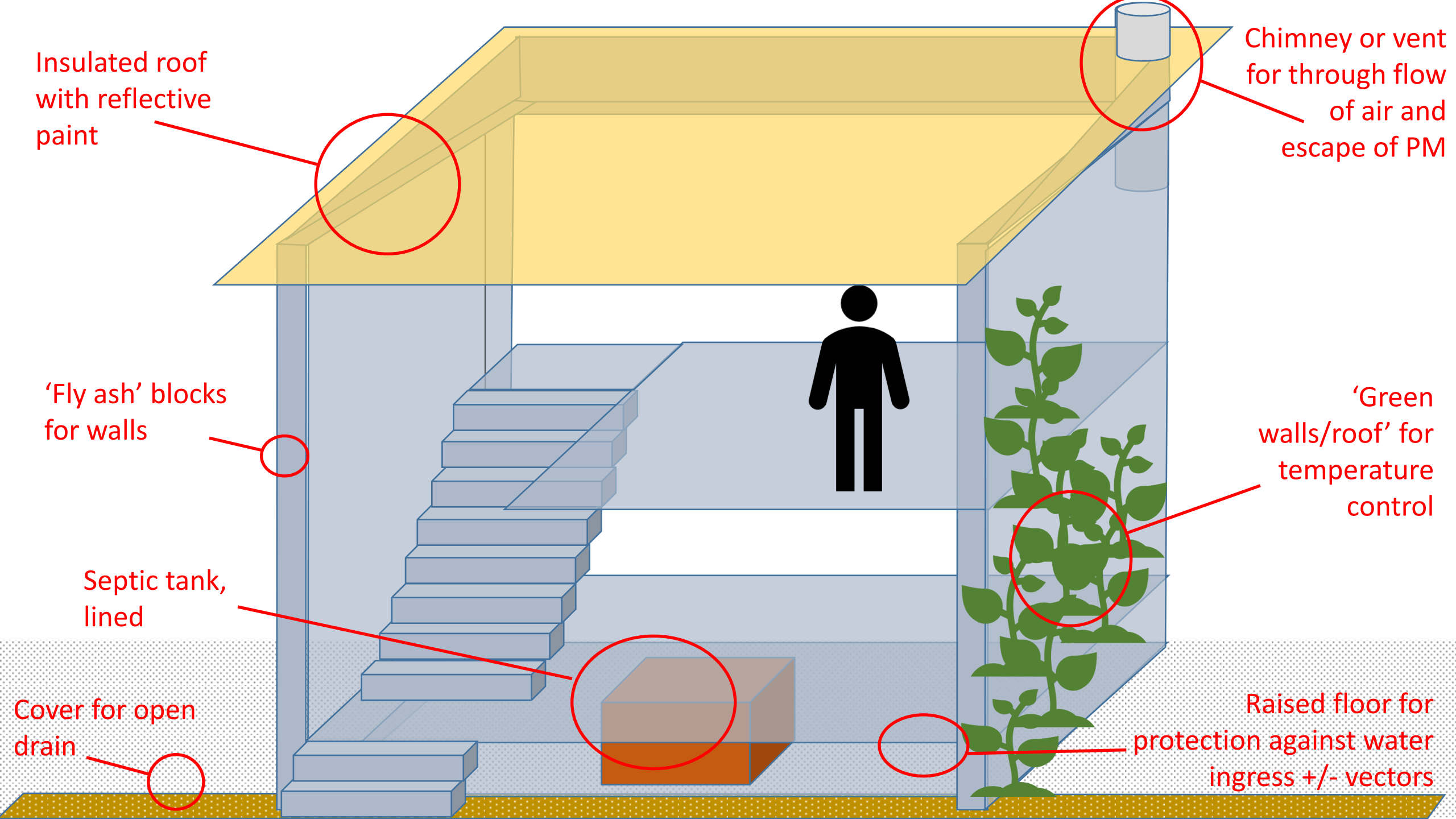
Indoor air pollution: Savda Gevra dwelling



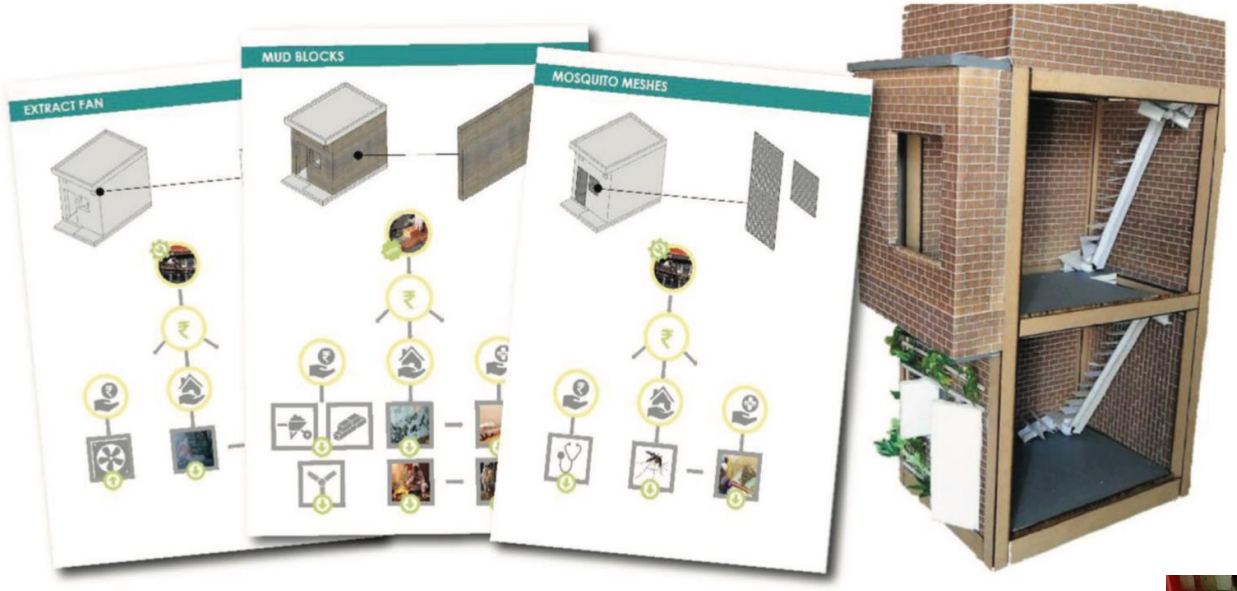
WHO guideline

25 µg/m3

(for 24h mean)


Insulated roof with reflective paint
Chimney or vent for through flow of air and escape of PM
'Fly ash' blocks for walls
'Green walls/roof' for temperature control
Septic tank, lined
Cover for open drain
Raised floor for protection against water ingress +/- vectors

Better quality dwellings: Design advice guides



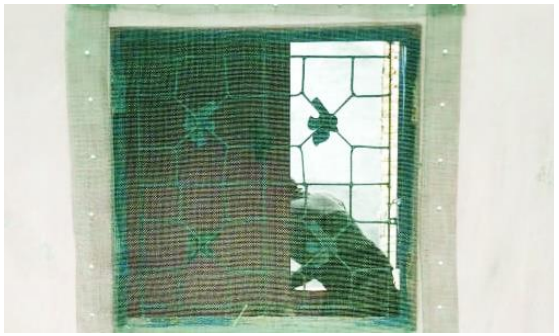
Fact sheets and model prototypes of solutions, as used in community workshops.

Methods:

- Design workshops
- Building simulation
- Health impact modelling
- Focus groups
- Expert workshops
- Intervention fact sheets and physical models

Implementing housing solutions

- Supported by SELAVIP foundation
- 10 new builds
- 10+ retrofits
- Capacity building by using local contractors and mansions
- Households contributing 20%+



Evaluating the impact of interventions (on-going)

Methods:

- Occupant interviews
- Indoor environmental monitoring
- Mosquito counts