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Healthy Homes: understanding the impact of energy efficiency upgrades on the home, carbon emissions, and resident health

Submission date
08/07/2025

Recruitment status
No longer recruiting

Registration date
30/07/2025

Overall study status
Ongoing

Last Edited
13/11/2025

Condition category
Other

[_] Prospectively registered
[_] Protocol
[_] Statistical analysis plan
[_] Results
[_] Individual participant data
[X] Record updated in last year

Plain English summary of protocol

Background and study aims
The quality of our homes can have a big impact on our health. Cold, damp, or poorly ventilated homes can lead to problems like mould, indoor air pollution, and stress, which may increase the risk of heart and lung conditions. Making homes more energy-efficient—known as retrofitting—can help improve health, reduce energy bills, and lower carbon emissions. However, if not done carefully, retrofitting could also reduce fresh air and make damp or pollution worse.
This study is working with a large social housing provider in Bradford to find out how retrofitting affects people's health, indoor air quality, and whether it offers good value for money. The results will help guide future housing improvements to benefit both people and the environment.

Who can participate?
Residents living in selected social housing properties in Bradford may be invited to take part. Some homes will be retrofitted, and others will be used for comparison.

What does the study involve?
If you take part, we may install small sensors in your home to measure air quality, temperature, and humidity. You'll be asked to complete short surveys about your health, comfort, and energy use at three different times. In some homes, we'll also measure mould and how windows are used for ventilation. A small number of residents will be invited to take part in interviews to share their experiences.

What are the possible benefits and risks of participating?
Taking part could help improve understanding of how to make homes healthier and more comfortable. It may also help shape future housing policies. There are no major risks, but some people may find the surveys or sensors slightly inconvenient. All information will be kept private and secure.

Where is the study run from?
Bradford Teaching Hospitals NHS Foundation Trust in partnership with a major social housing provider (UK)

When is the study starting and how long is it expected to run for?
July 2025 to December 2029

Who is funding the study?
National Institute for Health and Care Research (NIHR) (UK).

Who is the main contact?
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Type(s)
Public, Scientific, Principal investigator

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Additional identifiers

Integrated Research Application System (IRAS)
347237

Central Portfolio Management System (CPMS)
64093

National Institute for Health and Care Research (NIHR)
165582

Study information

Scientific Title
Evaluating the indoor environment, health, carbon emission, economic outcomes of retrofitting social housing properties to improve energy efficiency in a low-income multi-ethnic population: a quasi-experimental study with process evaluation

Acronym
Healthy Homes

Study objectives
We aim to assess the impact of improving the energy efficiency of social housing ('retrofit') on indoor environmental quality (including temperature, relative humidity, damp/mould, and indoor air quality (e.g. NO2, PM2.5, carbon dioxide [CO2]), health, and environmental and economic impacts. We will explore trade-offs in indoor conditions and other potential unexpected consequences, along with contextual and system factors which affect implementation and resident experience.

Our research questions (RQ) are:
RQ1: What is the impact of retrofit up to 12 months post-retrofit on: A) temperature, B) thermal comfort, C) indoor air quality (focusing on NO2, PM2.5, and air change rates) D) risk of damp /mould; E) energy use, F) self-reported satisfaction and mental and respiratory health?
RQ2: A) What is the impact of retrofit up to 5 years post-retrofit on adult residents' acute health care use related to i) mental health, ii) respiratory health, and iii) cardiovascular health?; B) Are there differential impacts for vulnerable groups (those with pre-existing health issues)?
RQ3: What is the impact of retrofit on short- and long-term A) exposure to indoor environmental conditions and carbon emissions (3A), and B) health and economic impacts? (3B)

RQ4: A) How was the retrofit implemented, and what system, and wider contextual factors influenced the implementation? B) Was the implementation as intended (from the perspective of residents and other stakeholders) and are there any unexpected consequences from implementation?

Ethics approval required
Ethics approval required

Ethics approval(s)
approved 13/05/2025, Yorkshire & The Humber - Bradford Leeds Research Ethics Committee (NHSBT Newcastle Blood Donor Centre, Holland Drive, Newcastle-upon-Tyne, NE2 4NQ, United Kingdom; +44 2071048083; bradfordleeds.rec@hra.nhs.uk), ref: 25/YH/0081

Study design
Observational cohort study

Primary study design
Observational

Study type(s)
Quality of life

Health condition(s) or problem(s) studied
Public Health, Persons with potential health hazards related to socioeconomic and psychosocial circumstances

Interventions
The Healthy Homes project is structured into four work packages (WPs) with both quantitative (WP1, WP2, WP3A + 3B) and qualitative (WP4) methods. WP1 and WP4 will require engagement with the public, recruitment/taking consent and data collection whilst WP2 will carry out secondary data analysis on the Connected Bradford dataset. WP3A utilises data collected as part of WP1 in order to model the changes in indoor conditions and energy/carbon exposures for a range of housing archetypes. WP3B is a health economic evaluation which utilises findings from WP3A to model the longer-term economic, productivity, and health impacts. Therefore, the methodology in the following will focus on WP1 and WP4.

WP1:
Residents of homes of interest will be made aware that they are eligible to take part in the study, information will be sent through Incommunities or directly to the household and raising awareness and engagement within the community.
Potential participants will be able to express their interest through various channels: either by phone, email, online, post, face to face and will provide their contact details. Potential participants that have previously consented to be part of one of our Born in Bradford cohorts and are identified as living at an eligible address, can be contacted directly (phone or letter) as they have consented to contact for further studies.
The Healthy Home team will contact interested residents and discuss their participation and ensure that they have access to the participant information sheet. A home visit will be arranged with residents who would like to take part at a convenient date and time.

At the first study visit:
The fieldworker will complete the consent form with the resident in the household that will

complete the baseline questionnaire (Survey 1) and subsequent questionnaires. The baseline questionnaire will be completed as part of the visit.
An air pollution sensor (AirGradient) will be installed in the main living area ensuring that the sensor's own internet connection is working. Ideally, monitoring will continue until the sensor is picked up 18 to 21 months later in March 2027 (from set up in the 3rd quarter of 2025).
Participants will receive monthly vouchers (£20) each month of the monitoring period.
The participant will receive a contact schedule considering his/her contact preferences.

Subsequent questionnaires:
Participants will receive three additional questionnaires to complete, roughly each about 6 months apart, covering the Winter 2025/26 (Survey 2), Summer 2026 (Survey 3) and Winter 2026 /2027 (Survey 4) periods. Questionnaires will be deployed according to participant preferences as an online link via email, in paper form, over the phone or as part of a home visit.

Energy meter readings:
We will collect energy meter readings before and after each winter period (e.g. 4 measurements in total). As much as possible we will tie these readings in with existing scheduled contacts. We give participants the option to take the reading themselves or to be taken by the fieldworker.

Additional measurements (sub-sample):
Mould sensor measurement: we may ask a smaller number of participants at the first visit whether they would agree to mould measurements at different time points. We will confirm with the participant each time that they are still happy with a repeat measurement.
Measuring ventilation: we may ask participants whether they would be happy to accommodate window sensors on the windows in the living room for periods of time, for example in the winter. We will provide further information before any deployment and confirm that the participant is happy to have these installed. We aim for that visits for installation or de-installation to coincide with scheduled contacts, for example, subsequent questionnaires, mould sensor measurements and/or delivery of voucher.

WP4: Interviews
Participants of the intervention group will be asked at the first visit whether they would be happy to receive information about interviews carried out as part of WP4.
Interested participants will receive further participant information in the winter period following recruitment. Up to 20 participants will become part of this sample and will sign a separate consent form prior to the interview. The interview will be conducted by a researcher using an interview guide and will take place at the participants home, or online, according to participant preferences. A further interview will take place one year later after the retrofitting has taken place. Participants will receive a £20 voucher for each interview.
10 non-resident stakeholders will also be interviewed. These will be those involved in social housing and delivering good indoor air quality and will be recruited through key contacts and snowball sampling. They will sign a separate consent form. The interviews will be conducted by a researcher of the Healthy Homes team using a different interview guide at a community venue, or online. These interviews will take place at two points, these are planned for Summer 2026 and Spring 2028.

WP4-Peer Research
10 Peer-researchers will be recruited by one or two community organisations. If they wish to be part of the study, they will sign a consent form. They will then undertake some training and work with the research team to design a study (this in unknown at present but could include photographs, questionnaires, mapping, audio recordings, workshops). Each peer researcher will collect data from 10 residents, in phase 1 and 10 residents in phase 2 (12-18 months later). We

will provide the ethics committee with further details of these activities as part of an amendment, prior to this element of the work starting.

Intervention Type
Other

Primary outcome(s)
Temperature measured via the AirGradient sensor in 5-minute periods continuously from baseline until monitoring ends in Spring 2027

Key secondary outcome(s))
1. Indoor air quality (PM2.5, CO2, NO2, relative humidity) measured via the AirGradient sensor in 5-minute periods continuously from baseline until monitoring ends in Spring 2027
2. Energy use measured via energy meter readings at four time periods: the start and end of winter 2025/2026 and start and end of winter 2026/2027
3. Mould concentrations measured via a mould sensor in winter 2025/2026 and winter 2026 /2027 (in a subset of homes)
4. Resident thermal comfort and satisfaction measured via questionnaire in winter 2025/2026 and in winter 2026/2027
5. Resident self-reported respiratory and mental health via questionnaire in winter 2025/2026 and in winter 2026/2027

Completion date
31/12/2029

Eligibility

Key inclusion criteria
WP1
1. Homes managed by Incommunities, with energy performance certificate EPC) rating less than ‘C’ and identified for retrofitting
2. Eligible homes will have retrofitting scheduled from March to October 2026 (intervention) Or after March 2027 (Control group). Ideally the control homes are a close match to the intervention homes in building age, type, and EPC
3. Residents of eligible home able to give informed consent and are 18 years or over

WP4
Interviews with resident
1. Participants who consented to WP1 and whose household is part of the intervention group
2. After a participant of such a household consented, other residents with minimum age 18 years of the same household will become also eligible , if they are able to give informed consent

Non-resident Stakeholder interviews
1. Participants over the minimum aged of 18 years and have consented to be interviewed
2. Participants involved in social housing and delivering good indoor air quality

Peer Researchers
1. Participants over the age of 18 years and consented to be part of study
2. Participants who belong to the same community where the research is taking place
3. Able to speak English well (additional languages welcomed)

Participant type(s)
Patient

Healthy volunteers allowed
No

Age group
Mixed

Lower age limit
18 years

Upper age limit
99 years

Sex
All

Total final enrolment
0

Key exclusion criteria
WP1
1. Households which are not scheduled for retrofitting according to the required timeline
2. Language barrier that can not be overcome with support of bilingual research assistants
3. Lack capacity for informed consent

WP4
Resident Interviews
1. Households which are not scheduled for retrofitting according to the required timeline
2. Lack capacity for informed consent
3. Language barrier that can not be overcome with support of bilingual research assistants

Non-resident stakeholder interviews
1. Not involved in social housing or air quality
2. Lack capacity for informed consent
3. Language barrier that can not be overcome with support of bilingual research assistants

Peer researchers
1. Lack capacity for informed consent
2. Unable to speak English well

Date of first enrolment
15/07/2025

Date of final enrolment
31/01/2026

Locations

Countries of recruitment
United Kingdom

England

Study participating centre
Bradford Teaching Hospitals NHS Foundation Trust
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Sponsor information

Organisation
Bradford Teaching Hospitals NHS Foundation Trust

ROR
https://ror.org/05gekvn04

Funder(s)

Funder type
Government

Funder Name
NIHR Evaluation, Trials and Studies Co-ordinating Centre (NETSCC)

Results and Publications

Individual participant data (IPD) sharing plan
Quantitative data collected in this study will be available as part of the Born in Bradford repository. Data will be cleaned prior to availability. All data collected have been granted ethical approval and participant consent for its continued availability. Data requests are made to the BiB executive using the form available from the study website: http://www.borninbradford.nhs.uk (please click on ‘Our Data’ and ‘How to Access Data’ to access the form and guidance). All requests are carefully considered and accepted where possible.

IPD sharing plan summary

Available on request, Stored in publicly available repository

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Participant information sheet	version 2.0	12/05/2025	16/07/2025	No	Yes
Study website	Study website	11/11/2025	11/11/2025	No	Yes