Impact of three decades of energy efficiency interventions in public housing buildings on cold-related mortality: a case-crossover analysis

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Background

- **Fuel Poverty**: Inability of household members to afford the energy requirements necessary to satisfy their basic needs (warmth, cooking, etc.) or as the need to spend an excessive part of household income to pay for energy bills.
  - 7.1 to 10.3% of households in Spain. (1)
  - Direct and indirect health effects.

- **Excess Winter Deaths**: The number of deaths that occurred in the winter period minus the expected number of deaths for that period.
  - Approximately 25,000 excess deaths each Winter in Spain. (2)
  - Between 21 and 50% can be attributed to cold housing – fuel poverty.

Housing interventions

- Health benefits
  - Modest positive effects – specially of energy efficiency interventions. (1)

- Energy Efficiency Facade Retrofitting (EEFR): Incorporation or improvement a thermal insulating material to the facade.
  - Reduces heating expenses between 19 and 24% (2).

The impact of this interventions on cold-related mortality has not been assessed.

Interventions

● 4 Neighbourhoods in Barcelona
○ La Pau, La Guineueta, Trinitat Nova y Verdum.


■ Low construction standards.

● Interventions since 1985 (in phases)
○ 310 blocks
■ 6,600 dwellings
■ 25,000 inhabitants
○ Publicly funded.
○ Façade Retrofitting.
○ In one of the neighbourhoods also roof impermeabilization.
Objectives

- **General**
  - Evaluate the impact of the EEFR interventions on the association between cold outdoor temperatures and mortality from neoplasms, circulatory system and respiratory system diseases from 1986 to 2012.

- **Specific**
  - Evaluate the impacts by sex, age and educational level
  - Estimate the number of deaths avoided by these interventions.
Methods – Case-Crossover Design

- Similar to a paired case – control design, but each case – in other time frames – is used as its own control. Useful to evaluate brief and changing exposures that modify the risk of an acute health event.
  - **Exposure**: Temperature
  - **Outcome**: Death

- Control periods can be selected bidirectionally - minimizes biases due to temporal trends in the exposures, seasonality and day of the week

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Methods – Information Sources and Variables

- Minimal Daily **temperatures** in the city were obtained from 1986 to 2012 (*www.ecad.eu*).
  - Cold months (October to March)
    - **Extremely cold** days (lower 5%)
    - Day of death and 20 previous days (Lag 0 – Lag 20)

- Barcelona`s **mortality** register was used to identify all deaths from the selected causes that occurred in the studied blocks.
  - During the cold months (October to March)
  - Death in the city
Methods – Information Sources and Variables

● Interventions
  ● Historical contract registry of Catalonia`s Housing Agency (Agència de l'Habitatge de Catalunya).
  ○ A building was considered intervened 6 months after the start date found in the registry.

○ Results stratified by:
  ○ Sex
    ○ No Studies: No formal education.
    ○ With Studies: incomplete primary, primary, secondary and university education.
  ○ Age:
    ○ Less than 70 years.
    ○ 70 – 79 years.
    ○ 80 or more years.
Methods – Statistical Analysis

- Controls (self - controls) were selected by time stratification
  - Same day of the week, month and year.

- **Conditional logistic regression models** were fitted to analyse the relationship between mortality and cold temperatures.
  - Temperatures for the day of death and the 20 previous days (Lag 0 – Lag 20)

- The *interaction between temperatures and the intervention status* was added to the models to analyse the effect of interventions on the death – cold temperature associations.

- Initially stratified by sex
  - Also stratified analyses by educational level and age groups.

- Finally, the preventive fractions and number of potential deaths avoided by the interventions were estimated.
RESULTS
Case Selection

Mortality Register 1986 - 2012
440,948 individual deaths

- Address not identified (missing or incorrectly specified)
  45,139 cases

- Not linked - address not in the studied buildings
  390,798 cases

Building Address linked directly
4,801 cases

Building Address linked through GIS and address revision
210 cases

Cases identified
5,011 cases

- Death during "cold months"
  2,745 cases

- Death during "hot months"
  2,257 cases

Meet exclusion criteria
865 cases

* Death outside Barcelona: 104 cases.
* Death cause classified in groups other than Neoplasias, Circulatory System or Respiratory System causes (761 cases).

TOTAL
1,880 cases (case periods)

Time-Stratified Self Controls
6,381 controls (control periods)
RR of death in extremely cold days in the Intervened and Non-Intervened groups

Men – Three Causes

Women – Three Causes

- No Intervention
- Intervention

●● Significant association between extreme cold and death

☆ Intervention modifies the extreme cold – death association significantly
RR of Death in Extremely Cold Days in Intervened and Non Intervened Women – Lag 0

43 deaths avoided

- No Intervention
- Intervention
- Interaction significant (p < 0.05)
Intervention modifies the extreme cold – death association significantly
Deaths Avoided - Men

Intervention modifies the extreme cold – death association significantly
Discussion

• **First evaluation of the impact of energy efficiency interventions on cold-related mortality.**
  - Impacts different among sex, age and educational level groups.
  - In women, a high percentage of the deaths associated with extreme cold could have been avoided by the interventions.

• Investing in EEFR interventions can have positive impacts on health.
  - Specially in women.
  - Adverse effects should be monitored and studied – specially in men.

• More research needed in order to assess other potential long term health impacts of the interventions (morbidity, determinants etc.).
  - Know how to prioritize funds.
    - Which groups should receive interventions first?
Strengths and Limitations

**Strengths**
- “Natural Experiment”
- Design controls individual characteristics and stationary and temporal variations in exposures.
- Analysis by educational level.

**Limitations**
- Information source change - Adresses.
- Interventions carried out for almost 30 years.
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