Turning down the heat

Indoor temperature, cool roofs & intimate partner violence in rural Burkina Faso

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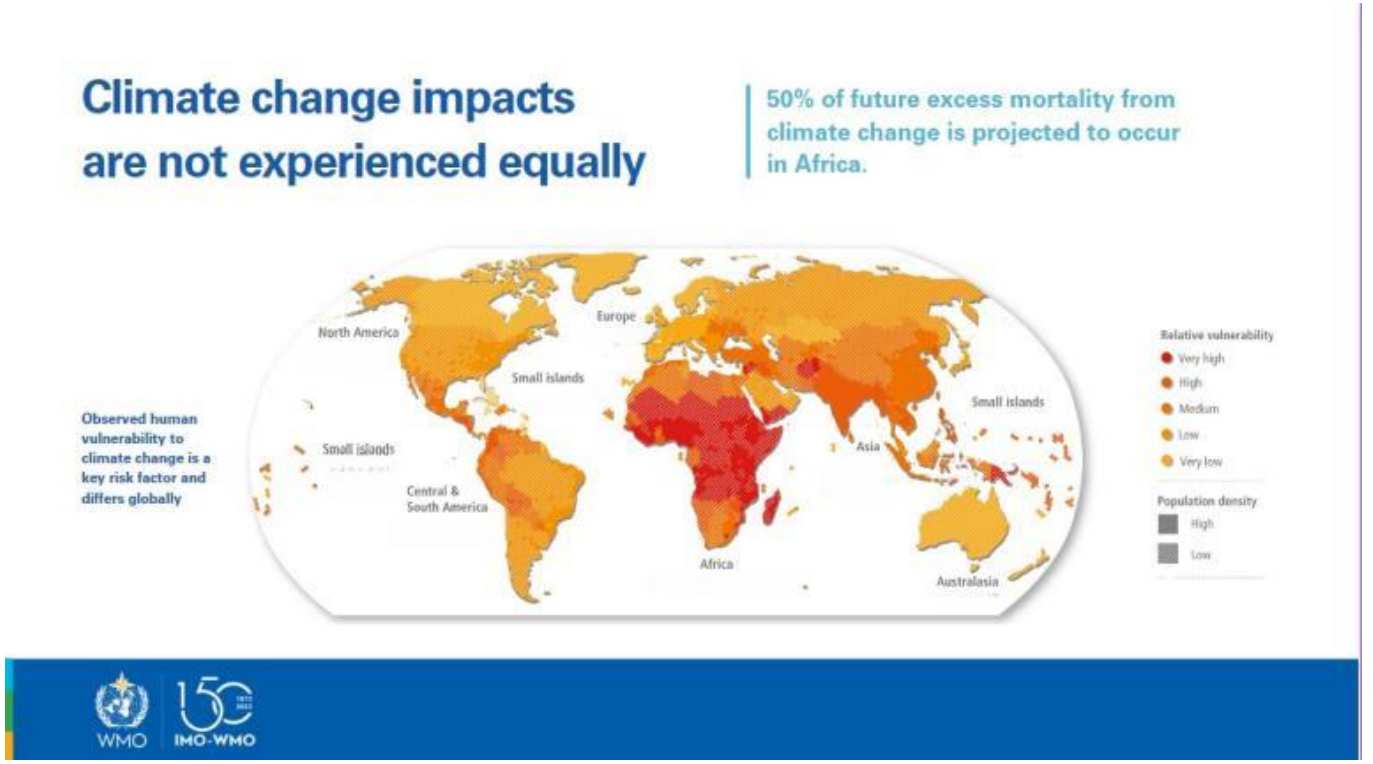
Background/Motivation

- Climate crisis is worsening and increasingly adversely affecting people's food, health and livelihoods.
- Problem is worse in low-income countries (Diffenbaugh & Burke, 2019).

- Within LDCs, those with poor housing conditions are disproportionately affected (IPCC, 2014).
  - —Advances in housing technologies has proved effective (Singh et al., 2010).
  - —Cool roofs are cheap & effective (3-4°C lower indoor temperature) (Taleb, 2014).

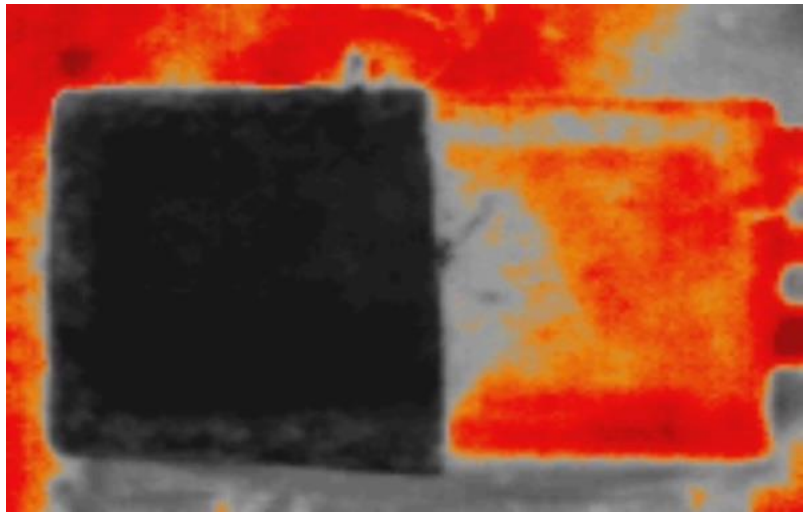


The cool roof intervention

- Heidelberg Institute of Global Health (HIGH) and Nouna Health Research Centre (CRSN).
- Implemented in Nouna, Burkina Faso.
- A household-(cRCT) to study the effect of cool roofs on wide range of health & economic outcomes.

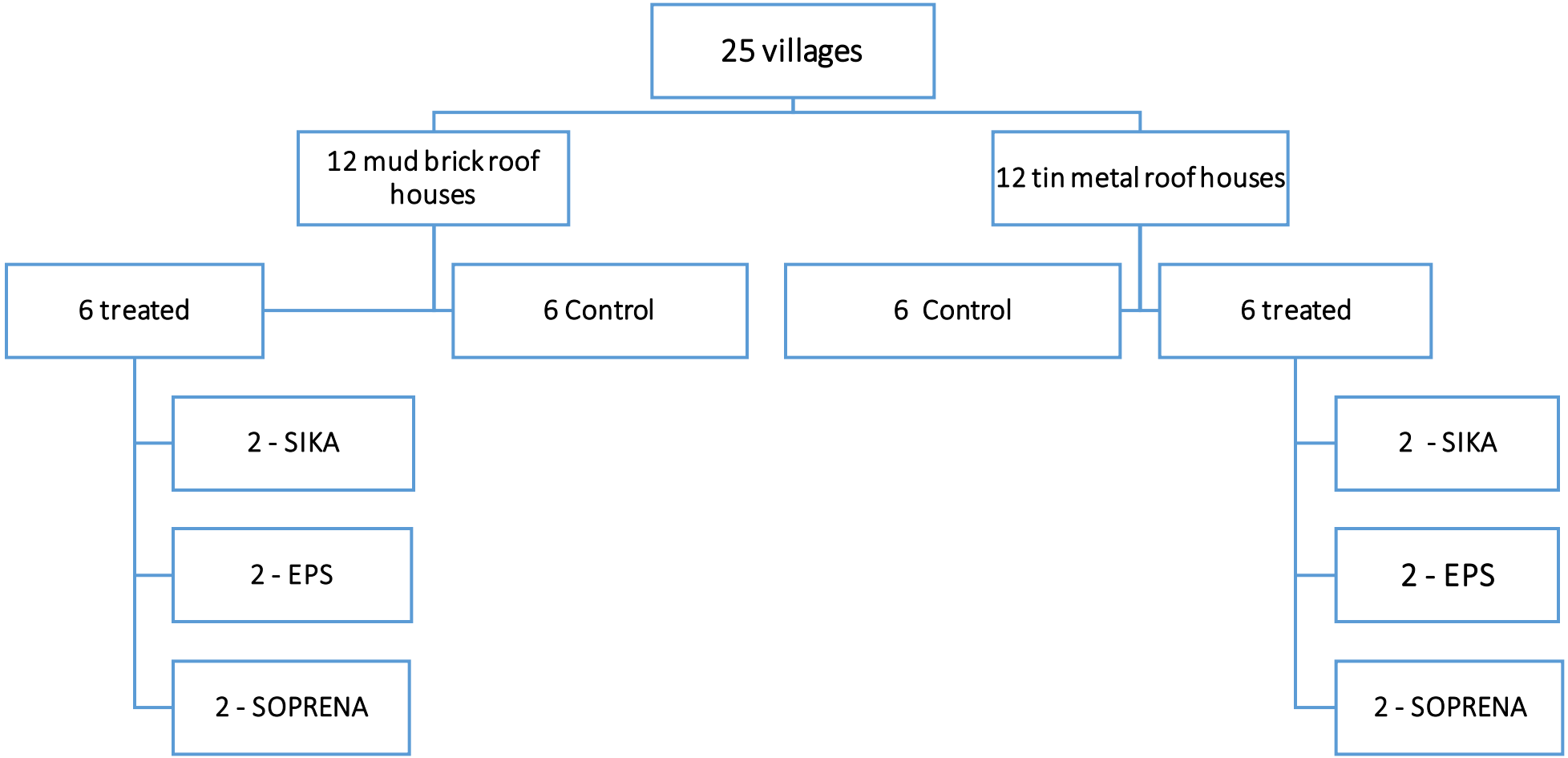
Application of cool roof coating

Coated (left) Vs. uncoated (right) roof



Thermal image of coated (left) Vs. uncoated roof

Design - cluster randomized controlled trial (cRCT)



Population: Nouna Health and demographic surveillance system (HDSS)

600 houses (300 control & 300 treated) are covered; in each HH a husband & wife are interviewed

Randomization

Table: Balance test

Variable	Total	Control mean	Mean difference
Age	42.97	43.25	-0.536
	(0.37)	(0.54)	
Female	0.503	0.51	-0.013
	(0.02)	(0.02)	
Household size	6.855	6.934	-0.157
	(0.12)	(0.17)	
Arc of residence (sqm)	33.06	33.69	-1.252
	(4.79)	(8.02)	
Access to electricity	0.036	0.023	0.025**
	(0.01)	(0.01)	
House has cooling/heating appliance	0.008	0.007	0.002
	(0.00)	(0.00)	
House has metal roof	0.506	0.503	0.005
	(0.01)	(0.02)	
Observation	1190	596	1190

Data

- No baseline data
- 22 monthly data in 2022 & 2023 – captures seasonality
- Data collection:
  - —Climate vars (temp, humidity): every 15mins – using installed sensors
  - — Selected outcomes (HR, activity): continuously – using smart watches
  - — Other data: monthly visits – surveys
  - —Survey modules our RG contributed: seasonally
    - **Food intake**: FCS
    - **Psycho-social wellbeing**: Depression, aggression, life satisfaction & **IPV**
    - **Personality elicitation**: trust, PANAS, perceived Stress, reciprocity & altruism

Temperature & IPV

- High ambient temperature is a major or underlying cause of IPV (Anderson et al. 2000; Hsiang et al. 2013).
  - **Direct**: increasing discomfort & irritability, leading to aggression (Anderson et al. 1995).
  - **Indirect**: disrupt sleep patterns, impair cognitive functioning, increased social gatherings & alcohol consumption (Lan et al. 2017); reduce productivity and income, fueling tension (Nguyen 2024).
- Most existing studies focus on **outdoor temperature**, based on **non-experimental** data, or **lab experiment** (Almås et al. 2025).
- **Objective**: Use lab-in-the-field setting to examine:
  - How indoor temperature affects IPV
  - The role of cool roofs on IPV

The IPV questionnaire – **a list randomization** design

During the last three months……..

List 1	List 2
1. …I have taken care of a sick relative who is unable to care for themselves	1. ….I have taken care of a sick relative who is unable to care for themselves
2. …I used contraceptives to reduce the incidence of pregnancies	2. ….I used contraceptives to reduce the incidence of pregnancies
3. *…I have been slapped, beaten or physically harmed by my husband/partner*	3. ….I ran out of the money I needed for basic things more often than before
4. …I ran out of the money I needed for basic things more often than before	4. ….I attended the wedding celebration of a friend/relative
5. …I attended the wedding celebration of a friend/relative	
# of agreed statements: ***IPV1***	*# of agreed statements:* ***IPV0***

Prevalence= IPV1 – IPV0

The IPV questionnaire - **double-list** randomization

Respondents assigned to Group 1	Respondents assigned to Group 2
List A	List A
1. …. I have taken care of a sick relative who is unable to care for themselves 2. ….I used contraceptives to reduce the incidence of pregnancies 3. *….I have been slapped, beaten or physically harmed by my husband/partner* 4. ….I ran out of the money I needed for basic things more often than before 5. …I attended the wedding celebration of a friend/relative	1. ….I have taken care of a sick relative who is unable to care for themselves 2. …. I used contraceptives to reduce the incidence of pregnancies 3. ….I ran out of the money I needed for basic things more often than before 4. ….I attended the wedding celebration of a friend/relative
List B	List B
1. ….I spent much more time working than I normally would have 2. ….I thought about having more children 3. …there were more arguments in our household than there were before. 4. ….I felt much closer to my family than I did before	1. ….I spent much more time working than I normally would have 2. ….I thought about having more children 3. *….I have been slapped, beaten or physical harmed by my husband/partner* 4. ….there were more arguments in our household than there were before 5. ….I felt much closer to my family than I did before

$$Y_i = \alpha + \boldsymbol{\beta_1} IPV_i + \beta_2 G + \varepsilon_i$$

Prevalence of IPV

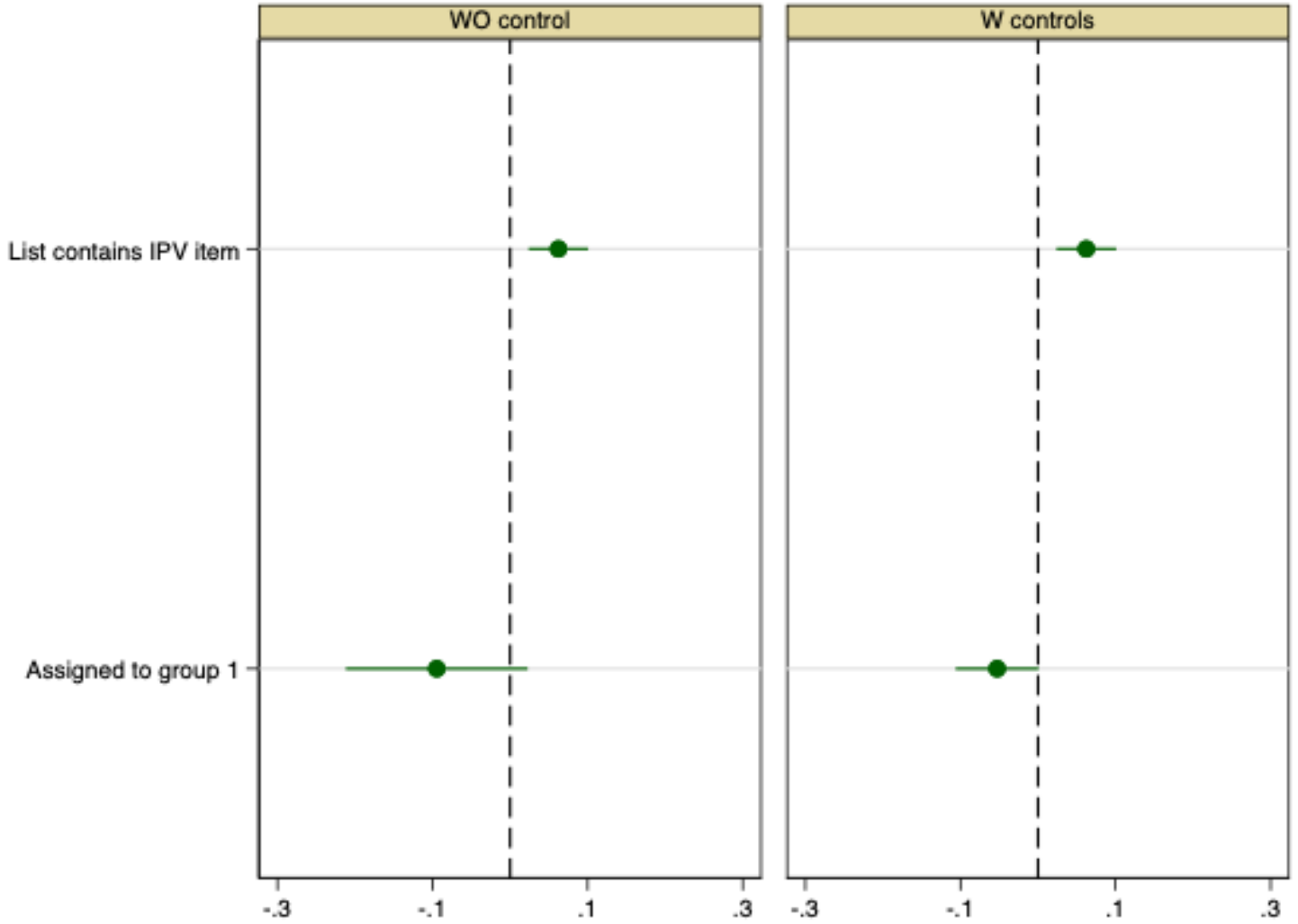
- *Model:*

$$Y_i = \alpha + \boldsymbol{\beta_1} IPV_i + \beta_2 X_i + \varepsilon_i$$

Y_i: # *of agreed statements;*

X_i : *HH & location characteristics;*

IPV_i *is a binary variable =1 if the list contains an IPV item, zero otherwise.*



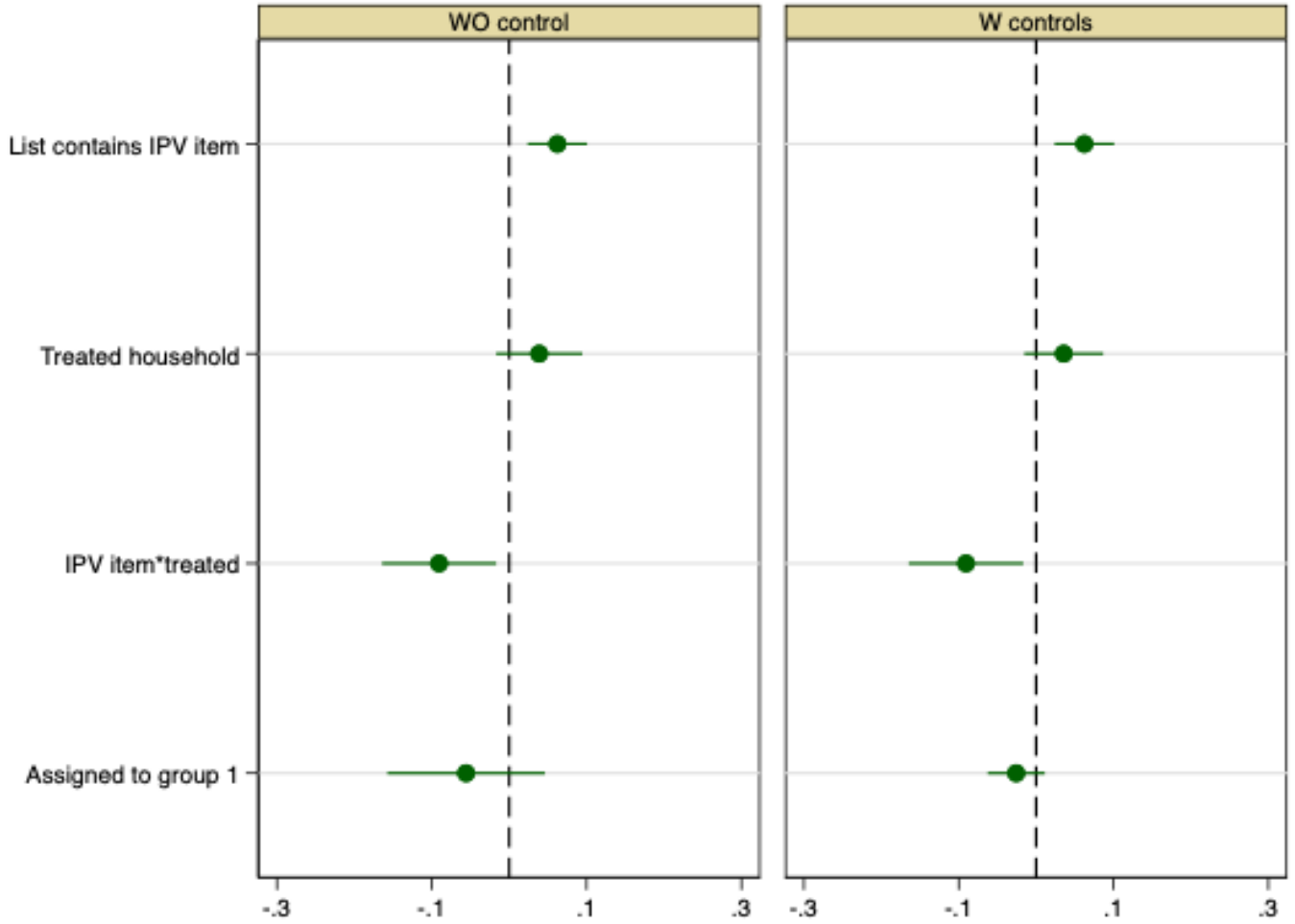
Note: *Dots: coefficient from ordinary least square regressions; Bars: 95% confidence intervals.*

Cool roof intervention reduced IPV

- The effect of cool roof on the prevalence of the IPV:

$$Y_i = \alpha + \beta_1 IPV_i + \beta_2 T_i + \boldsymbol{\beta_3} IPV_i * T_i + \varepsilon_i$$

The intervention leads to a reduction of the IPV by 9.2 pp.



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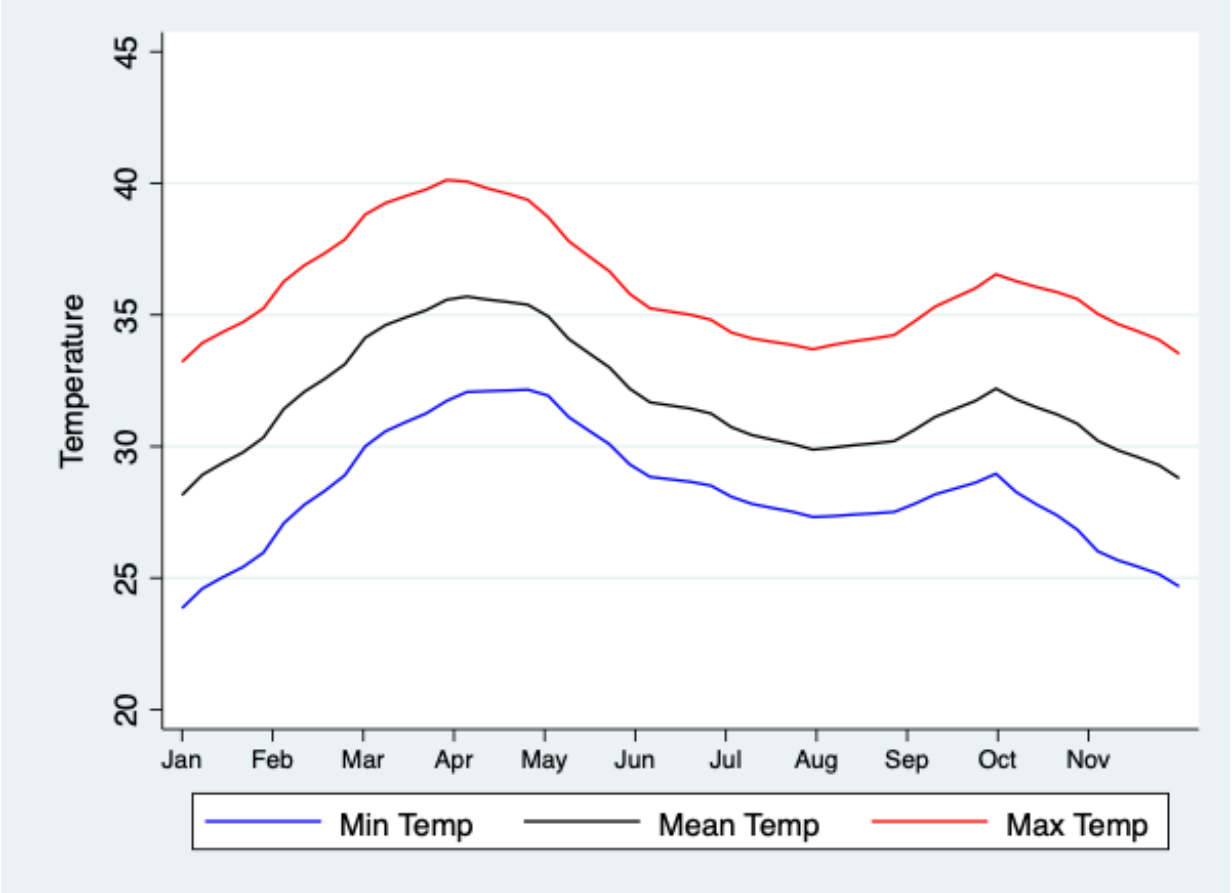
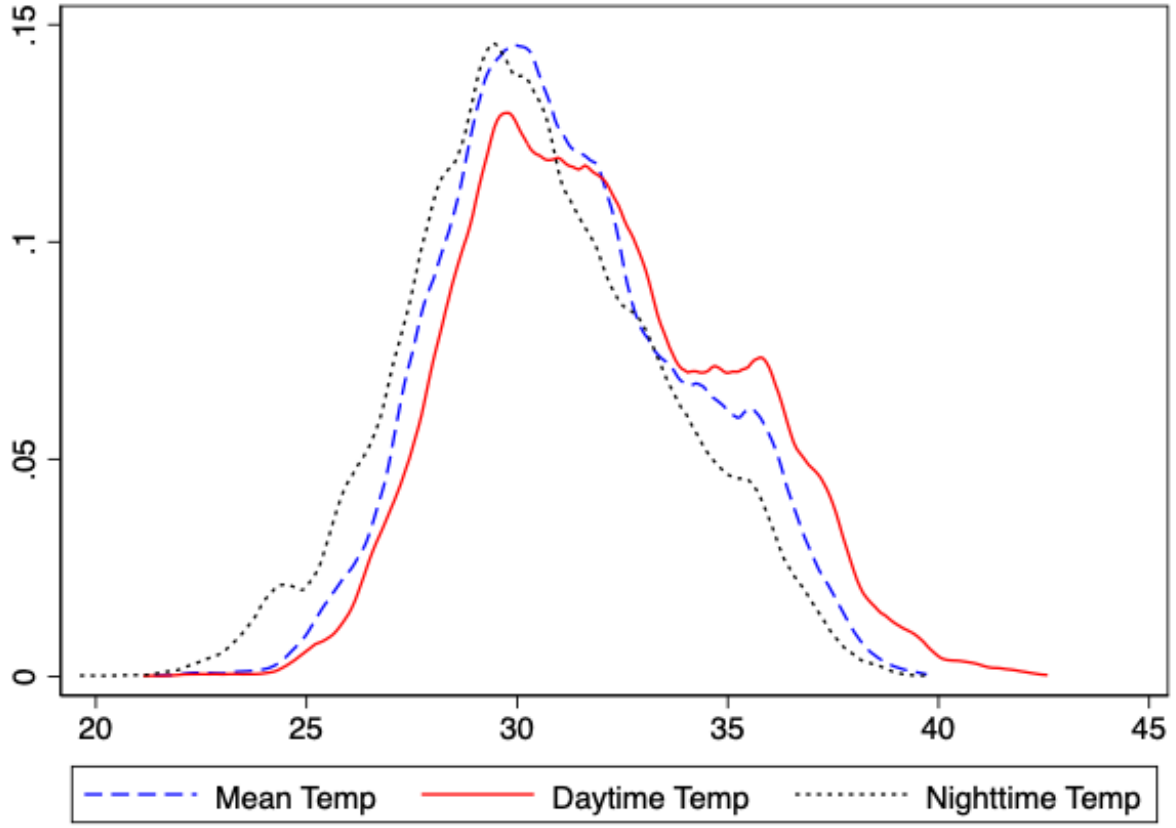
Indoor temperature and IPV

Patterns in temperature in Nouna, BF





First stage regression

Objective: estimate the impact of indoor temperature on IPV.

$$Y_i = \alpha + \beta_1 IPV_i + \beta_2 T_i + \boldsymbol{\beta_3} IPV_i * T_i + \varepsilon_i$$

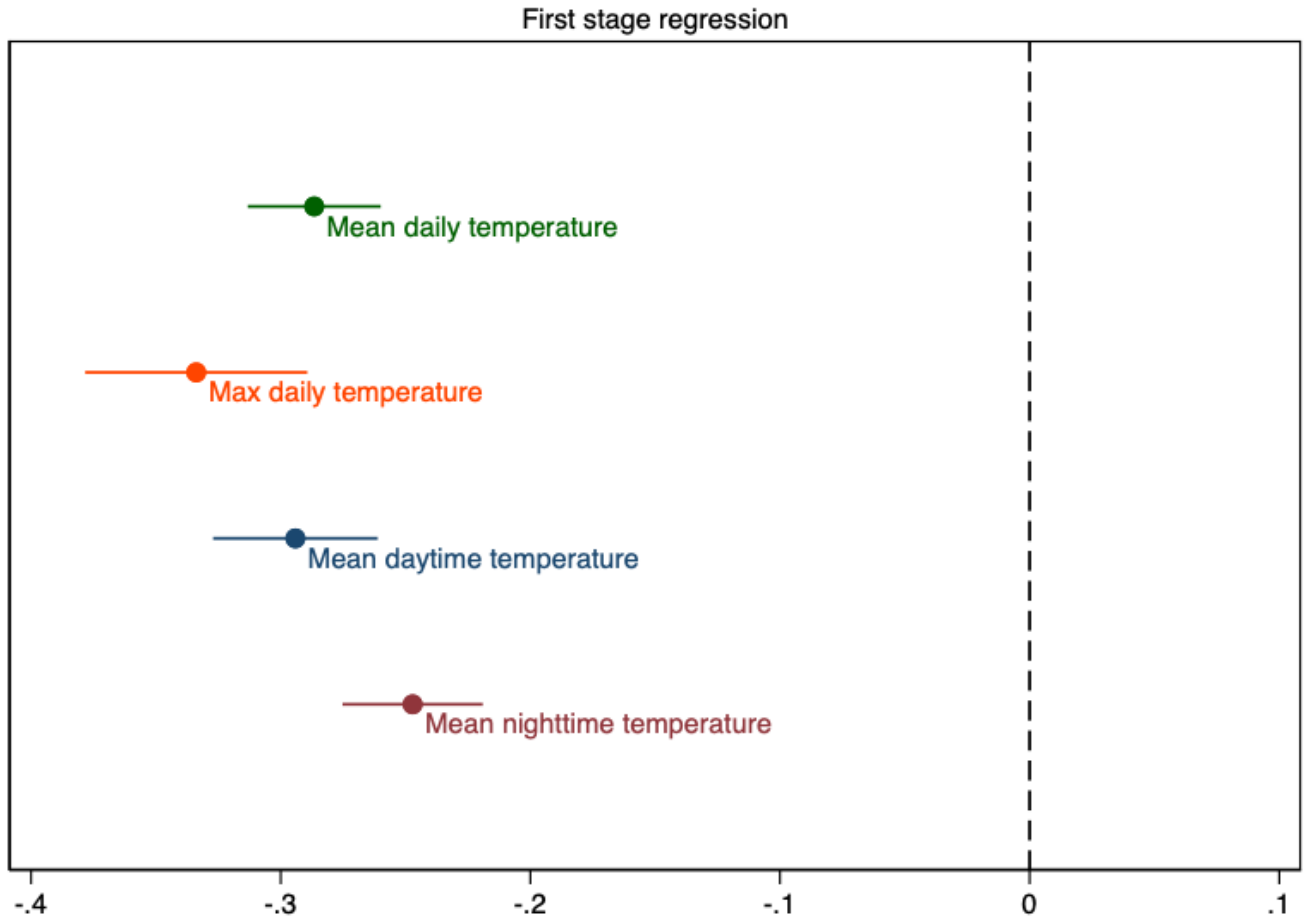
T_i : *temperature (z-score);*

But: indoor temperature is likely endogenous.

We use ITT as instrument for temperature.

First stage regression:

$$\text{Temp} = \alpha + \boldsymbol{\gamma_1} Treat_i + \gamma_2 X + \varepsilon_i$$



Note: *Dots: coefficient from ordinary least square regressions; Bars: 90% confidence intervals.*

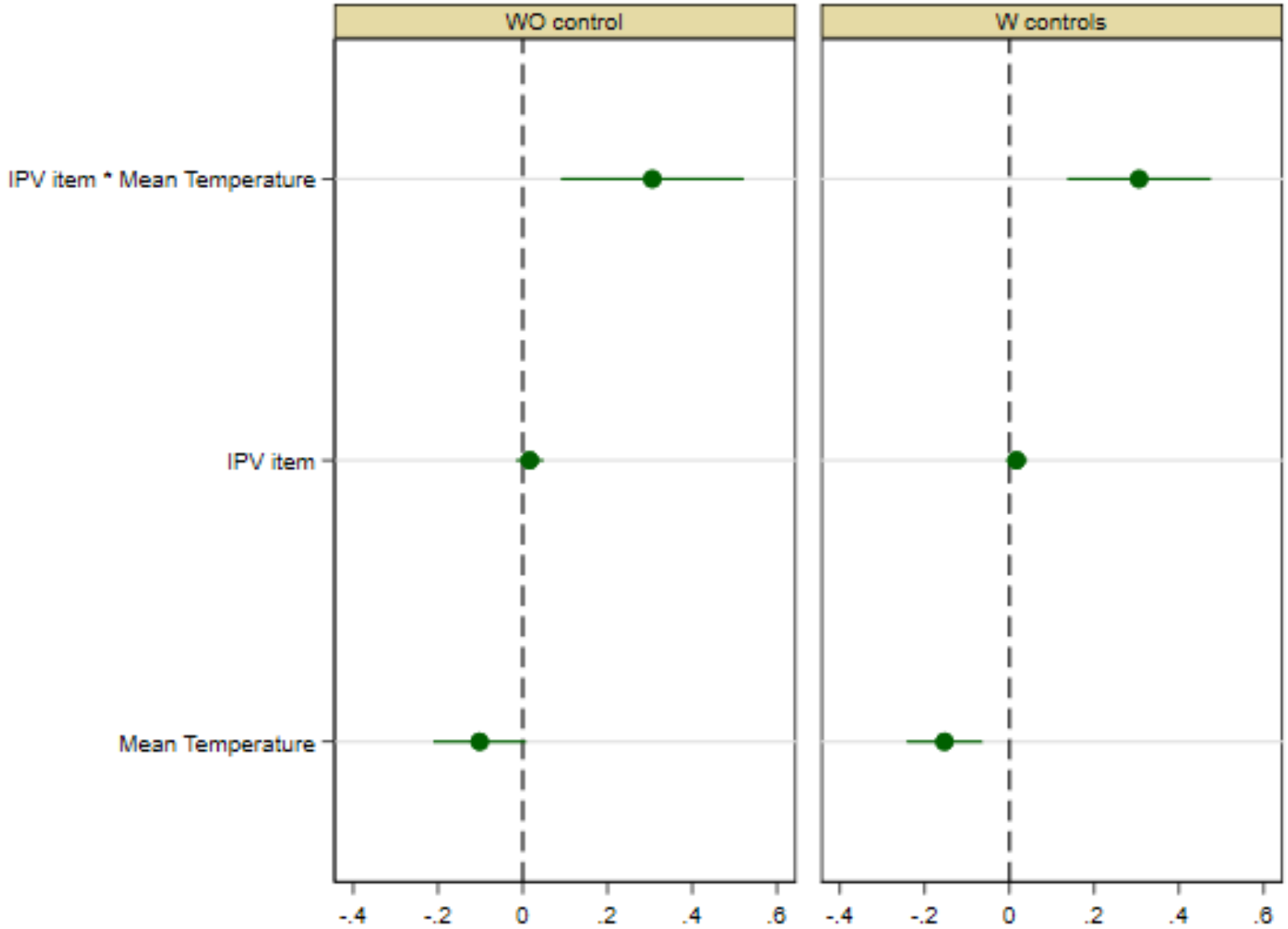
Higher indoor temperature increases IPV

$$Y_i = \alpha + \beta_1 IPV_i + \beta_2 T_i + \boldsymbol{\beta_3} IPV_i * T_i + \varepsilon_i$$

Y_i: # of agreed statements;

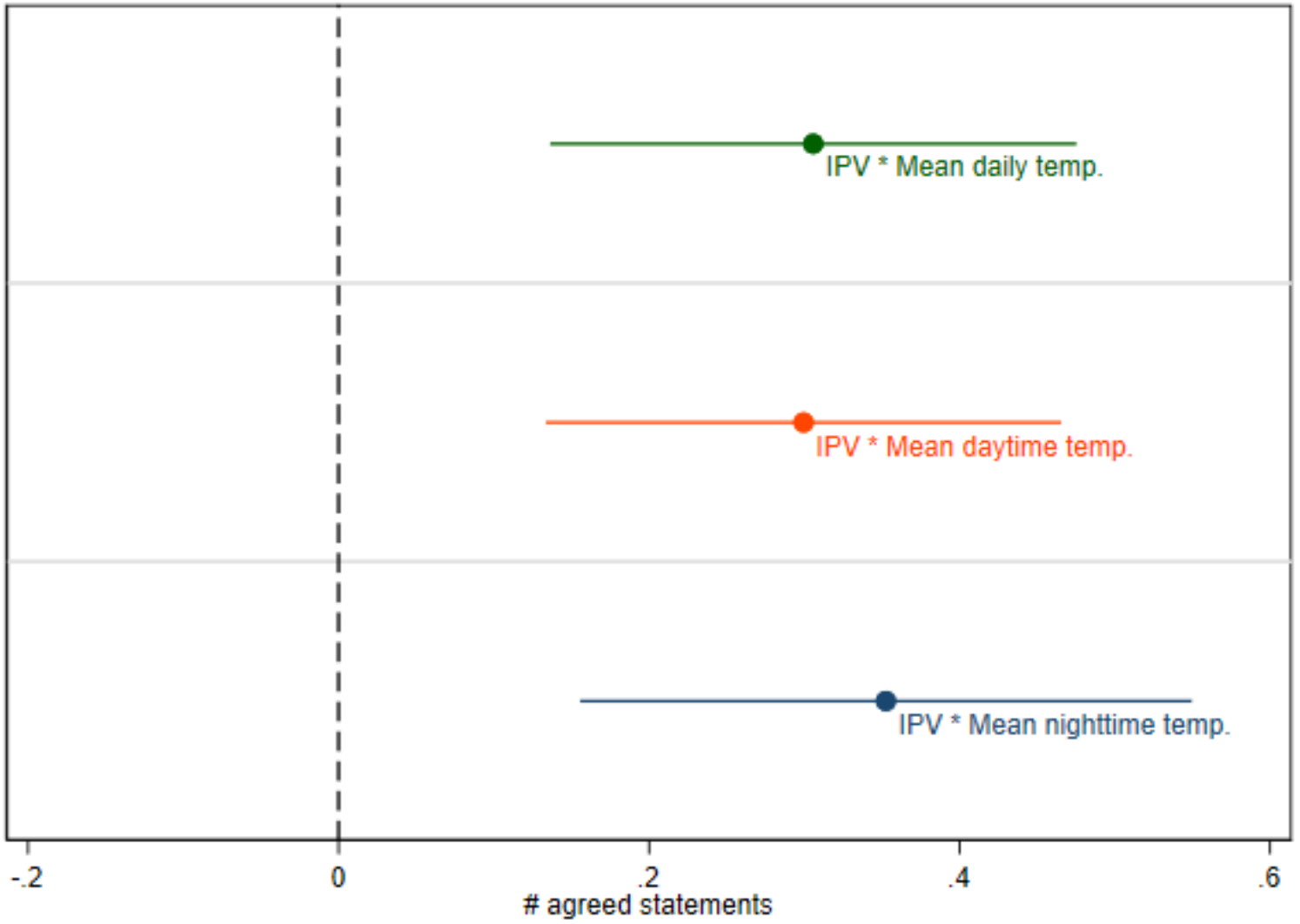
T_i : temperature (z-score);

1 SD increase in temperature leads to 30.5 pp. reduction in IPV.



***Note**: Dots: coefficient from IV-2SLS regressions; Bars: 90% confidence intervals.*

Sensitivity test



Summary and Implications

- Current level of climate change is causing wide ranging challenges
- Costs and damages expected to rise rapidly with warming.
- Climate change related crises worsen inequality:
  - Stronger impacts on the poor and vulnerable (gender, age, wealth ….)
- Current economic costs underestimate true impact
  - Longer term impact need to be considered (e.g.. Impact on human capital)
  - Non-economic impacts receive less attention (e.g. mental health)
- Less costly adaption mechanisms are available (e.g. cool roof)

Thank You!

Estimation challenge

Indoor temperature is endogenous

- Indoor temp can be affected by SEC (wealth, geography, housing), etc.).
- We use IV approach.
  - ITT for indoor temp

Variable	Total	Thermal discomfort	Mean difference
age	40.31	40.55	-0.76**
	(0.14)	(0.17)	
Household size	6.84	6.89	-0.17*
	(0.05)	(0.06)	
House has metal roof	0.52	0.51	0.03**
	(0.01)	(0.01)	
Access to electricity	0.02	0.02	0.001
	(0.00)	(0.00)	
Respondent has privacy	0.58	0.58	-0.011
	(0.01)	(0.01)	
Log (size of house)	3.16	3.15	0.020*
	(0.01)	(0.01)	
	7582	5190	7582