Does lower indoor temperature reduce risk of intimate partner violence (IPV)? Experimental evidence from rural Burkina Faso

Abstract

This paper presents findings from an ongoing study conducted to assess the effectiveness of lower indoor temperature in reducing the prevalence of intimate partner violence (IPV) in rural Burkina Faso. Using a clustered randomized control trial (cRCT) and double list experiment design, the study is aimed at examining the impact of improved thermal comfort resulting from cool roof intervention on the occurrence of IPV incidents. We find that the cool roof intervention reduces IPV incidents by 12 percentage points. This reduction is quite substantial given the established added impact of IPV on economic as well as women's mental health. The research provides strong evidence of the efficacy of cool roof interventions in mitigating IPV in developing countries contexts.

1. Introduction: background and motivation

Intimate Partner Violence (IPV) remains a global public health concern, affecting individuals across diverse sociocultural backgrounds and economic strata (World Health Organization, 2018). Defined as any behavior within an intimate relationship that causes physical, psychological, or sexual harm to one's partner, IPV poses profound and enduring consequences for victims and their communities. Although both males and females can be affected by IPV, the majority of the victims are females. Research done in ten countries[1] across the globe on women aged 15-49, (Rahmat et al., 2006b) showed that physical or sexual violence, or both, was experienced by as high as 71% of the participants. The adverse effects of IPV often persist, as it can worsen or lead to poor personal health, including physical issues such as mobility difficulties, memory loss, and pain, as well as mental health challenges like suicidal ideation and emotional distress (Ellsberg et al., 2008).

[1] The countries covered in the study were: Bangladesh, Brazil, Ethiopia, Japan, Namibia, Peru, Samoa, Serbia and Montenegro, Thailand, and the United Republic of Tanzania.

High ambient temperature has been identified as a major or underlying causes of IPV[2]. By contributing to heightened levels of stress, frustration, and aggression, exposure to high temperature can increase the likelihood IPV. As temperatures rise, so too can feelings of discomfort and irritability, exacerbating existing tensions within relationships (Anderson et al., 1995). Additionally, prolonged exposure to heat can disrupt sleep patterns and impair cognitive functioning, diminishing individuals' ability to cope with interpersonal conflicts effectively (Lan et al., 2017). Moreover, hot weather often coincides with increased social gatherings and alcohol consumption, factors known to escalate instances of IPV [Ref]. In households where economic strain is already present, negative shock to income can further strain relationships, leading to escalated conflicts and instances of violence. This is particularly the case in agriculture-dependent communities where diminishing agricultural yields as a result of extreme temperatures proportionately cut down income (Almås et al., 2019).

In line with this, empirical studies conducted in different settings have shown that high ambient temperature increases the likelihood of IPV (Auliciem & DiBartolo, 1995; Rotton & Cohn, 2000; Sanz-Barbero et al., 2018). However, these studies reveal several notable gaps that warrant further investigation. First, many of studies suffer from serious shortcomings in their data collection methodologies, which may compromise the reliability and validity of their findings. Commonly, respondents underreport IPV when direct questioning approach is used due to social desirability bias, fear, shame (Gibson et al., 2022; Peterman et al., 2018). Second, most of these studies relied on non-experimental data sources which limits the ability to establish causal relationships and accurately assess the impact of various factors on IPV. Third, the studies do not rigorously identify and test the underlying mechanisms, which hinders our understanding of the processes driving outcomes in this domain. Additionally, most of the studies are concentrated in on advanced countries. This is regardless of the disproportionately more concentrated cases of IPV in low-income countries (Chersich et al., 2019; Rahmat et al., 2006a; Stöckl et al., 2014).

Our paper addresses these gaps. Our research design combines a double list randomization approach for the collection of the IPV data from women sampled based on a clustered randomized control trial (cRCT) conducted in Nouna, rural Burkina Faso.

[2] Other complementary causes include: socioeconomic status (e.g. educational level, wealth), childhood abuse, alcohol consumption (Sanz-Barbero et al., 2018).

The research cohort is comprised of 600 women, half of which are randomly assigned to the intervention group where cool roof installations were implemented, whereas the other half are from households without roof coating. While the list randomization helps to mitigate the reporting bias, the use of cRCT helps tease out the causal link between heat exposure and IPV. Our paper also delineates the underlying mechanisms driving the relationship between heat exposure and IPV, focusing on microeconomic and psychosocial factors. Economic factors encompass sources of livelihood and income, while psychosocial factors include sleep quality, thermal comfort and aggression.

Our analysis reveals four key results. First, cool roof intervention is effective in reducing indoor temperatures. The daytime temperature of houses that received the cool roof intervention is lower by 1.8 degree centigrade (<0.001). Second, IPV is significantly prevalent within the study setting. About 30% of women reported to have faced IPV. Third, our study demonstrates that the cool roof intervention leads to a significantly lower in IPV incidents. Fourth, the effects are not significantly higher in the hot season, perhaps indicating the lagged effect of the intervention. The overall result suggests that interventions that reduce indoor temperature can have a tangible impact on reducing the occurrence and severity of IPV. This finding holds promising implications for public health initiatives seeking novel approaches to IPV prevention and intervention.

This study also underscores the health benefit of tackling climate change. As rising temperatures are a major part of climate change and that high temperature is already an important deriving factor of intergroup and interpersonal conflicts, this effect of climate change will probably become even more important in the future(Mach et al., 2019). In line with this, Hsiang et al., (2013), finds that a shift in climate towards higher temperatures results in a 4% increase in interpersonal conflicts.

The rest of the paper is organized as follows. The next section presents the conceptual framework linking indoor temperature to IPV. Section 3 briefly presents the design of the overall study and the description of the data. Section 4 highlights the econometric model used in estimation. Section 5 discusses the result before concluding remarks are given in the last section.

2. Indoor temperature and Intimate Partner Violence (IPV)

Hot weather appears to be closely intertwined with an upswing in violent incidents, suggesting connection between high temperatures and increased aggression (Anderson et al., 2000). Hotter weather is often associated with higher levels of irritability, frustration, and aggressive behavior, which can potentially lead to conflicts between individuals or groups. In the US, for example, hot summers and hot years were found to be significantly positively correlated with violent crime statistics such as the murder rate and the number of deadly assaults (Anderson et al., 1997, 2000).

With Intimate partner violence (IPV) being a type of violence, the above relationship between heat and general violence naturally extends to IPV. In line with this, Sanz-Barbero et al. (2018b) show that heat waves are linked with an increase in IPV. With the help of a time series analysis and data from Madrid, Spain, they find that heat waves increase the relative risk of intimate partner femicides (IPF) and IPV by 40% with a delay varying from one to five days depending on which indicator is considered. A positive relationship between maximum air temperature and an increase in police calls for complaints about domestic violence has been similarly found in Australia (Aulicie & DiBartolo, 1995) and the USA (Henke & Hsu, 2020).

The aforementioned studies find a link between heat and IPV. However, they are all conducted in high-income countries. Literature on the link between environmental influences and IPV in low-income countries is sparse. In a study conducted in Kenya, Allen et al., (2021) finds that there is a link between severe weather events (SWEs; defined as any flood >10 days) induced by climate change and an increase in IPV. Precisely, the chance of reporting IPV in a county with a SWE is 60% higher compared to a county without one.

Why may we expect link between indoor temperature and IPV? The literature identifies at least two major mechanism that links heat and violence. First, heat directly increases feelings of hostility and indirectly increases aggressive thoughts (Anderson, 2001; Hsiang & Burke, 2014). It is also found to significantly reduce emotional well-being (Noelke et al., 2016). Second, high indoor temperature can disrupt sleep patterns, leading to reduced sleep quality, lower labor productivity and income which can, in turn, increase the risk of IPV (Motoki et al., 2018).

The relationship between heat and IPV could be modulated by several underlying factors including sources of livelihood (Allen et al., 2021), socioeconomic development, bargaining power of women (Henke & Hsu, 2020), and the quality of institutional support system (Buller et al., 2018). Cultural norms and community context can also influence how individuals perceive and respond to hot indoor temperatures. Cultural norms may influence attitudes toward IPV and affect help-seeking behaviors or the acceptability of violence within relationships in the context of heat-related stress.

In this study, we examine the effect of exposure to heat on the prevalence of IPV after factoring in the differences in the outlined underlying factors, individual, household and community characteristics.

3. Design of the study and description of data

The data used in this study is collected in collaboration with Heidelberg Institute of Global Health (HIGH) and Nouna Health Research Centre (CRSN). This study is part of a broader project aimed at studying the impact of sunlight-reflecting roof coatings, known as 'cool roofs,' on the health, environmental, and economic outcomes in Nouna, rural Burkina Faso (Bunker et al., 2024). This is a two-year community-based stratified cluster randomized controlled trial (cRCT) involving 600 households and 1,200 participants (600 males, 600 females) from 25 villages in the Nouna. Participants were recruited from households that met specific criteria such as residing in the Nouna Health and Demographic Surveillance System (HDSS) and have consented to participate in the study. However, ethnicity, race, political orientation, religion and class are not criteria for inclusion or exclusion in the study. Overall, 600 houses were randomly assigned to either the intervention group or the control group. The intervention group (300 houses) received cool roof installations, while the control group did not undergo any changes to their roofing system.

Table 1 presents socio-demographic characteristics of sample respondents used in the analysis by treatment status and overall. The average household is headed by 30 years old male and includes about 7 family members, of which 4 members live in the household at the time of survey. The average residence house is about 32 square meter in area with little to no access to electricity. None of the households use cooling and heating appliances. About 60 percent of the respondents had privacy when responding to the survey questions. The random assignment of households generated comparable treatment and control groups at household level, with differences in all selected variables being statistically insignificant except for access to electricity. We will include access to electricity in all the regressions.

Table 1: Descriptive statistics

Variable	(3) Total	(1) Control	(2) Treated	Test Diff.(1)-(2)
Age of respondent (years)	29.54	29.75	29.32	0.43
	[0.46]	[0.63]	[0.66]	
Respondent is female, yes=1	0.50	0.50	0.50	0.00
	[0.01]	[0.02]	[0.02]	
Household size	6.79	6.85	6.72	0.13
	[0.08]	[0.11]	[0.11]	
# of residents	4.03	3.99	4.07	-0.08
	[0.03]	[0.05]	[0.05]	
Area of your home (sq. m)	32.58	34.23	30.96	3.27
	[3.33]	[5.85]	[3.24]	
Access to electricity, yes=1	0.02	0.02	0.03	-0.02**
	[0.01]	[0.01]	[0.01]	
House has metal roof, yes=1	0.51	0.51	0.50	0.01
	[0.01]	[0.02]	[0.02]	
Respondent has privacy, yes=1	0.59	0.58	0.59	0.00
	[0.01]	[0.02]	[0.01]	
House has cooling appliance, yes=1	-	-	-	
House has heating appliance, yes=1	-	-	-	
Observation	2,334	1,155	1,179	

*Note: The value displayed in parenthesis is standard deviation. The value displayed for t-tests are the differences in the means across the groups.***, **, and * indicate significance at the 1, 5, and 10 percent critical level.*

The survey part used for this analysis is based on 600 female respondents, 300 of whom were from houses that received the intervention whereas the remaining 300 were from the control group. Baseline data on IPV prevalence and household characteristics were not collected before the intervention due to delay in ethical approval. Instead, we collected the data monthly throughout the year. Our empirical method exploits the marked seasonality in the study area (see Figure A1 in the appendix) (see section 4 for methods).

Direct elicitation of intimate partner violence has proven difficult due to social desirability bias (Gibson et al., 2022). This is especially the case for people who are poorly educated or live in households with less gender equality. A viable method to remedy this bias is by using alternative indirect questioning such as list randomization (Peterman et al., 2018). List randomization is a method to collect sensitive information in surveys discreetly. Respondents choose items from a randomized list, making it hard to discern their specific choices. This technique promotes more honest responses on sensitive topics, benefiting social science research and survey design (Gibson et al., 2022).

In this study, half of the sample of women received a panel with 4 non-sensitive statements and were asked how many of the statements they agree with. The other half received the same panel with one additional sensitive IPV item: "*Have you been slapped, punched, kicked, or physically harmed by your partner*" (see Table A1 in the appendix). By subtracting the number of affirmatively reported statements between the two groups, the percentage of women who report IPV can be estimated. The approach has been validated in different setting including in sub-Saharan African countries (SSA) and proved to provide more accurate estimate. For example, when a list randomization approach was used in Rwanda, the reports of IPV increased by 100% (Cullen, 2020).

To increase efficiency, double-list experiments can be used for IPV-related surveys (Lépine et al., 2020). In this method, there are two lists (List A and List B) with different non-sensitive items, and two groups are utilized, with each group alternately serving as both the control group and the treatment group (Droitcour et al. 1991). We use cRCT in combination with double list experiment method to examine the prevalence and correlates of IPV in Burkina Faso.

4. Econometric approach

To estimate the prevalence of sensitive behavior, we use the following regression:

$$Y_i = \alpha + \beta_1 IPV_i + \varepsilon_i \qquad (1)$$

Where Y_i is the number of statements the respondent agreed with and IPV_i is a binary variable equal to one if the respondent is assigned to the group that includes the IPV item and zero otherwise. The average sensitive behavior prevalence rate is then given by β_1 and corresponds to the average difference between the number of statements that the control group and the treatment group agreed with.

To estimate the influence of cool roof on the prevalence of the IPV, we add an interaction between IPV_i and the treatment categories (equation 2). In this specification, β_1 reports the sensitive behavior prevalence rate among the control households, while (β_1 + β_3) indicates the sensitive behaviour prevalence rate among the treated households. Therefore, β_3 reports the difference in the prevalence rate of the sensitive behavior between individuals in the coated and non-coated roofs.

$$Y_i = \alpha + \beta_1 IPV_i + \beta_2 T_i + \beta_3 IPV_i * T_i + \varepsilon_i \qquad (2)$$

Furthermore, we include a dummy variable that takes a value of one if the individual draws the questions from list A, zero if the draw is from list B. This controls for whether the prevalence rate of the IPV item differs between the two lists used in the survey. Finally, we include other relevant household characteristics such as access to electricity, household size, type of roof, interview privacy, size of the house, and village fixed effects.

5. Results and discussions

5.1. Validity and effectiveness of the intervention

Before we formally test our hypothesis that the lower indoor temperature due to cool roof reduced IPV, we should first test the validity of the randomization approach and effectiveness of the cool intervention. Validity of the approach implies that there is no selection bias in allocating respondents to the list with the sensitive item or not[3]. That is, on average, respondents that are allocated to the list with the sensitive item are the same as respondents that are allocated to the list without the sensitive item. We conduct this test by checking the balance of the two groups based on observable pre-treatment characteristics. Table 2 presents the balance test separately for list A and list B. It shows that the characteristics of two groups of respondents are statistically indistinguishable.

[3] The balance of the sample based on the intervention is presented in section 3.

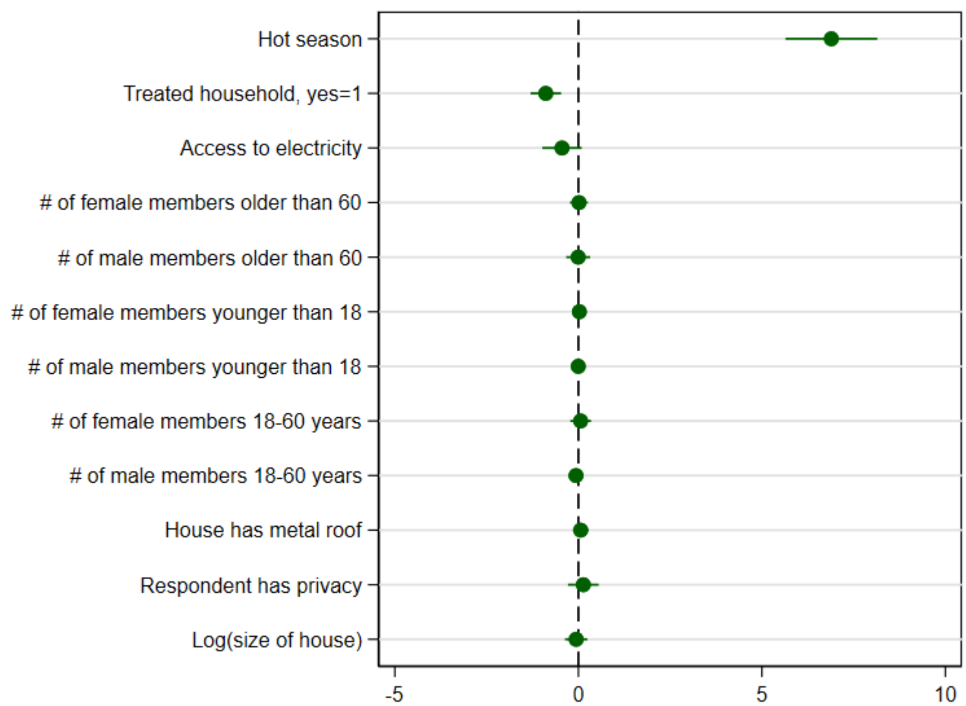
Table 2: Balance test

	List A				List B			
				t-test				t-test
	Total	IPV=1	IPV=0	Diff.	Total	IPV=1	IPV=0	Diff.
Variable		[1]	[2]	[1]-[2]		[3]	[4]	[3]-[4]
Access to electricity	0.021	0.023	0.019	0.004	0.021	0.019	0.023	-0.004
	[0.004]	[0.006]	[0.006]		[0.004]	[0.006]	[0.006]	
# of female members > 60	0.091	0.087	0.095	-0.008	0.091	0.095	0.087	0.008
	[0.009]	[0.012]	[0.013]		[0.009]	[0.013]	[0.012]	
# of male members > 60	0.165	0.167	0.163	0.004	0.165	0.163	0.167	-0.004
	[0.011]	[0.016]	[0.016]		[0.011]	[0.016]	[0.016]	
# of female members < 18	0.975	0.959	0.991	-0.032	0.975	0.991	0.959	0.032
	[0.031]	[0.045]	[0.044]		[0.031]	[0.044]	[0.045]	
# of male members < 18	0.983	0.989	0.976	0.013	0.983	0.976	0.989	-0.013
	[0.032]	[0.045]	[0.045]		[0.032]	[0.045]	[0.045]	
# of female members 18-60 years	0.969	0.952	0.985	-0.033	0.969	0.985	0.952	0.033
	[0.013]	[0.018]	[0.018]		[0.013]	[0.018]	[0.018]	
# of male members 18-60 years	0.902	0.911	0.894	0.018	0.902	0.894	0.911	-0.018
	[0.015]	[0.022]	[0.020]		[0.015]	[0.020]	[0.022]	
House has metal roof	0.511	0.535	0.487	0.048	0.511	0.487	0.535	-0.048
	[0.015]	[0.021]	[0.021]		[0.015]	[0.021]	[0.021]	
Respondent has privacy	0.596	0.613	0.58	0.033	0.596	0.58	0.613	-0.033
	[0.015]	[0.020]	[0.021]		[0.015]	[0.021]	[0.020]	
Log(size of house)	3.16	3.153	3.167	-0.014	3.16	3.167	3.153	0.014
	[0.014]	[0.022]	[0.016]		[0.014]	[0.016]	[0.022]	
Observation	1135	566	569		1135	569	566	

*Note: The value displayed in parenthesis is standard deviation. The value displayed for t-tests are the differences in the means across the groups. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.*

The second important condition is the effectiveness requirement. The hypothesized impact of cool roof intervention on IPV is predicated on the expected lower indoor temperature in houses where the cool roof coating was applied. Therefore, is important to first test this link between heat exposure and the intervention. Figure 1 provides evidence that the intervention is effective in improving thermal comfort. It shows the result of a regression of a Heat Strain Score Index (HSSI) on several household level characteristics, season dummy and household treatment status. HSSI is a weighted average score of several indicators of heat stress at home such as state of indoor temperature (humidity, air flow); adopted heat regulation mechanisms (clothing, ventilation) and heat related sickness symptoms (headache, dizziness, muscle pain). The Figure shows that the cool roof intervention was effective in reducing thermal stress within household (i.e., the coefficient estimate of the treatment dummy is negative and statistically significant).

Figure 1: Correlates of Heat Strain Score Index (HSSI)



Note: Dots: coefficient from ordinary least square regressions; Bars: 95% confidence intervals; Excluded category: village-level fixed effect. This regression result is obtained by estimating equation: $Y_i = \alpha + \beta_1 T_i + \beta_2 H_i + \beta_3 X_i + \varepsilon_i$*, where* Y_i *is HSSI;* H_i *is seasonal dummy;* X_i *is HH and location characteristics;* T_i *treatment dummy.*

5.2. The basic result

Prevalence of intimate partner violence (IPV)

Table 3 presents the average number of statements the respondents agreed with when presented with a panel with a list of 4 non-sensitive items (IPV0) and a panel with a list 4 non-sensitive and one sensitive item (IPV1). As described in the methods section, the difference between IPV1 and IPV0 represents the prevalence of physical IPV. The overall prevalence rate of IPV during the survey period was 7%. Between the cold and the warm seasons, we observe only a modest difference. While women in both the treated and control households report incidence of IPV, the prevalence rate for the treated group (2%) is significantly lower compared to the control group (13%), and the pattern is consistent during both cold and warm seasons.

Table 3: Estimated prevalence of IPV using list experiments method

	Total Sample			Cold season (February)			Warm season (April)		
Treated	IPV0	IPV1	Estimated IPV[(a)]	IPV0	IPV1	Estimated IPV[(a)]	IPV0	IPV1	Estimated IPV[(a)]
Control	1.50	1.63	0.13	1.54	1.69	0.15	1.46	1.58	0.12
Treated	1.58	1.60	0.02	1.60	1.60	0.01	1.57	1.59	0.03
Total	1.542	1.615	0.07	1.568	1.644	0.08	1.52	1.59	0.07

Estimated prevalence corresponds to the β_1 *in equation (1).* $Y_i = \alpha + \beta_1 IPV_i + \varepsilon_i$

In Figure 2, we present the estimation result from equation 1, after accounting for seasonality - dummy for hot season, the design effect (whether list 1 or list 2 is used), and household characteristics (household size and composition, access to electricity, type of roofing, area of the residence house and survey privacy). In line with the result in Table 3, the rate of prevalence of physical IPV is 7% ($p<0.05$), indicating that IPV is prevalent in the study setting. Between the cold and the warm season, we see no statistically significant difference in the incidence of IPV (see Figure A2 in the appendix).

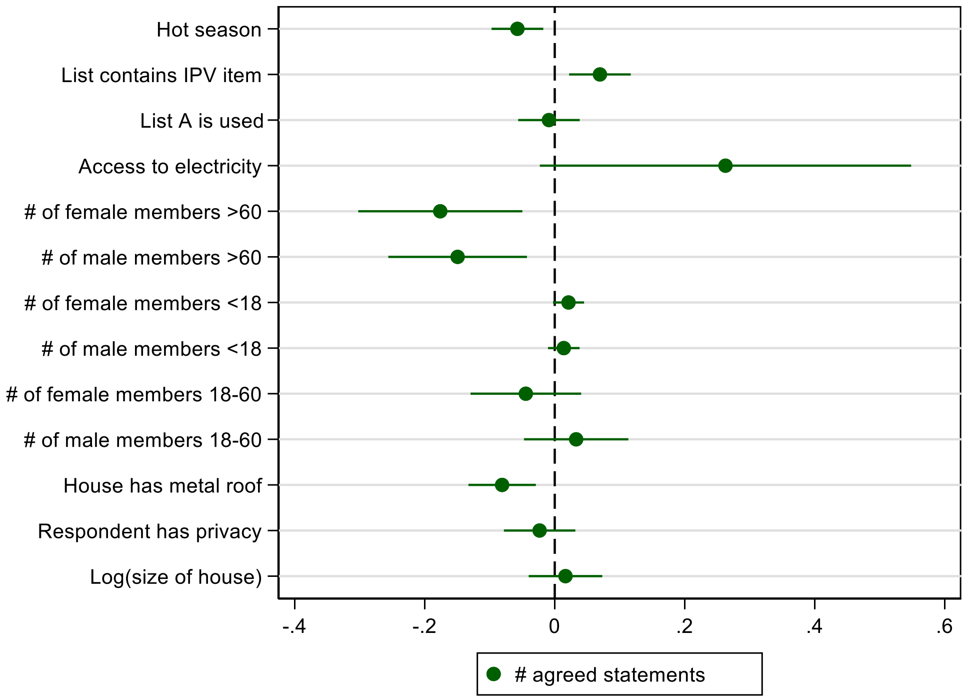


Figure 2: Regression result of prevalence of IPV

Note: *Dots: coefficient from ordinary least square regressions; Bars: 95% confidence intervals; Excluded category: village-level fixed effect. This regression result is obtained by estimating equation:* $Y_i = \alpha + \beta_1 IPV_i + \beta_4 H_i + \beta_5 X_i + \varepsilon_i$, *where* Y_i *is the number of statements participants is agreed with;* H_i *is seasonal dummy;* X_i *is HH and location characteristics;*IPV_i *is a binary variable that indicates whether the list contains IPV item or not.*

Impact of cool roof on the prevalence of IPV

Estimation of the impact of the cool roof on the prevalence of IPV is tantamount to estimating the coefficient of the interaction term (IPV*treated) in equation (2). In Figure 3, the coefficient is negative and statistically significant indicating that the intervention group, which received the cool roof installations, reported a lower IPV incidents compared to the control group. specifically, the cool roof intervention leads to a reduction in IPV incidents by 12 percentage points.

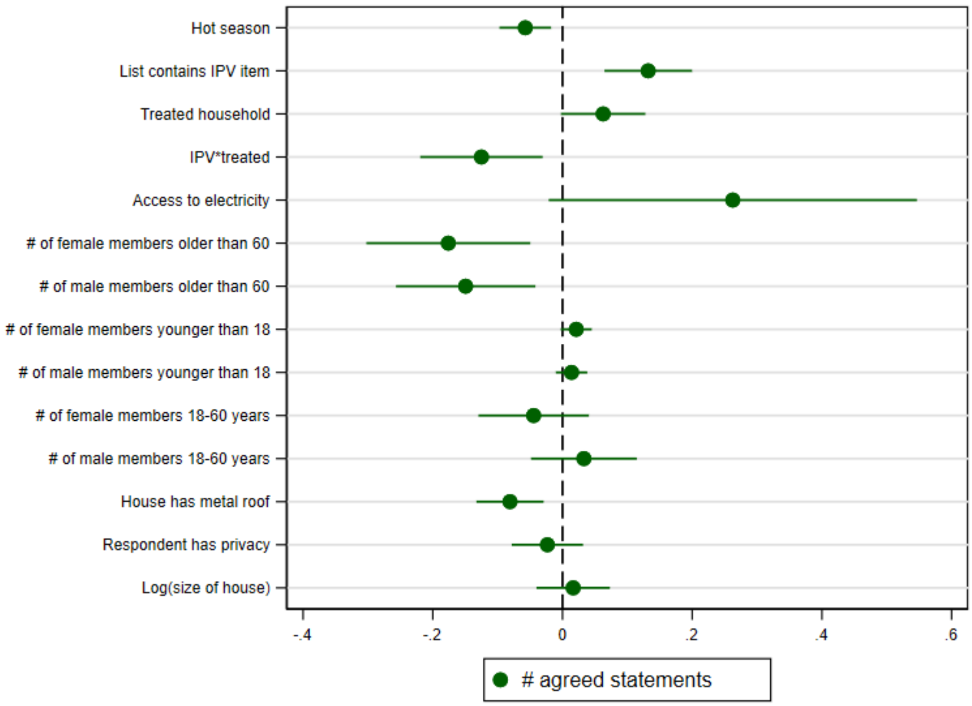


Figure 3: Regression result of IPV on treatment status

Note: *Dots: coefficient from ordinary least square regressions; Bars: 95% confidence intervals; Excluded category: village-level fixed effect. This regression result is obtained by estimating equation:* $Y_i = \alpha + \beta_1 IPV_i + \beta_2 T_i + \beta_3 IPV_i * T_i + \beta_4 H_i + \beta_5 X_i + \varepsilon_i$, *where* Y_i *is the number of statements participants agreed with;* H_i *is seasonal dummy;* X_i *is HH and location characteristics;* T_i *treatment dummy;* IPV_i *is a binary variable that indicates whether the list contains IPV item or not.*

To test if the effect of the cool roof intervention is stronger during the warm season, we disaggregated estimation result above by survey round. The result presented in Figure 4 shows that, the effect of cool roofs on the prevalence of IPV is more pronounced in the cold than hot season.

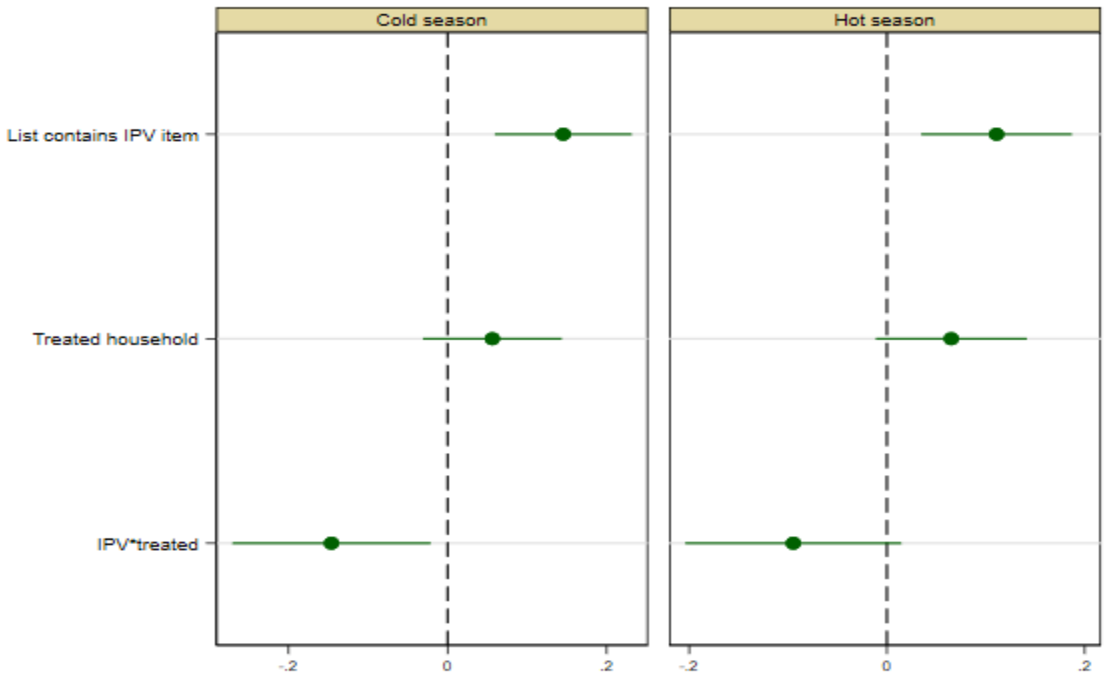


Figure 4: Regression result of IPV on treatment status, by season

***Note**: Dots: coefficient from ordinary least square regressions; Bars: 95% confidence intervals; Excluded category: household characteristics and village-level fixed effect. This regression result is obtained as in Figure 3 but splitting the sample into cold and warm season.*

5.3. Underlying mechanisms

Our analysis revealed preliminary evidence supporting sleep quality and thermal comfort as key underlying mechanisms for the impact of cool roof interventions on intimate partner violence (IPV). Cool roof implementation demonstrated a significant improvement in both sleep quality and thermal comfort (Table 4), highlighting their crucial roles in mediating the relationship between environmental factors and IPV.

Table 4: Mechanism Analysis

	# times woke up	# hours of sleep	Heat stress score
Treated household	-0.113*	0.039	0.166
	(0.058)	(0.047)	(0.108)
Hot season	-0.010	-0.285**	8.106***
	(0.097)	(0.129)	(0.658)
Hot season*treated	-0.005	0.155**	-2.215***
	(0.062)	(0.063)	(0.540)
House has metal roof	-0.025	-0.036	0.042
	(0.040)	(0.039)	(0.098)
Constant	1.914***	7.951***	1.937***
	(0.108)	(0.196)	(0.491)
Number of observations	2,244	2,242	2,244
R2	0.005	0.011	0.646
Adjusted R2	0.004	0.010	0.646

*Note: 01 - ***; .05 - **; .1 - *. This regression result is obtained by estimating the outcome variable (sleep quality and thermal comfort on dummy for hot season, and interaction of hot season by treatment dummy. Excluded category: village-level fixed effect.*

Conclusion

The findings of this cRCT provide evidence supporting the effectiveness of improvements in thermal comfort resulting from cool roofs interventions in reducing IPV prevalence in developing countries. These findings underscore the importance of integrating sustainable housing initiatives with IPV prevention efforts to foster safer and healthier intimate relationships in developing country contexts. The findings of this RCT have significant implications for policymakers, practitioners, and organizations working on IPV prevention in developing countries and beyond.

References

Allen, E. M., Munala, L., & Henderson, J. R. (2021). Kenyan women bearing the cost of climate change. International Journal of Environmental Research and Public Health, 18(23). https://doi.org/10.3390/ijerph182312697

Anderson, C. A. (2001). Heat and violence. Current Directions in Psychological Science, 10(1), 33–38. https://doi.org/10.1111/1467-8721.00109

Anderson, C. A., Anderson, K. B., Dorr, N., DeNeve, K. M., & Flanagan, M. (2000). Temperature and Aggression. ADVANCES IN EXPERIMENTAL SOCIAL PSYCHOLOGY, 32(January 1992), 157–179.

Anderson, C. A., Bushman, B. J., & Groom, R. W. (1997). Hot years and serious and deadly assault: Empirical tests of the heat hypothesis. Journal of Personality and Social Psychology, 73(6), 1213–1223. https://doi.org/10.1037/0022-3514.73.6.1213

Aulicie, A., & DiBartolo, L. (1995). Domestic Violence in a subtropical environment: Police calls and weather in Brisbane. International Journal of Biometeorology, 39(1), 34–39. https://doi.org/10.1007/BF01320891

Buller, A. M., Peterman, A., Ranganathan, M., Bleile, A., Hidrobo, M., & Heise, L. (2018). A mixed-method review of cash transfers and intimate partner violence in low- and middle-income countries. World Bank Research Observer, 33(2), 218–258. https://doi.org/10.1093/wbro/lky002

Cullen, C. (2020). Method Matters Underreporting of Intimate Partner Violence in Nigeria and Rwanda. http://www.worldbank.org/prwp.

Gibson, M. A., Gurmu, E., Cobo, B., Rueda, M. M., & Scott, I. M. (2022). Measuring Hidden Support for Physical Intimate Partner Violence: A List Randomization Experiment in South-Central Ethiopia. Journal of Interpersonal Violence, 37(7–8), NP4238–NP4257. https://doi.org/10.1177/0886260520914546

Henke, A., & Hsu, L. chi. (2020). The gender wage gap, weather, and intimate partner violence. Review of Economics of the Household, 18(2), 413–429. https://doi.org/10.1007/s11150-020-09483-1

Hsiang, S. M., & Burke, M. (2014). Climate, conflict, and social stability: What does the evidence say? Climatic Change, 123(1), 39–55. https://doi.org/10.1007/s10584-013-0868-3

Hsiang, S. M., Burke, M., & Miguel, E. (2013). Quantifying the influence of climate on human conflict. Science, 341(6151). https://doi.org/10.1126/science.1235367

Lépine, A., Treibich, C., & D'Exelle, B. (2020). Nothing but the truth: Consistency and efficiency of the list experiment method for the measurement of sensitive health behaviors. Social Science and Medicine, 266(August). https://doi.org/10.1016/j.socscimed.2020.113326

Mach, K. J., Kraan, C. M., Adger, W. N., Buhaug, H., Burke, M., Fearon, J. D., Field, C. B., Hendrix, C. S., Maystadt, J. F., O'Loughlin, J., Roessler, P., Scheffran, J., Schultz, K. A., & von Uexkull, N. (2019).

Climate as a risk factor for armed conflict. Nature, 571(7764), 193–197. https://doi.org/10.1038/s41586-019-1300-6

Motoki, K., Saito, T., Nouchi, R., Kawashima, R., & Sugiura, M. (2018). The paradox of warmth: Ambient warm temperature decreases preference for savory foods. Food Quality and Preference, 69(December 2017), 1–9. https://doi.org/10.1016/j.foodqual.2018.04.006

Noelke, C., McGovern, M., Corsi, D., Pescador-Jimenez, M., Stern, A., Wing, I. S., & Berkman, L. (2016). INCREASING AMBIENT TEMPERATURE REDUCES EMOTIONAL WELL-BEING.

Peterman, A., Palermo, T. M., Handa, S., & Seidenfeld, D. (2018). List randomization for soliciting experience of intimate partner violence: Application to the evaluation of Zambia's unconditional child grant program. Health Economics (United Kingdom), 27(3), 622–628. https://doi.org/10.1002/hec.3588

World Health Organization. (2018). Violence against women prevalence estimates, 2018: global, regional and national prevalence estimates for intimate partner violence against women and global and regional prevalence estimates for non-partner sexual violence against women : executive summary.

Appendix

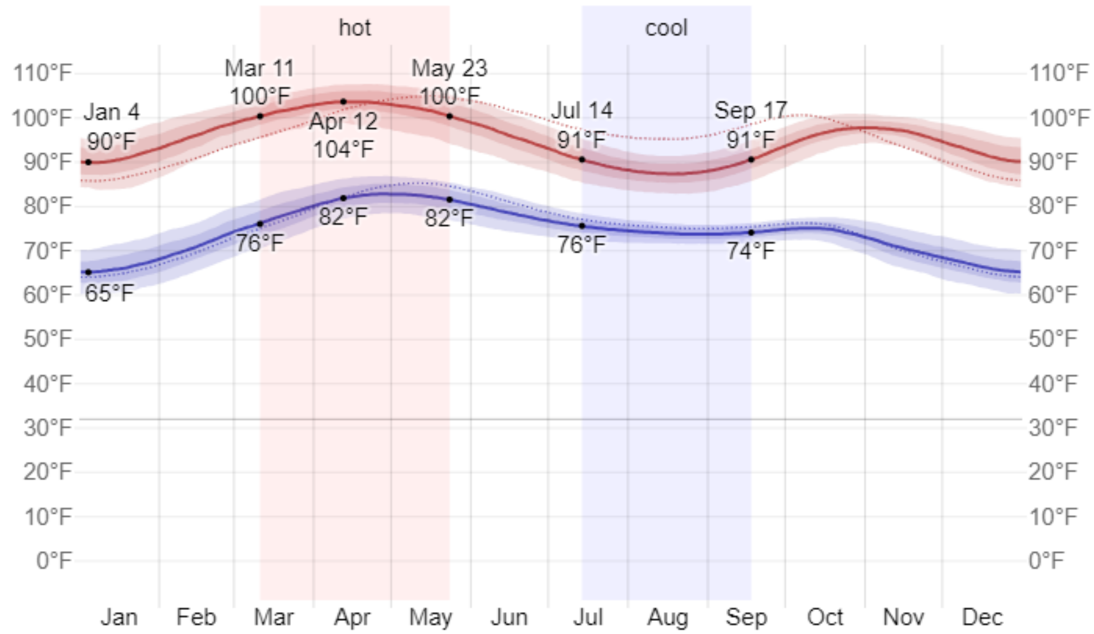


Figure A1: Seasonality in Nouna, Burkina Faso

***Source**: WeatherSpark.com. The daily average high (red line) and low (blue line) temperature, with 25th to 75th and 10th to 90th percentile bands. The thin dotted lines are the corresponding average perceived temperatures (1980-2016)*

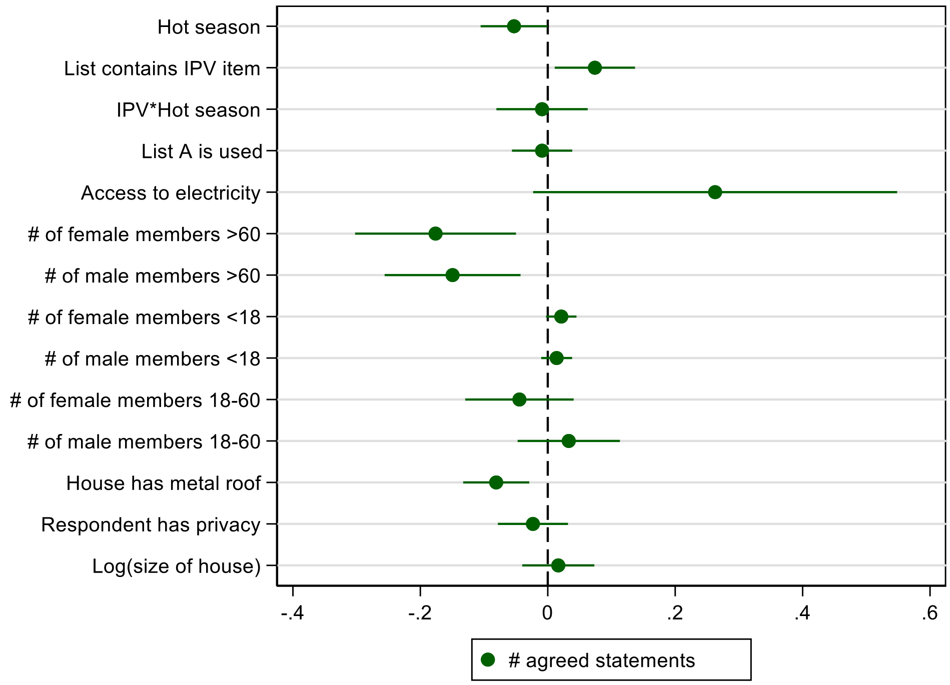


Figure A2: Regression result of prevalence of IPV, by season

Note: *Dots: coefficient from ordinary least square regressions; Bars: 95% confidence intervals; Excluded category: village-level fixed effect. This regression result is obtained by estimating equation:* $Y_i = \alpha + \beta_1 IPV_i + \beta_4 H_i + \beta_5 H_i * IPV + \beta_6 X_i + \varepsilon_i$*, where* Y_i *is the number of statements participants is agreed with;* H_i *is seasonal dummy;* X_i *is HH and location characteristics;*IPV_i *is a binary variable that indicates whether the list contains IPV item or not.*

Table A1: A double list randomization questionnaire design

<table>
<tr><th>Respondents assigned to Group 1</th><th>Respondents assigned to Group 2</th><th>Prevalence of IPV</th></tr>
<tr><td>List A</td><td>List A</td><td></td></tr>
<tr><td>1. In the last 3 months, I have taken care of a sick relative who is unable to care for themselves
2. In the last 3 months, I used contraceptives to reduce the incidence of pregnancies
3. In the last 3 months, I have been slapped, beaten or physically harmed by my husband/partner
4. In the last 3 months, I ran out of the money I needed for basic things more often than before
5. In the last 3 months, I attended the wedding celebration of a friend/relative</td><td>1. In the last 3 months, I have taken care of a sick relative who is unable to care for themselves
2. In the last 3 months, I used contraceptives to reduce the incidence of pregnancies
3. In the last 3 months, I ran out of the money I needed for basic things more often than before
4. In the last 3 months, I attended the wedding celebration of a friend/relative</td><td>In the last 3 months, I have been slapped, beaten or physically harmed by my husband/partner</td></tr>
<tr><td># of agreed statements: IPV1-list A</td><td># of agreed statements: IPV0-list A</td><td></td></tr>
<tr><td>List B</td><td>List B</td><td>Prevalence of IPV</td></tr>
<tr><td>1. In the last 3 months, I spent much more time working than I normally would have
2. In the last 3 months, I thought about having more children
3. In the last 3 months, there were more arguments in our household than there were before.
4. In the last 3 months, I felt much closer to my family than I did before</td><td>1. In the last 3 months, I spent much more time working than I normally would have
2. In the last 3 months, I thought about having more children
3. In the last 3 months, I have been slapped, beaten or physical harmed by my husband/partner
4. In the last 3 months, there were more arguments in our household than there were before
5. In the last 3 months, I felt much closer to my family than I did before</td><td>In the last 3 months, I have been slapped, beaten or physical harmed by my husband/partner</td></tr>
<tr><td># of agreed statements: IPV0-list B</td><td># of agreed statements: IPV1-list B</td><td></td></tr>
</table>