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Burning Rage: How Heat Shapes Gender-Based Violence

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Burning Rage: How Heat Shapes Gender-Based Violence

Abstract

Gender-based violence (GBV) remains a critical threat to women's safety and equality worldwide, yet the role of climate and environmental stressors in shaping violence against women remains underexplored, particularly in developed countries. This study identifies the causal impact of short-run temperature fluctuations on GBV in Italy using ten years of province-level data (2013-2022) on helpline calls and femicides and a two-way fixed effects estimation strategy. We find that higher temperatures increase both help-seeking behavior and lethal GBV. Accounting for nighttime temperatures shows that elevated minimum temperatures are particularly consequential relative to daytime heat. Heterogeneity analyses indicate that temperature effects are not uniform across provinces, with evidence of differential responses along selected dimensions related to adaptation and socio-economic context. Overall, the results highlight the relevance of considering climate-related stressors within violence prevention and social protection frameworks, even in high-income countries.

JEL classification

J12, J16, Q51, Q54

Keywords

climate change, gender-based violence, temperatures, femicide, violence prevention

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1 Introduction

Gender equality and the elimination of gender-based violence (GBV) are central global development priorities, prominently featured in the United Nations Sustainable Development Goal 5 (SDG 5) and central to the 2030 Agenda (United Nations, 2015). Despite decades of legislative reforms, international commitments, and the expansion of support services, GBV, including intimate partner violence (IPV), sexual assault, harassment, and femicide, persists as a pervasive manifestation of gender inequality and constitutes one of the most widespread human rights violations worldwide (EIGE, 2021).

The consequences of GBV extend far beyond individual suffering, generating substantial social and economic costs through impacts on health, productivity, labor market participation, public services, and long-term well-being (Ouedraogo and Stenzel, 2021; World Bank, 2022).

Italy presents a particularly pressing case. Despite its status as a high-income European nation with formal legal protections and institutional support systems, Italy continues to face high levels of GBV. Between 2017 and 2021, emergency room visits related to violence increased from 14.1 to 18.3 per 10,000 inhabitants, with women comprising the vast majority of victims (Istat, 2023a). Calls to the 1522 national helpline, a public service dedicated to supporting victims of domestic abuse and stalking, have steadily increased over the past decade, consistent with both continued victimization and increased awareness and reporting (Istat, 2023b). Femicides, the most extreme form of GBV, continue to claim lives at troubling rates. These statistics underscore the inadequacy of current interventions and the urgent need to understand the multifaceted drivers of GBV, including those that operate through environmental and climatic pathways (Allen et al., 2023).

Alongside these structural challenges rooted in persistent gender inequality, a growing body of interdisciplinary research suggests that GBV may also respond to environmental stressors, particularly those linked to climate change. This literature links high temperatures to elevated aggression, emotional dysregulation, and interpersonal violence through multiple physiological and behavioral mechanisms (Anderson, 2001; Ranson, 2014; Nguyen, 2024). These mechanisms include sleep disruption, dehydration, increased indoor confinement, and heightened irritability, all of which can escalate tensions within households and foster conditions conducive to violence (Sanz-Barbero et al., 2018; Behrer and Bolotnyy, 2024).

Empirical studies from the United States, India, and Latin America document temperature-

related increases in homicide and violent crime, especially in economically vulnerable contexts, consistent with channels such as irritability, negative affect, and mental health stress (Li et al., 2023; Mares and Moffett, 2016).

However, the existing literature on climate-induced GBV faces several important limitations. First, empirical evidence is heavily concentrated in low- and middle-income countries, where climate vulnerability, limited institutional capacity, and weak legal protections can amplify the effects of environmental stressors. Evidence from high-income settings with stronger climate-resilience infrastructure, legal protections, and support systems remains scarce. Second, the focus of prior research has been predominantly on IPV in the strict sense, often in agricultural or economically vulnerable contexts. This emphasis overlooks the wider range of GBV manifestations observed in developed economies, where violence takes diverse forms and is shaped by distinct social and institutional dynamics. Third, the mechanisms through which temperature variations translate into violence in high-income settings are still poorly understood, particularly with respect to how environmental conditions interact with social structures and institutional responses to either mitigate or intensify these effects.

In this context, the Mediterranean region, where Italy is located, is a climate change hotspot, characterized by rapid warming, more frequent and intense heatwaves, and pronounced temperature variability (IPCC, 2021). As global temperatures rise, understanding the unintended consequences of climate change, including its effects on social cohesion and interpersonal violence, becomes increasingly critical for designing effective climate adaptation and mitigation policies. Moreover, climate-related stressors may compound women's exposure to violence by interacting with persistent gender inequality, gender norms, and power imbalances. These considerations motivate a systematic assessment of whether short-run temperature shocks translate into measurable changes in violence against women in a high-income context.

This paper examines whether short-run fluctuations in ambient temperature causally affect GBV in Italy, a high-capacity institutional setting characterized by formal legal protections, established support services, and comparatively high adaptive capacity. We assemble weekly province-level data on femicides and calls to the national 1522 helpline over 2013–2022 and merge them with high-resolution meteorological records. We implement a quasi-experimental research design that exploits within-province deviations from province-specific monthly temperature normals, controlling for air pollution, other weather conditions, province-specific time trends, and common time shocks, to estimate

the effects of both unusually high and unusually low temperatures (maximum and minimum) on GBV outcomes. Because the administrative data do not permit a clean separation of IPV from other forms of domestic abuse and stalking, we adopt a broad GBV definition; this choice allows us to capture shifts in help-seeking behavior and lethal violence in tandem, thereby extending the empirical scope beyond IPV-only measures that dominate prior work.

Our contribution is threefold: (i) we provide evidence from a highly institutionalized European country where adaptive capacity may attenuate climate-related harms; (ii) we measure GBV using two complementary administrative outcomes, helpline calls and femicides, that capture distinct margins of violence; and (iii) we assess asymmetries across the temperature distribution while documenting heterogeneity by environmental exposure, socioeconomic conditions, and local gender norms.

We find that higher temperatures, particularly elevated nighttime heat, are associated with increases in both help-seeking behavior (calls to the 1522 helpline) and lethal violence (femicides). These effects are robust across alternative specifications and persist when excluding the COVID-19 lockdown period. Calls to the helpline respond only to contemporaneous temperature, whereas femicides show evidence consistent with acclimation, with temperature effects attenuating when extreme heat persists over consecutive weeks.

Linear heterogeneity analyses indicate that the temperature response differs across provinces along a limited set of dimensions. In particular, femicides exhibit a significantly stronger temperature sensitivity in provinces with higher residential air-conditioning penetration, while helpline calls show a relatively stronger response in provinces with lower shares of tertiary-educated individuals. For the remaining dimensions considered, linear temperature effects do not differ significantly across groups.

The remainder of the paper is organized as follows. Section 2 reviews the literature on temperature, climate change, and GBV, with particular attention to mechanisms and the distinction between GBV and IPV. Section 3 describes the data sources and empirical strategy. Section 4 presents the main results and robustness analyses. Section 5 concludes and discusses policy implications.

2 Literature Review

A large interdisciplinary literature documents that climate and environmental conditions shape human behavior and violent crime. Elevated temperatures are consistently associated with increases in aggression, assaults, and homicides across a wide range of contexts, as shown by recent systematic reviews and meta-analyses (Corcoran and Zahnow, 2022; Choi et al., 2024; Mišák, 2024; Zhao et al., 2024). While the temperature-violence relationship appears robust, estimated effects vary substantially with socioeconomic conditions, institutional capacity, and local environments.

Beyond the role of temperature, other environmental stressors, including precipitation, extreme weather events, and air pollution, have been shown to affect violent behavior by altering routine activities, physiological stress, and emotional regulation (Miles-Novelo and Anderson, 2019; Herrnstadt et al., 2021). This body of work establishes a general link between environmental stress and violence, but it is largely gender-neutral.

A large empirical literature focuses more specifically on the relationship between temperature and violent crime. Evidence from the United States documents significant increases in violent and gun-related offenses on hotter days, with particularly pronounced effects in economically disadvantaged areas (Michel et al., 2016; Berman et al., 2020). Cross-country and global analyses confirm that temperature extremes exacerbate violent behavior, especially in regions characterized by economic instability and weaker institutional capacity (Li et al., 2023).

More recent contributions move beyond correlational evidence by examining heterogeneity and mechanisms, highlighting the role of local economic conditions, urban structure, and institutional responses in shaping the temperature-crime relationship (Blakeslee et al., 2021; Cohen and Gonzalez, 2024). Despite these advances, this literature has largely focused elsewhere, paying limited attention to GBV and highly institutionalized, high-income settings.

A growing body of research explicitly examines how climate conditions affect IPV. Seminal evidence shows that heatwaves increase IPV risk (Sanz-Barbero et al., 2018), with subsequent studies documenting similar effects for rainfall variability, droughts, and other climate shocks (Le and Nguyen, 2024; Rizzotto et al., 2025).

Proposed mechanisms include psychological responses to heat, such as irritability and aggression (Anderson et al., 2000), as well as economic stress induced by climate shocks that disrupt income and employment, loss of control (proxied by alcohol use) and worse

labor market outcomes(Epstein et al., 2020; Díaz and Saldarriaga, 2023; Nguyen, 2024).

Climate stressors may also alter daily routines, increasing exposure to potential abusers (Schinasi and Hamra, 2017; Cools et al., 2020). These effects are often amplified in contexts characterized by weak institutions and entrenched gender inequality (UN Women and DESA, 2025).

While the IPV literature has expanded rapidly, broader forms of GBV remain comparatively understudied. Recent scoping reviews highlight fragmented empirical evidence linking climate change to sexual violence, harassment, and other non-partner forms of violence against women (Agrawal et al., 2023; Mulambo et al., 2025).

Conceptual and policy-oriented research increasingly frames climate change as a "threat multiplier" that intensifies existing gender inequalities and socioeconomic stressors, thereby increasing women's exposure to multiple forms of GBV (Desai and Mandal, 2021; Mandal, 2023). Empirical analyses that move beyond IPV are therefore essential, particularly in high-income contexts with strong legal protections and support systems.

Finally, while most studies focus on heat exposure, there is some indication that cold temperatures may also influence violent behavior. Research indicates that both hot and cold extremes can disrupt emotional regulation and mental health, providing plausible behavioral pathways linking temperature variability to violence (Prudkov and Rodina, 2019; Chen et al., 2023).

Accounting for both ends of the temperature distribution is thus important for understanding the full range of climate-related violence risks. By examining the effects of both unusually high and unusually low temperatures on GBV in Italy, this study contributes to a more comprehensive assessment of how temperature variation shapes violence against women through its interaction with mental health, daily routines, and institutional contexts.

3 Method

3.1 Data and sample

To measure the intensity of GBV, we used two different data sources. First, we exploited data gathered by the Italian National Institute of Statistics (Istat), consisting of weekly counts of calls to the 1522 helpline for each province from the beginning of 2013 until

the end of 2022.[1] The 1522 helpline,[2] a public service initiated by the Presidency of the Council – Department for Equal Opportunities in 2006, operates around the clock and is available at no cost. This service provides specialized professionals offering assistance and support to victims of violence and stalking.

Calls are distinguished between those made by victims, defined as individuals who personally experienced some form of intra- or extra-family GBV, and those made by non-victims, defined as callers who witnessed GBV or sought information or support related to GBV or stalking. For our empirical analyses, we exclusively use calls made by victims to the 1522 helpline. The dataset contains only calls classified as consistent with the nature of the service provided. Although 1522 operators collect socio-demographic information on callers and information on the call, such as the reason for the call, the type of violence, and the location, Istat does not release data at province-by-week level further disaggregated by these characteristics to protect the privacy of the individuals involved.[3]

Analyzing the impact of temperature only on calls to the 1522 helpline may provide a limited and potentially biased view of the causal relationship between temperature and GBV. Indeed, extreme heat could have behavioral consequences that go beyond increased aggressiveness, emotional dysregulation, and interpersonal violence. For example, it may also affect reporting behavior in an ambiguous way. On the one hand, extreme heat may discourage victims from reporting due to fatigue and reduced mobility during heatwaves, leading to under-reporting that masks the true effect on violence. On the other hand, heat may facilitate reporting if, for example, women spend more time online at home and become more aware of GBV campaigns and helpline services. Distinguishing between a genuine impact of heat on GBV and changes in reporting behavior using helpline calls alone is therefore a challenging identification issue.

The second data source aims to overcome this limitation. We extracted femicide data for Italy from the annual reports written and published by "Casa delle Donne",[4] an asso-

[1]The 1522 helpline dataset can be downloaded from the Istat webpage: https://www.istat.it/notizia/il-numero-di-pubblica-utilita-1522-anni-2013-2024 (last accessed January 9, 2026). At the time of conducting the empirical analysis and writing the paper, the dataset covered the period 2013–2022.

[2]See https://www.1522.eu/?lang=en (last accessed January 9, 2026).

[3]In November 2023, we requested weekly counts of 1522 calls at the province level disaggregated by socio-demographic characteristics and type of violence but the Istat contact center denied our request due to a privacy protection issue concerning the individuals involved. In October 2024, we requested invalid 1522 calls; also this request was denied.

[4]These reports can be downloaded from https://femicidiocasadonne.wordpress.com/ricerche-pubblicazioni (last accessed January 9, 2026).

ciation that offers help and support to women who have been threatened or subjected to violence. Each annual report provides a comprehensive list of femicides occurring in Italy during the respective year. For each victim, the report includes the date, municipality, and province of the incident, along with individual details such as the woman's age and the weapon used in the crime. Because the data on calls to the 1522 helpline are available at the weekly and provincial level for the period 2013–2022, we aggregated femicide data to the same temporal and geographical resolution. Unlike helpline calls, femicides are observable events that cannot easily go unreported, as deaths are verifiable and formally recorded events. As a result, femicide counts are largely independent of victim reporting behavior.

We merged these datasets with meteorological data from the Copernicus Programme, the European Union's Earth Observation initiative. Specifically, we used the E-OBS dataset, which provides daily gridded land-only observational data for Europe.[5] We downloaded meteorological variables including precipitation, wind speed, relative humidity, and daily temperature (average, maximum, and minimum) measured at two meters above ground level, with a horizontal grid resolution of $0.25° \times 0.25°$ (about 28 square kilometers). These data cover the period from January 1, 2013, to December 31, 2022. Within the same time frame, we also obtained daily data from the Copernicus Atmosphere Monitoring Service global greenhouse gas reanalysis (EGG4) (Inness et al., 2019). This dataset provides measurements of particulate matter with a diameter of less than 2.5 micrometers ($PM_{2.5}$) and ozone (O_3), with a horizontal resolution of $0.75° \times 0.75°$. These air pollution variables are included as controls because they may be correlated with meteorological conditions, such as temperature (Liu et al., 2020), and with violent or criminal activities, as air pollution may affect the central nervous system through mechanisms involving ultrafine toxicants or inflammatory responses (Xu et al., 2013).

We matched weekly data on 1522 helpline calls and femicides with daily meteorological and atmospheric data by first aggregating daily weather variables to weekly averages and then spatially assigning them to provinces using the latitude and longitude of the provincial capital. Consequently, as in Filomena and Picchio (2024), we used meteorological conditions within the $0.25° \times 0.25°$ latitude-longitude grid encompassing the provincial capital to approximate the conditions for the entire province.[6] This approach

[5] For more details, see https://cds.climate.copernicus.eu/datasets/insitu-gridded-observations-europe?tab=overview (last accessed January 9, 2026).

[6] The average surface area of Italian provinces is approximately 2,800 square kilometers. This range

may introduce a measurement error, potentially biasing estimated effects toward zero. However, this concern is mitigated by two factors. First, population distribution within provinces is highly uneven, with residents disproportionately concentrated in provincial capitals. Although provincial capitals account for only 6.8% of Italy's land area, they are home to approximately 30% the population.[7] Second, our identification strategy relies on deviations of weekly average temperature from the monthly average temperature for the same province. Such short-term deviations are likely to be more evenly distributed across a province compared to weekly temperature variations because of the strong spatial correlation of climatic events.

The final dataset includes 109 provinces, excluding Brindisi due to incomplete wind speed data.[8] The observations period covers up to 522 weeks from 2013 to 2022, yelding a total of 55,905 province-week observations. For a subset of provinces (i.e. Agrigento, Caltanissetta, Catania, Catanzaro, Enna, Messina, Palermo, Ragusa, Reggio Calabria, Siracusa, Trapani, and Vibo Valentia) meteorological information is missing for some weeks. Consequently, these provinces contribute between 411 and 492 weekly observations instead of the full 522.

Table A.1 in the appendix displays the summary statistics of the outcome variables and the set of covariates, both meteorological and atmospheric, used in the empirical analysis. The average number of victim weekly calls to the 1522 helpline is about 0.32 per 100,000 inhabitants. The average number of femicides in a province per week is 0.044. The number of femicides is a count variable, extremely skewed to the right, with a very large proportion of zeros (98.1%), 1.8% of the observations (991 cases) with one femicide and the remaining 1.1% (59 observations) with two of more femicides in a week.[9] The weekly average of the maximum temperature is 19.7°C, ranging from -8°C to almost 40°C. The weekly average of the minimum temperature is about 10°C lower. [10]

Figure 1 presents the unconditional relationship between maximum temperatures and

includes provinces that exceed 7,000 square kilometers, such as Sassari and Bolzano, as well as those that are smaller than 400 square kilometers, such as Prato and Trieste.

[7] These figures pertain to 2015 and are sourced from the Atlante Statistico dei Comuni (Istat, https://asc.istat.it/ASC/asc.html, last accessed January 9, 2026).

[8] Italy had 110 provinces from 2005 until 2016, when the number was reduced to 107.

[9] After weighting by provincial population, the proportion of zeros is 96%, the proportion of observations with one femicide is 3.7% and the one with two of more femicides is 0.3%.

[10] Figure A.1 in the appendix visualizes the differences between provinces in the calls of victims to the 1522 helpline, femicides, and the maximum temperature, after averaging across weeks from the beginning of 2013 to the end of 2022.

1522 helpline calls when callers are victims (panel a) or femicides (panel b). These graphs show the smoothed values of kernel-weighted local first-order polynomial regression of our GBV outcomes on the weekly average of the daily maximum temperatures. There is a marked increase in victim call rates as temperatures rise to approximately 10°C. Beyond this point, the relationship becomes negligible until 27°C, after which victim calls begin to rise again, although at a modest rate. In the case of femicides (panel b of Figure 1), the upward trend is more pronounced, particularly above 30°C, where the increase becomes notably steep.

To establish a credible identification of the causal impact of temperatures on GBV, as measured by either the number of calls to the 1522 helpline or incidents of femicide, we estimated regression models conditioned on the covariates listed in Table A.1. Additionally, we incorporated fixed effects (FE) at the month-year-province level and at the sequential week level to mitigate potential omitted variable bias. Moreover, by including month-year-province FE, we exploit the deviation of the weekly average temperature from the monthly average in a given province as plausibly exogenous identifying information, conditional on a common time trend, captured by the sequential week FE, and the meteorological and air quality variables reported in Table A.1.

3.2 Empirical strategy

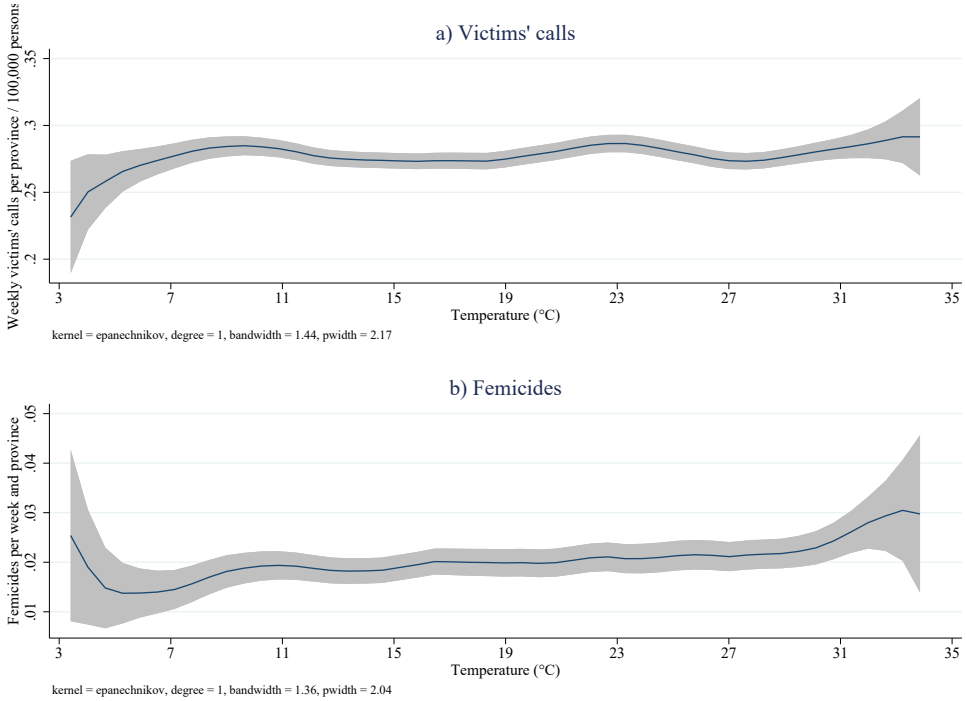
Recent years have seen a rapid expansion in empirical research utilizing non-experimental data to examine the influence of weather conditions on economic outcomes (Dell et al., 2014). In this context, a robust method for identifying causal effects relies on longitudinal high-frequency data and the short-term temporal variation of weather conditions within a specific spatial unit. By exploiting this presumably exogenous short-term variation in weather variables, it becomes feasible to determine the impact of temperature on outcomes such as GBV.

When the outcome variable y_{it} is the weekly number of victim calls to the 1522 helpline per 100,000 inhabitants, we estimate the following linear model:

$$y_{it} = f(temp_{it}; \boldsymbol{\beta}) + \boldsymbol{\alpha}\mathbf{x}_{it} + \delta_t + \gamma_{im} + \varepsilon_{it}, \tag{1}$$

where $i = 1, \ldots, 109$ indexes the 109 provinces and $t = 1, \ldots, 522$ refers to the different sequential weeks in our observed time window spanning from January 2013 until Decem-

Figure 1: Kernel-weighted local polynomial smoothing of the relation between GBV outcomes and weekly average of daily maximum temperatures



Notes: This figure is obtained using 54,786 observations: from the original 55,905 observations we excluded the first and last percentiles of the weekly maximum temperatures, which correspond to 3.4°C and 33.9°C, respectively. The gray area shows the 95% confidence interval.

ber 2022; δ_t is the sequential-week FE; γ_{im} is the month-year-province FE; $f(temp_{it}; \boldsymbol{\beta})$ is a step function of the weekly average temperature and $\boldsymbol{\beta}$ is the parameter vector associated with the linear combination of indicators of temperature intervals; $\mathbf{x}_{it}$ is a $1 \times K$ vector of other weather and air quality characteristics which are likely to be correlated with both temperatures and to aggressiveness and therefore GBV. finally, ε_{it} is the idiosyncratic error term. When the outcome variable y_{it} is the number of femicides in province i in week t, given the count nature of this variable, we took the exponential of the right-hand side of Equation (1), resulting in the Poisson regression model which is estimated by pseudo-maximum likelihood. We weighted each regression by the provincial population registered at the beginning of the year of the observation.

Sequential-week FE, denoted as δ_t, controls for weekly shocks common at the national level. Hence, it flexibly captures the national trend in GBV over time. It removes from estimates the fact that GBV may vary over particular weeks of the year, different months of the year, and different years. The scientific literature suggests that GBV exhibits seasonal patterns (Landau and Fridman, 1993). For example, the sequential-week FE accounts for the increase in domestic violence during major holidays (Cohn, 1993) or during big sporting events (Forsdike et al., 2022), which occur at particular times of the year and therefore are correlated with particular weather conditions.

The month-year-province FE, denoted as γ_{im}, accounts for potential variations in GBV that could arise from changes in local labor market conditions and the business cycle. More specifically, it allows us to base our identification strategy on the exogeneity of weekly temperature deviations relative to the average temperature in the same month and province.

To avoid imposing stringent parametric constraints on $f(temp_{it}; \boldsymbol{\beta})$, we employed a step function to describe the relationship between weekly average maximum temperatures and 1522 helpline calls. We partitioned the range of weekly average maximum temperatures into bins of equal size, each spanning two degrees Celsius. The first bin captures maximum temperatures below 4°C, while the last bin includes maximum temperatures above 30°C. We selected the bin $(6, 8]$°C as a reference category and excluded its corresponding indicator variable from the regressors in Equation (1).[11]

Finally, the idiosyncratic error term may exhibit correlation within both sequential weeks t and province i. The correlation across sequential weeks may arise from anomalous weather events, such as heatwaves or cold spells, which tend to affect large areas

[11] This normalization does not affect the generality of the results.

and create spatial correlation among observations from different provinces during those weeks. Furthermore, as our climate-gridded dataset was derived using spatial interpolation from station data, it is very likely to be characterized by spatial correlation in temperature shocks (Hsiang, 2016). Concerning the correlation within provinces, each area has unique characteristics related to geography, climate, social norms, labor market conditions and the business cycle. Consequently, observations may not be independent over time within a given province. To account for this, we conduct inference using the two-way cluster variance estimator proposed by Cameron et al. (2011), clustering at both the provincial and sequential month levels.[12] This estimator of the variance-covariance matrix is robust to heteroskedasticity, serial correlation within provinces, and cross-sectional spatial correlation.

4 Results

4.1 Main results

Figure 2 reports our main findings. It displays the estimated coefficients of each temperature bin, using the 6–8°C range as the reference category. The full set of estimation results is reported in Table 1. Heat affects victim calls and femicides in a similar manner: as temperatures rise, both the victim call rate and the number of femicides show an increasing pattern. When weekly maximum temperatures exceed 28°C, the call rate peaks, reaching values 0.057–0.063 points higher than that at 6–8°C, corresponding to an increase of approximately 19–21% relative to the reference temperature of 6–8°C (0.307).[13] When average maximum temperatures exceed 30°C, the expected number of femicides is nearly 300% higher than at 6–8°C.

The policy relevance of our findings in the context of climate change depends on whether individuals can acclimate to changing weather conditions, or whether temperature effects accumulate with prolonged exposure(Kahn, 2016). To assess whether the

[12]We had 109 provinces and 120 sequential months, providing a sufficiently large number of clusters in both dimensions. We run a sensitivity analysis to check if inference would change by either clustering at the sequential week level or by not addressing the concern of spatial correlation at all, i.e. by not clustering observations at whatever time unit. This robustness check is discussed in Subsection 4.5.

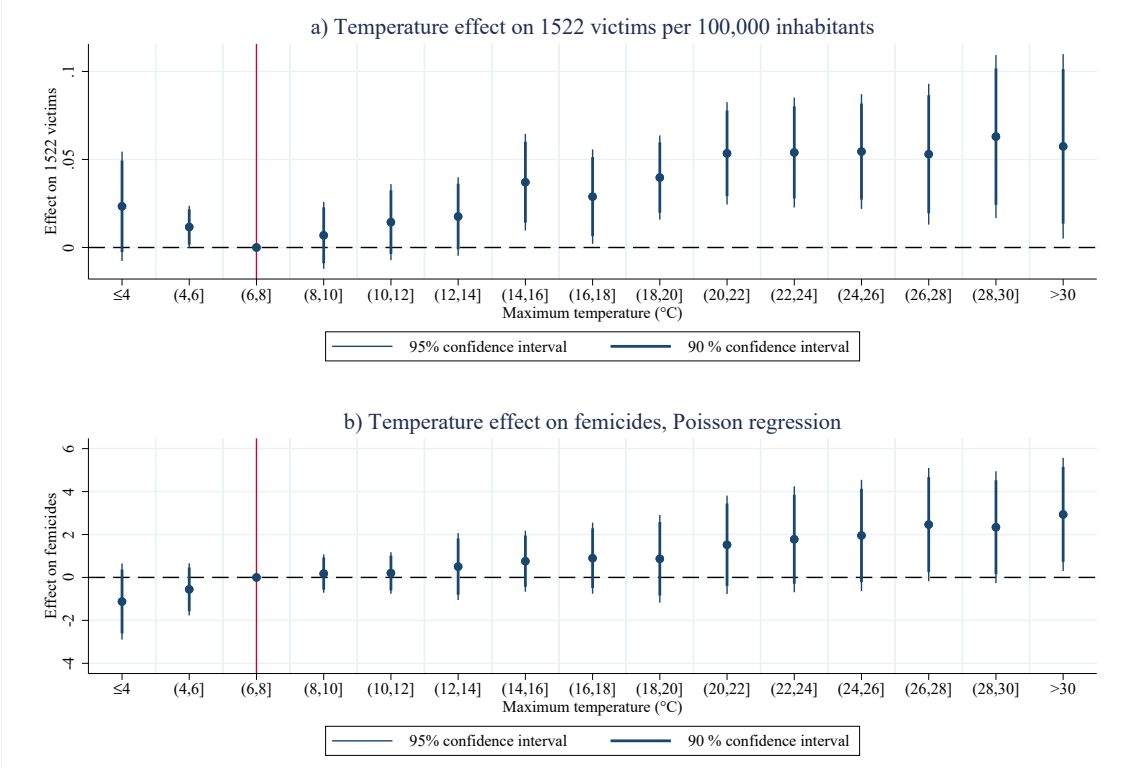
[13]The victim call rate becomes significantly higher than that at the reference temperature bin already at 14–16°C. Since these figures represent weekly averages of maximum temperatures, this result may reflect a few particularly hot days within the week and thus explain why an effect is already observed at temperatures that, on average, are not yet extremely high.

Table 1: Estimation of GBV equation

Outcome:	Victims' calls per 100,000 inhabitants	Femicides
Regression model:	Two-way FE	Poisson pseudo-likelihood
	(1)	(2)
Weekly average of maximum daily temperature - Reference: $(6, 8]°C$		
$< 4°$C	0.0234	−1.1220
	(0.0157)	(0.9045)
$(4, 6]°$C	0.0116*	−0.5559
	(0.0061)	(0.6192)
$(8, 10]°$C	0.0069	0.1796
	(0.0096)	(0.4550)
$(10, 12]°$C	0.0144	0.2047
	(0.0109)	(0.4939)
$(12, 14]°$C	0.0176	0.5056
	(0.0112)	(0.7957)
$(14, 16]°$C	0.0371***	0.7565
	(0.0139)	(0.7251)
$(16, 18]°$C	0.0289**	0.8973
	(0.0135)	(0.8442)
$(18, 20]°$C	0.0398***	0.8671
	(0.0121)	(1.0414)
$(20, 22]°$C	0.0535***	1.5214
	(0.0147)	(1.1694)
$(22, 24]°$C	0.0540***	1.7767
	(0.0158)	(1.2598)
$(24, 26]°$C	0.0545***	1.9542
	(0.0164)	(1.3227)
$(26, 28]°$C	0.0530***	2.4626*
	(0.0202)	(1.3455)
$(28, 30]°$C	0.0630***	2.3382*
	(0.0234)	(1.3301)
$> 30°$C	0.0574**	2.9346**
	(0.0264)	(1.3453)
Wind speed (m/s)	0.0040	−0.4428**
	(0.0032)	(0.2106)
Precipitation (mm/m^2)	0.0001	0.0239
	(0.0006)	(0.0346)
$PM_{2.5}$	0.8467	14.1095
	(0.5150)	(21.4562)
Ozone (mg/kg)	0.2062	−15.9467
	(0.3854)	(18.4229)
# of observations	55,896	3,825
# of months	120	120
# of provinces	109	105
Adj. R-Square / Pseudo R-Square	0.4828	0.1531
Joint significance test H_0: $\boldsymbol{\beta} = \mathbf{0}$, p-value	0.0050	0.0618

Notes: * p-value$<$0.10, ** p-value$<$0.05, *** p-value$<$0.01. Two-way clustered standard errors are in parenthesis; clusters are at the level of sequential months and of provinces. Each regression includes sequential week FE and month-year-province FE and is weighted by the provincial population during the year of the observation. The number of observations is lower than what shown in Table A.1 because: in column (1) 9 observations were singleton observations; in column (2) 52,080 observations were singletons or separated by a fixed effect. Separated observations, e.g. perfectly predicted observations after conditioning on high dimensional fixed effects, do not offer information about the parameters with interior solutions and can be safely dropped when searching the maximum of the pseudo-likelihood function (Correia et al., 2020, 2021).

Figure 2: Effect of weekly average maximum temperature on weekly calls to 1522 helpline by victims (graph a) and on femicides (graph b)



Notes: The vertical lines indicate the reference category $(6, 8]$°C, whose coefficient is normalized to zero. Each regression is weighted by the provincial population of the year of the observation. The average of victims' helpline calls per 100,000 inhabitants is 0.307 at 6–8°C. Confidence intervals are derived from two-way clustered standard errors, with clusters at the level of sequential months and of provinces.

relationship between temperature and GBV accumulates over time, we examine the sensitivity of GBV to temperatures observed in the previous week, following the approach of Helo Sarmiento (2023) and Filomena and Picchio (2024).

Figure 3 presents both contemporaneous and lagged temperature effects on GBV and provides little evidence of accumulation over time. Graph (a) shows that calls to the helpline respond only to contemporaneous temperatures conditions with no detectable delayed effect from temperatures in the preceding week. Graph (b) is consistent with the acclimation hypothesis, as the estimated temperature effect appears attenuated when extremely high temperatures persist for two consecutive weeks. However, the attenuation of the effect at very high temperatures in the lagged specification may partly reflect the rarity and non-recurrent nature of femicides. If extreme heat in one week trigger incidents in a given area, the pool of potential cases in the following week, often under similarly warm conditions, may be mechanically reduced, generating a negative serial correlation in the data rather than a true lagged temperature effect.

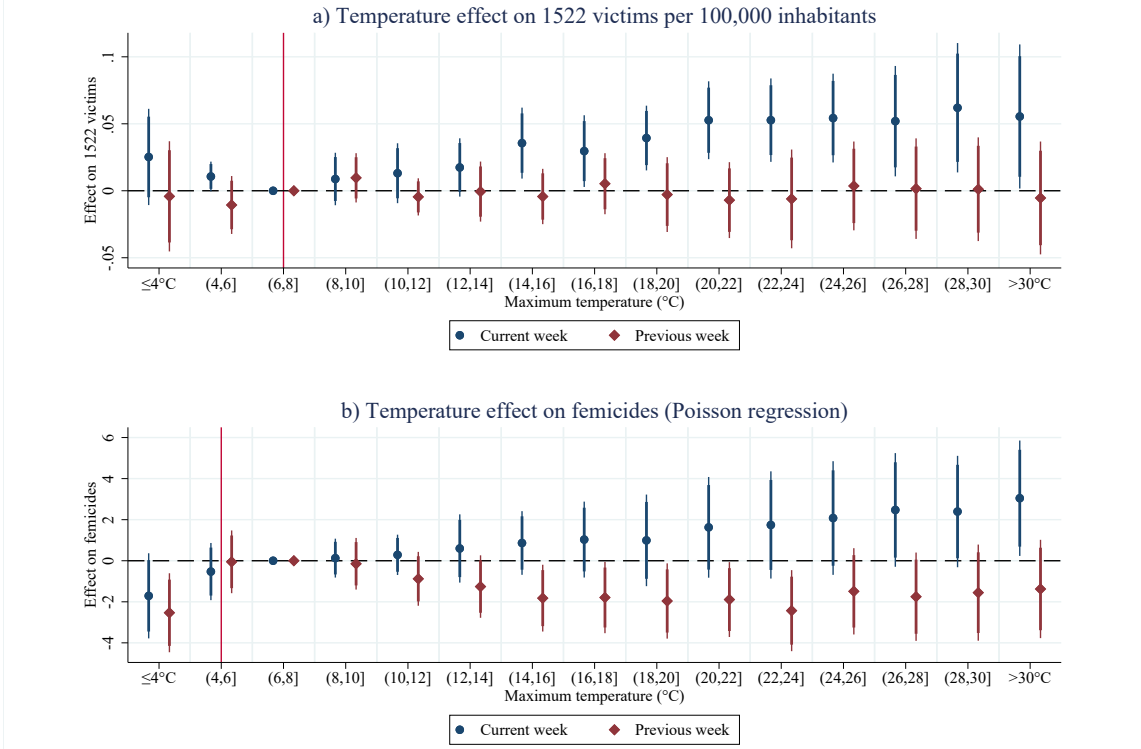
4.2 Can sleep quality trigger violence?

Exposure to excessive heat can alter cognitive performance and trigger physiological responses that promote intolerance and aggression (Corcoran and Zahnow, 2022). However, this direct impact is not the sole concern. Indirect effects may also occur due to poor sleep quality, as elevated temperatures are known to disrupt sleep (Mullins and White, 2019), which can subsequently increase aggression (Anderson et al., 2000).

To isolate and provide evidence for the indirect effects of nighttime temperatures, distinct from those driven by daytime conditions, we modified the baseline model. Specifically, we included bins for weekly average *minimum* temperatures, in addition to bins for weekly average maximum temperatures.[14] Minimum temperatures serve as a proxy for overnight conditions, as they are typically recorded in the early morning hours, while maximum temperatures represent daytime conditions, because they are generally observed in the early afternoon. Figures 4 and 5 show the effect of minimum and maximum temperatures when both are jointly included in the model specification, for victim call rates and femicides, respectively. In each figure, panel (a) displays the estimated effects

[14]The bins for minimum temperatures are defined differently, with all values shifted 6°C lower to ensure an adequate number of observations in each bin. Consequently, the lowest bin includes weekly average minimum temperatures below −2°C, while the highest bin captures those above 24°C (the reference category is 0–2°C).

Figure 3: Contemporaneous and lagged temperature effects



Notes: The vertical lines indicate the reference category $(6, 8]$°C, whose coefficient is normalized to zero. Each regression is weighted by the provincial population of the year of the observation. The average of victims' helpline calls per 100,000 inhabitants is 0.307 at 6–8°C. Confidence intervals are derived from two-way clustered standard errors, with clusters at the level of sequential months and of provinces.

of maximum temperatures, while panel (b) presents the effect of minimum temperatures. We find that minimum temperatures play a relevant role in affecting victim call rates and femicides outcomes. When the weekly average of minimum temperatures is above 24°C, the victim call rate is 0.096 points higher than that with a weekly average minimum temperature of 0–2°C, corresponding to approximately 31% of the average at the reference (0.313). over the same range, the expected number of femicides is roughly 390% higher than at the reference temperature of 0–2°C. Altogether, these findings, along with evidence that the incorporation of minimum temperatures decreases the effect of high maximum temperatures, suggest that elevated nighttime temperatures exert a greater influence on GBV than hot daytime temperatures.

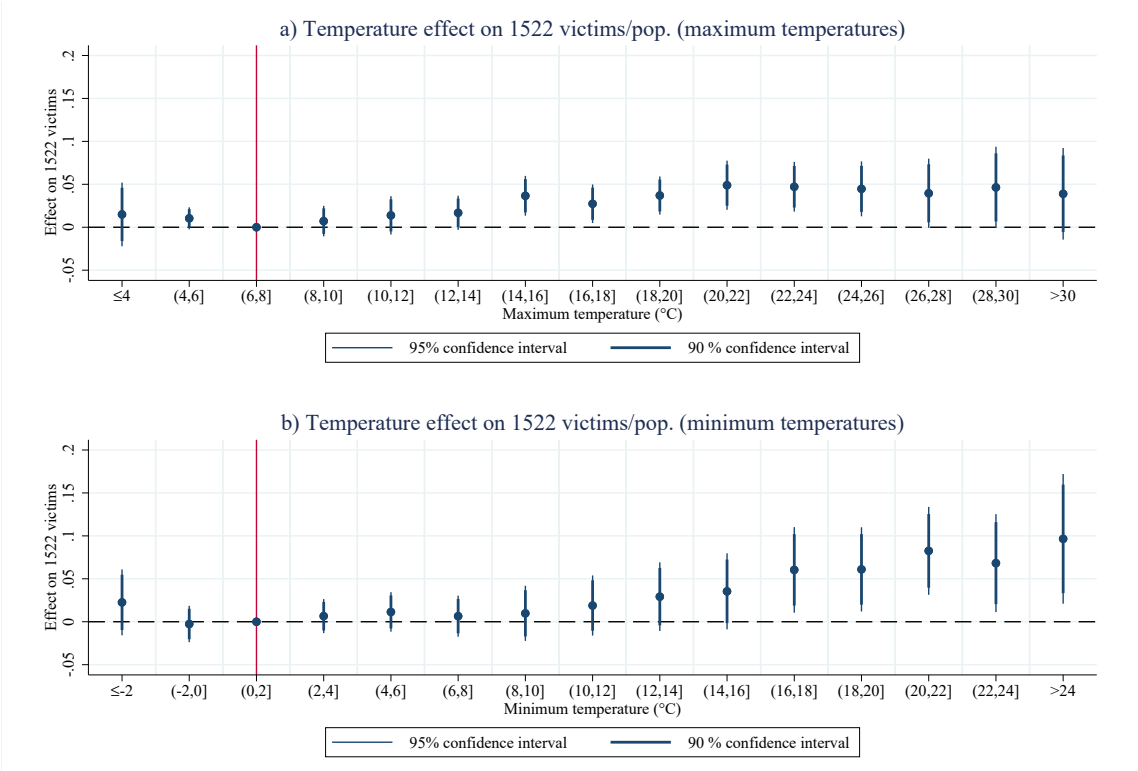
A possible explanation of this phenomenon is that elevated nighttime temperatures negatively affect sleep quality, leading to increased irritability, frustration and aggression and, therefore, to an amplification of the likelihood of triggering violence against women. However, there are other possible explanations. For example, with warmer nighttime temperatures, women may stay out later for social and economic activities that extend into the night. This may increase the likelihood of being exposed to less secure areas, where the risk of violence and harassment is greater.

4.3 Average heat, heat variability or extreme events?

Our baseline specification focuses on the effect of average weekly maximum temperature, and we find that its impact on GBV is strong and almost linear. However, temperature can influence human behavior through multiple channels. Average weekly heat reflects sustained exposure to warm conditions, which may affect mood, stress levels, sleep patterns, and social interactions over several days. In contrast, short-term fluctuations in temperature within a week or brief periods of extreme heat may trigger more acute physiological or behavioral responses. Distinguishing among these dimensions has direct policy relevance: if violence response primarily to average heat, the implications concern long-run adaptation to a warmer climate; if it rises mainly during heat waves, policy attention should instead focus on early-warning systems and short-term preventive interventions.

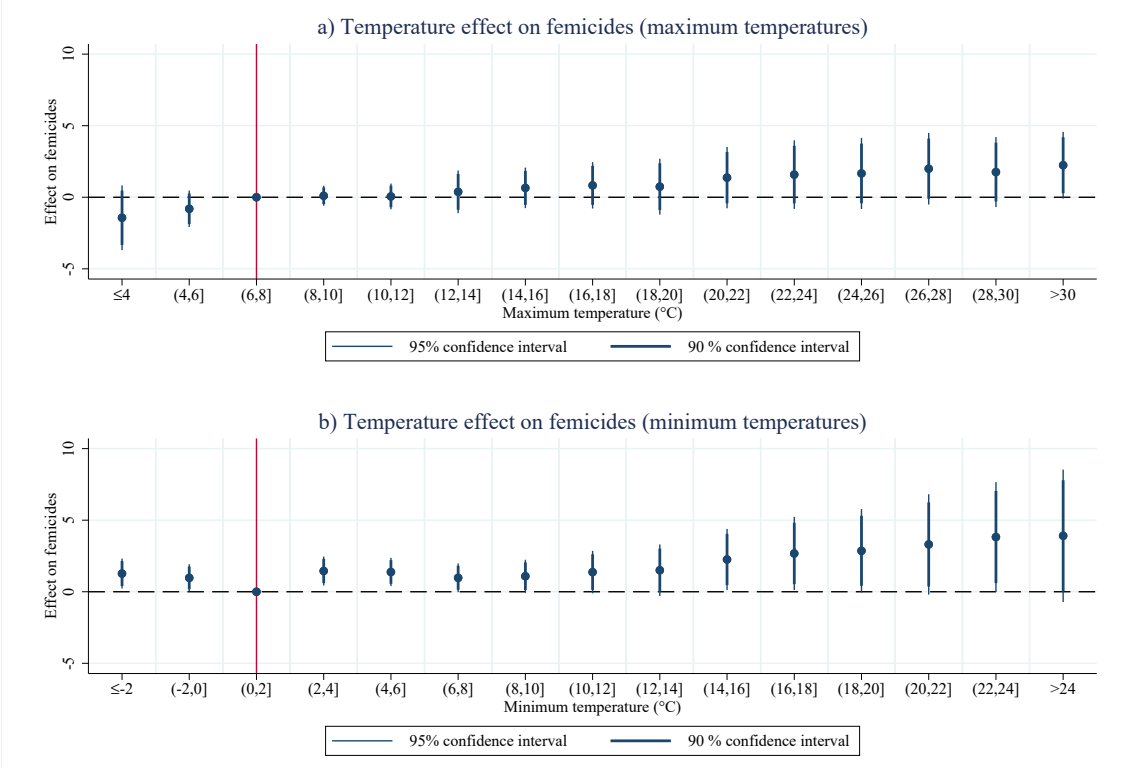
To explore whether the effect of temperature is driven by sustained heat exposure or by short-term thermal shocks, we extend the baseline model by including, in a linear specification, three distinct temperature dimensions: (i) the average weekly maximum temperature; (ii) a measure of intra-week variability, captured either by the standard devi-

Figure 4: Effect of weekly average maximum and minimum temperature on victims' weekly calls to 1522 helpline



Notes: The vertical lines indicate the reference category, $(6, 8]$°C for maximum temperatures and $(0, 2]$°C for minimum temperatures, whose coefficient are normalized to zero. Each regression is weighted by the provincial population of the year of the observation. The average of the dependent variable, weekly 1522 helpline calls by victims per 100,000 inhabitants, at the reference bin for each graph is as follows: a) 0.307; b) 0.313. Confidence intervals are derived from two-way clustered standard errors, with clusters at the level of sequential months and of provinces.

Figure 5: Effect of weekly average maximum and minimum temperature on femicides (Poisson regression)



Notes: The vertical lines indicate the reference category, $(6, 8]$°C for maximum temperatures and $(0, 2]$°C for minimum temperatures, whose coefficient are normalized to zero. Each regression is weighted by the provincial population of the year of the observation. Confidence intervals are derived from two-way clustered standard errors, with clusters at the level of sequential months and of provinces.

ation of daily maximum temperatures or by their weekly maximum-minimum range; and (iii) a measure of extreme heat events, defined either as a dummy equal to one if the week includes three or more consecutive days above the provincial 95th percentile of maximum temperature, or as the total number of such extreme days in each week. This approach allows us to assess whether GBV responds primarily to average warmth or to transient episodes of extreme heat.

Table 2 reports the estimated effects. Column (1) shows the linear effect of a one-degree Celsius increase in the weekly average of daily maximum temperatures, without controlling for measures of intra-week variability or extreme heat events. A one-degree increase significantly raises the victim call rate by 0.003 points and femicides by 17%. Including measures of intra-week variability (the weekly standard deviation or the weekly range of daily maximum temperatures) or of extreme heat events (the number of extreme days, defined as days above the 95th percentile of the province-specific distribution of daily maximum temperatures, or a dummy for three consecutive extreme days in a week) does not alter this linear effect. Moreover, across all model specifications, none of the coefficients associated with intra-week variability or extreme heat measures are statistically significant once average heat is controlled for. These results suggest that GBV in Italy responds to sustained exposure to higher ambient temperatures rather than to short-lived extreme heat events.

4.4 Effect heterogeneity

We examine effect heterogeneity in the estimated linear temperature response by re-estimating the baseline specification separately for provinces above and below the median of seven contextual characteristics:[15] geographical location (North vs. Center-South), residential air-conditioning (AC) penetration, unemployment, tertiary education attainment, immigrant share, prevailing gender norms, and the availability of anti-violence centers (AVC).

Table C.1 in the appendix summarizes pairwise correlations among the split variables. The geographical partition is correlated with several socio-economic characteristics: Northern provinces tend to feature lower unemployment, higher immigrant shares, and less traditional gender norms. Unemployment is also correlated with both the im-

[15] Given the rarity of femicides and the demanding nature of the empirical specification, a finer partition of the sample would substantially reduce statistical power.

Table 2: Linear effect of weekly average temperature, weekly intra-variability of temperature and extreme heat events

	(1)	(2)	(3)	(4)	(5)
a) Weekly victims' calls per 100,000 inhabitants					
Weekly average maximum temperature	0.003**	0.003**	0.003**	0.003**	0.003**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Weekly standard deviation of daily maximum temperatures	–	−0.002	–	−0.002	–
		(0.002)		(0.002)	
Weekly maximum-minimum range of daily maximum temperatures	–	–	−0.001	–	−0.001
			(0.001)		(0.001)
# extreme days (above 95^{th} percentile of provincial daily max. temp.)	–	−0.0003	−0.0005	–	–
		(0.003)	(0.003)		
At least 3 consecutive extreme days in a week	–	–	–	−0.005	−0.005
				(0.009)	(0.009)
b) Weekly femicides					
Weekly average maximum temperature	0.178**	0.177**	0.177**	0.173**	0.174**
	(0.070)	(0.074)	(0.074)	(0.071)	(0.070)
Weekly standard deviation of daily maximum temperatures	–	0.132	–	0.123	–
		(0.110)		(0.110)	
Weekly maximum-minimum range of daily maximum temperatures	–	–	0.024	–	0.021
			(0.044)		(0.045)
# extreme days (above 95^{th} percentile of provincial daily max. temp.)	–	0.018	0.029	–	–
		(0.110)	(0.110)		
At least 3 consecutive extreme days in a week	–	–	–	0.338	0.375
				(0.428)	(0.433)

Notes: ** p-value$<$0.05. Two-way clustered standard errors are in parenthesis; clusters are at the level of sequential months and of provinces. Each regression includes sequential week FE and month-year-province FE and is weighted by the provincial population during the year of the observation. The number of observations is 55,826 in panel a) and 3,825 in panel b).

migrant share and gender norms. These correlations imply that subgroup comparisons should be interpreted as descriptive of bundled local characteristics rather than as isolating any single channel.

Table 3 reports split-sample estimates under a linear temperature specification and tests equality of the temperature coefficients across subgroups. For femicides, equality is strongly rejected across provinces with above- versus below-median AC penetration (p-value $= 0.0002$). For 1522 calls, equality is marginally rejected when splitting by tertiary education attainment (p-value $= 0.0922$). For the remaining dimensions, we fail to reject equality, indicating no statistically detectable differences in the linear temperature coefficient across groups.[16]

Turning to AC, we use regional data on residential AC availability from Istat (2022). For 1522 calls, the estimated linear temperature coefficients are statistically similar across provinces with above- versus below-median AC penetration (p-value $= 0.8170$). For femicides, instead, the estimated temperature coefficient is substantially larger in high-AC provinces (0.209, s.e. 0.070) than in low-AC provinces (0.070, s.e. 0.068), and the equality test rejects at conventional levels (p-value $= 0.0002$). This pattern is consistent with the possibility that adaptive technologies and indoor thermal comfort shape the translation of temperature shocks into severe outcomes. However, AC penetration is also a proxy for broader local characteristics (e.g., housing conditions and socio-economic development), and the split-sample design does not identify the underlying mechanism. We therefore interpret the stronger temperature-femicide gradient in high-AC provinces as suggestive evidence of heterogeneous exposure or behavioral responses rather than as a causal effect of AC per se.

We next consider educational attainment, measured as the share of the working-age population holding a tertiary degree (Istat Labour Force Survey, 2013–2022). For 1522 calls, the point estimate of the linear temperature coefficient is larger in below-median education provinces (0.0040, s.e. 0.0014) than in above-median provinces (0.0019, s.e. 0.0012), with the equality test marginally rejecting at the 10% level (p-value $= 0.0922$). For femicides, differences across education groups are not statistically significant (p-value $= 0.2479$).

Interpreting heterogeneity in helpline calls is inherently challenging, as call volumes reflect both underlying exposure to risk and help-seeking or reporting behavior. The stronger temperature-calls association observed in lower-education provinces may there-

[16] Results based on non-linear temperature specifications are reported in Appendix C.

fore arise from differences in baseline vulnerability, reporting responses, or access to alternative support channels. The present design does not allow these mechanisms to be separately identified.

Table 3: Effect heterogeneity

Dependent variable:	Victims' calls to the 1522 helpline				Femicides			
	Coeff.	Equality test	Std.Err.	p-value	Coeff.	Equality test	Std.Err.	p-value
a) Geographical area								
North	0.0025	**	0.0011	0.1357	0.1821	**	0.0708	0.6385
Center-South	0.0031	**	0.0015		0.1694	*	0.0885	
b)Air conditioning penetration index								
Above the median	0.0027	**	0.0012	0.8170	0.2087	***	0.0698	0.0002
below the median	0.0030	*	0.0016		0.0696		0.0684	
c) Unemployment rate								
Above the median	0.0024	*	0.0015	0.7076	0.1773	**	0.0793	0.9646
below the median	0.0029	**	0.0012		0.1794	**	0.0702	
d) Fraction of active population with tertiary education								
Above the median	0.0019		0.0012	0.0922	0.1620	**	0.0744	0.2479
below the median	0.0040	***	0.0014		0.2209	***	0.0790	
e) Fraction of foreigners (citizenship)								
Above the median	0.0028	**	0.0012	0.9115	0.1816	**	0.0734	0.8245
below the median	0.0026	*	0.0014		0.1689	**	0.0766	
f) Gender norm index[(a)]								
Above the median	0.0034	**	0.0015	0.4637	0.1587	**	0.0794	0.6662
below the median	0.0023	*	0.0012		0.1853	**	0.0729	
g) Presence of anti-violence centers[(b)]								
Above the median	0.0025	**	0.0012	0.5433	0.1901	***	0.0714	0.1357
below the median	0.0033	**	0.0015		0.1047		0.0775	
Observations	55,896				3,825			

Notes: * p-value<0.10, ** p-value<0.05, *** p-value<0.01. Standard errors are clustered at the level of sequential months and of provinces. Each regression includes sequential week FE and month-year-province FE and is weighted by the provincial population during the year of the observation.

[(a)] We employ the Gender Norms Index (GNI) developed by Carrer and De Masi (2024), which captures societal attitudes toward gender roles across multiple dimensions. Provinces with high GNI are more conservative, whereas provinces with low GNI are more egalitarian.

[(b)] The presence of anti-violence centers is based on the mapping developed by Cerqua et al. (2024).

4.5 Sensitivity analyses

To assess the robustness of our findings, we first replicated the analysis excluding the COVID-19 lockdown period. Figure B.1 in the appendix shows the estimated effect of weekly average maximum temperature on 1522 helpline calls (panel a) and femicides (panel b) after removing weeks affected by the national lockdown and major restrictions. The results confirm the validity of the main patterns: both the direction and magnitude of the coefficients remain broadly consistent with those obtained using the full sample. This

suggests that the relationship between temperature and domestic violence outcomes is not driven by pandemic-specific dynamics, and that the estimates are robust to the inclusion of this exceptional period.

Second, we conducted a sensitivity analysis to assess whether our inference changes under alternative clustering assumption. Specifically, we consider clustering at the sequential week level and a specification that does not account for spatial correlation, that is, without clustering at any time unit. In the benchmark model, the estimation of the variance-covariance matrix is robust to heteroskedasticity, within-province serial correlation, and cross-sectional spatial correlation, as we use the two-way cluster variance estimator proposed by Cameron et al. (2011), with clustering at the provincial and monthly levels. We found that, when the dependent variable is the number of victims' calls to the 1522 helpline, different clustering methods yielded very similar standard errors. However, when the outcome is the number of femicides, our standard errors were more conservative. In particular, clustering only at the local area level to account only for within-province serial correlation would have produced more precise standard errors, about 16% smaller for the estimated coefficients of the extreme heat temperature bins. This suggests that ignoring spatial correlation in temperature shocks, which is highly likely with granular data on climatic exposure, can more easily lead to a type I error.

Third, in Figure B.2 in the appendix, we report the estimates of the benchmark model without weighting provinces by their population. The estimates for victims' calls to the 1522 helpline are very similar to those displayed in Figure 2. In contrast, the estimated profile of the temperature-femicides relationship is flatter. However, the effect of extreme heat, while not significantly different from zero at the conventional 5% significance level, is still substantial, with femicides increasing by about 100% when temperatures exceed 26°C compared to 6–8°C.

Finally, we add the weekly average relative humidity as an additional control variable. Relative humidity typically co-moves with temperature, and if it independently affects aggression, stress, sleep, or time spent in risky settings, omitting it could lead to omitted-variable bias. Figure B.3 in the appendix shows the estimated temperature profile when relative humidity is included as a further regressor. Figure B.4 displays the temperature profile when we include the full set of interactions between relative humidity (normalized to the sample mean) and the indicator variables for temperature bins. Both figures clearly show that the temperature profile remains unaffected. Moreover, all the coefficients on the interactions between warm temperature bins and relative humidity are statistically not

significant.

5 Conclusions

This study provides new evidence on the relationship between temperature extremes and GBV in Italy, using weekly province-level data on helpline calls and femicides (2013–2022) matched with high-resolution weather information. Using a two-way fixed effects design that exploits within-province variation in temperature, we identify the causal effects of both cold spells and heatwaves on violence outcomes.

Results indicate that higher temperatures are associated with increases in both help-seeking behavior, proxied by calls to the 1522 helpline, and lethal violence, measured by femicides. When minimum temperatures are included in the specification, the estimated effect of high maximum temperatures is attenuated, indicating that elevated nighttime temperatures play a particularly salient role in shaping GBV outcomes. This pattern suggests that sustained thermal stress during nighttime hours may be more consequential than daytime heat alone.

Additionally, distinguishing between contemporaneous and lagged temperature exposures shows that helpline calls respond primarily to contemporaneous temperature fluctuations, whereas femicides exhibit dynamics consistent with acclimation, with the impact of extreme heat weakening as high temperatures persist over consecutive weeks.

The magnitude of these effects is not uniform across provinces. Differences in temperature sensitivity emerge along a limited set of dimensions related to adaptation capacity and socio-economic context. In particular, femicides exhibit a significantly stronger temperature response in provinces with higher residential AC penetration, while helpline calls show a relatively stronger response in provinces with lower tertiary educational attainment. Along the remaining dimensions considered, linear temperature effects do not differ in a statistically detectable way. The observed heterogeneity should be interpreted as evidence of context-dependent exposure to temperature shocks, rather than as identifying specific behavioral or institutional mechanisms, which cannot be separately isolated within the present empirical framework.

By documenting a causal link between temperature extremes and GBV in a high-income setting, this study broadens our understanding of how climate change intersects with social harm. These findings support interpreting extreme heat as relevant risk factors rather than as background correlates of violence. From this perspective, recognizing GBV

as part of the climate change challenge is relevant for progress toward both gender equality (SDG 5) and climate action (SDG 13) in developed-country contexts.

Taken together, the evidence shows that climate-related stressors constitute a relevant risk factor for GBV even where legal protections and support services are well established. As climate change increases the frequency and intensity of temperature extremes, accounting for environmental stressors may be relevant for the design and timing of violence prevention and support frameworks. More broadly, our findings reinforce the importance of viewing GBV among the social consequences of climate change.

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References

Agrawal, P., L. A. Post, J. Glover, D. Hersey, P. Oberoi, and B. Biroscak (2023). The interrelationship between food security, climate change, and gender-based violence: A scoping review with system dynamics modeling. *PLOS Global Public Health 3*(2), e0000300.

Aizer, A. and P. Dal Bó (2009). Love, hate and murder: Commitment devices in violent relationships. *Journal of Public Economics 93*(3–4), 412–428.

Allen, E. M., L. Munala, and J. Ward-Rannow (2023). Do gender-based violence interventions consider the impacts of climate change? A systematic review. *Trauma, Violence, & Abuse 25*(3), 2421–2435.

Anderberg, D., H. Rainer, J. Wadsworth, and T. Wilson (2016). Unemployment and domestic violence: Theory and evidence. *Economic Journal 126*(597), 1947–1979.

Anderson, C. A. (2001). Heat and violence. *Current Directions in Psychological Science 10*(1), 33–38.

Anderson, C. A., K. B. Anderson, N. Dorr, K. M. DeNeve, and M. Flanagan (2000). Temperature and aggression. In M. P. Zanna (Ed.), *Advances in Experimental Social Psychology*, Volume 32, pp. 63–133. New York: Academic Press.

Behrer, P. and V. Bolotnyy (2024). Heat and law enforcement. *PNAS Nexus 3*(5), pgad425.

Berman, J. D., J. Bayham, and J. Burkhardt (2020). Hot under the collar: A 14-year association between temperature and violent behavior across 436 U.S. counties. *Environmental Research 191*, 110181.

Blakeslee, D., R. Chaurey, R. Fishman, D. Malghan, and S. Malik (2021). In the heat of the moment: Economic and non-economic drivers of the weather-crime relationship. *Journal of Economic Behavior & Organization 192*, 832–856.

Boyle, M. H., K. Georgiades, J. Cullen, and Y. Racine (2009). Community influences on intimate partner violence in India: Women's education, attitudes towards mistreatment and standards of living. *Social Science & Medicine 69*(5), 691–697.

Cameron, A., J. Gelbach, and D. Miller (2011). Robust inference with multiway clustering. *Journal of Business & Economic Statistics 29*(2), 238–249.

Carrer, L. and L. De Masi (2024). Municipal-level gender norms: Measurement and effects on women in politics. mimeo.

Cerqua, A., C. Giannantoni, M. Letta, and G. Pinto (2024). Femicides, anti-violence centers, and public salience. Available at SSRN: http://dx.doi.org/10.2139/ssrn.4899917.

Chen, Y., R. Sun, X. Chen, and X. Qin (2023). Does extreme temperature exposure take a toll on mental health? Evidence from the China Health and Retirement Longitudinal Study. *Environment and Development Economics 28*(5), 486–510.

Choi, H. M., S. Heo, D. Foo, Y. Song, R. Stewart, J. Son, and M. L. Bell (2024). Temperature, crime, and violence: A systematic review and meta-analysis. *Environmental Health Perspectives 132*(10), 106001.

Cohen, F. and F. Gonzalez (2024). Understanding the link between temperature and crime. *American Economic Journal: Economic Policy 16*(2), 480–514.

Cohn, E. (1993). The prediction of police calls for service: The influence of weather and temporal variables on rape and domestic violence. *Journal of Environmental Psychology 13*(2), 71–83.

Cools, S., M. Flatø, and A. Kotsadam (2020). Rainfall shocks and intimate partner violence in Sub-Saharan Africa. *Journal of Peace Research 57*(3), 377–390.

Corcoran, J. and R. Zahnow (2022). Weather and crime: A systematic review of the empirical literature. *Crime Science 11*, 16.

Correia, S., P. Guimarães, and T. Zylkin (2020). Fast Poisson estimation with high-dimensional fixed effects. *The Stata Journal 20*(1), 95–115.

Correia, S., P. Guimarães, and T. Zylkin (2021). Verifying the existence of maximum likelihood estimates for generalized linear models. arXiv:1903.01633.

Dell, M., B. F. Jones, and B. A. Olken (2014). What do we learn from the weather? The new climate-economy literature. *Journal of Economic Literature 52*(3), 740–98.

Desai, B. H. and M. Mandal (2021). Role of climate change in exacerbating sexual and gender-based violence against women: A new challenge for international law. *Environmental Policy and Law 51*(3), 137–157.

Díaz, J.-J. and V. Saldarriaga (2023). A drop of love? Rainfall shocks and spousal abuse: Evidence from rural Peru. *Journal of Health Economics 89*, 102739.

EIGE (2021). *The Costs of Gender-Based Violence in the European Union*. Luxembourg: Publications Office of the European Union.

Epstein, A., E. Bendavid, D. Nash, E. D. Charlebois, and S. D. Weiser (2020). Drought and intimate partner violence towards women in 19 countries in Sub-Saharan Africa during 2011–2018: A population-based study. *PLOS Medicine 17*(3), e1003064.

Fernbrant, C., B. Essén, P.-O. Östergren, and E. Cantor-Graae (2014). Perceived threat of violence and exposure to physical violence against foreign-born women: A Swedish population-based study. *Journal of Interpersonal Violence 29*(4), 658–676.

Filomena, M. and M. Picchio (2024). Unsafe temperatures, unsafe jobs: The impact of ambient temperatures on work related injuries. *Journal of Economic Behavior and Organization 224*, 851–875.

Forsdike, K., G. O'Sullivan, and L. Hooker (2022). Major sports events and domestic violence: A systematic review. *Health & Social Care in the Community 30*(6), e3670–e3685.

González, L. and N. Rodríguez-Planas (2020). Gender norms and intimate partner violence. *Journal of Economic Behavior & Organization 178*, 223–248.

Gracia, E., A. López-Quílez, M. Marco, P. Escobar-Hernández, and M. Lila (2025). Neighborhoods can be sexist too: Hostile sexism and risk of intimate partner violence across city neighborhoods. *Social Science & Medicine 380*, 118241.

Heise, L. L. and A. Kotsadam (2015). Cross-national and multilevel correlates of partner violence: An analysis of data from population-based surveys. *The Lancet Global Health 3*(6), e332–e340.

Helo Sarmiento, J. (2023). Into the tropics: Temperature, mortality, and access to health care in Colombia. *Journal of Environmental Economics and Management 119*, 102796.

Herrnstadt, E., A. Heyes, E. Muehlegger, and S. Saberian (2021). Air pollution and criminal activity: Microgeographic evidence from Chicago. *American Economic Journal: Applied Economics 13*(4), 70–100.

Hsiang, S. (2016). Climate econometrics. *Annual Review of Resource Economics 8*, 43–75.

Inness, A., M. Ades, A. Agustí-Panareda, J. Barré, A. Benedictow, A.-M. Blechschmidt, J. J. Dominguez, R. Engelen, H. Eskes, J. Flemming, V. Huijnen, L. Jones, Z. Kipling, S. Massart, M. Parrington, V.-H. Peuch, M. Razinger, S. Remy, M. Schulz, and M. Suttie (2019). The CAMS reanalysis of atmospheric composition. *Atmospheric Chemistry and Physics 19*(6), 3515–3556.

IPCC (2021). *Climate Change 2021: The Physical Science Basis*. Cambridge: Cambridge University Press.

Istat (2022). Consumi energetici delle famiglie italiane. Istituto Nazionale di Statistica, Statistiche Report, https://www.istat.it/it/files/2022/06/REPORT-CONSUMI-ENERGETICI-FAMIGLIE-2021-DEF.pdf (last accessed August 5, 2025).

Istat (2023a). Gli accessi al Pronto Soccorso e i ricoveri ospedalieri dele donne vittime di violenza. Istituto Nazionale di Statistica, Rapporto per il Ministero della Salute e la Presidenza del Consiglio dei Ministri, Dipartimento per le Pari Opportunità, https://www.istat.it/it/files/2023/05/Accessi-pronto-soccorso-donne-5mag2023.pdf (last accessed August 5, 2025).

Istat (2023b). The helpline 1522 - IV quarter 2023. Istituto Nazionale di Statistica, https://www.istat.it/en/dataset/the-helpline-1522-quarterly-data-as-of-q4-2023 (last accessed August 5, 2025).

Kahn, M. (2016). The climate change adaptation literature. *Review of Environmental Economics and Policy 10*(1), 166–178.

Landau, S. and D. Fridman (1993). The seasonality of violent crime: The case of robbery and homicide in Israel. *Journal of Research in Crime and Delinquency 30*(2), 163–191.

Le, K. and M. Nguyen (2024). Rainfall and intimate partner violence. *Population and Environment 46*, 19.

Li, J., C. Feng, and J. Yang (2023). Climate attribution of interpersonal violence: International evidence. *Environmental Research 236*(Part 2), 116836.

Liu, Y., Y. Zhou, and J. Lu (2020). Exploring the relationship between air pollution and meteorological conditions in China under environmental governance. *Scientific Reports 10*, 14518.

Mandal, M. (2023). The role of climate change in exacerbating sexual and gender-based violence in international law: In search of a solution. Technical Report 35, University of Duisburg-Essen, Käte Hamburger Kolleg / Centre for Global Cooperation Research.

Mares, D. M. and K. W. Moffett (2016). Climate change and interpersonal violence: A "global" estimate and regional inequities. *Climatic Change 135*(2), 297–310.

Michel, S. J., H. Wang, S. Selvarajah, J. K. Canner, M. Murrill, A. Chi, D. T. Efron, and E. B. Schneider (2016). Investigating the relationship between weather and violence in Baltimore, Maryland, USA. *Injury 47*(2), 272–276.

Miles-Novelo, A. and C. A. Anderson (2019). Climate change and psychology: Effects of rapid global warming on violence and aggression. *Current Climate Change Reports 5*(1), 36–46.

Mišák, V. (2024). Does heat cause homicides? A meta-analysis. *International Review of Law and Economics 78*, 106191.

Mulambo, C., S. Thakur, and R. Mathew (2025). Hot weather and violence against women: A global scoping review. *International Journal of Environmental Research and Public Health 22*(7), 1069.

Mullins, J. T. and C. White (2019). Temperature and mental health: Evidence from the spectrum of mental health outcomes. *Journal of Health Economics 68*, 102240.

Newberry, J. A., A. Garabedian, F. Qin, M. A. Gimenez, A. S. Anurudran, H. Hedlin, and M. C. Strehlow (2025). Intimate partner violence among foreign-born women: A cross-sectional analysis of the National Intimate Partner and Sexual Violence Survey. *Journal of Family Violence 40*, 137–152.

Nguyen, M. (2024). Temperature and intimate partner violence. *Scottish Journal of Political Economy 71*(2), 197–218.

Ouedraogo, R. and D. Stenzel (2021). The heavy economic toll of gender-based violence: Evidence from Sub-Saharan Africa. IMF Working Paper No. 2021/277, International Monetary Fund, Washington, DC.

Picchio, M. and M. Ubaldi (2024). Unemployment and health: A meta-analysis. *Journal of Economic Surveys 38*(4), 1437–1472.

Prudkov, P. N. and O. N. Rodina (2019). Cold temperatures, stress, and violence. *Heliyon 5*(5), e01619.

Ranson, M. (2014). Crime, weather, and climate change. *Journal of Environmental Economics and Management 67*(3), 274–302.

Rizzotto, J. S., K. M. Sims, and H. K. Gibbs (2025). Hot tempers: Differential effects of heat and drought on domestic violence. *Review of Economics of the Household*.

Sanz-Barbero, B., C. Linares, C. Vives-Cases, J. L. González, J. J. López-Ossorio, and J. Díaz (2018). Heat wave and the risk of intimate partner violence. *Science of the Total Environment 644*, 413–419.

Schinasi, L. H. and G. B. Hamra (2017). A time series analysis of associations between daily temperature and crime events in Philadelphia, Pennsylvania. *Journal of Urban Health 94*(6), 892–900.

Schneider, D., K. Harknett, and S. McLanahan (2016). Intimate partner violence in the great recession. *Demography 53*(2), 471–505.

Tur-Prats, A. (2021). Unemployment and intimate partner violence: A cultural approach. *Journal of Economic Behavior & Organization 185*, 27–49.

UN Women and DESA (2025). *Progress on the sustainable development goals: The gender napshot 2025*. New York: UN Women and DESA.

United Nations (2015). Transforming our world: The 2030 agenda for sustainable development.

Wells, W., L. Ren, and W. DeLeon-Granados (2010). Reducing intimate partner homicides: The effects of federally-funded shelter service availability in California. *Journal of Criminal Justice 38*(4), 512–519.

World Bank (2022). *The Cost of Gender-Based Violence: Global Estimates and Evidence*. Washington, DC: World Bank.

Xu, A., C. Liu, Y. Wan, Y. Bai, and Z. Li (2013). Monkeys fight more in polluted air. *Scientific Reports 11*, 654.

Zhao, H., L. He, C. Liu, X. Shan, C. Gui, L. Zhang, Y. Yu, Y. Xiao, J. Xue, K. Zhang, and B. Luo (2024). Self-harm and interpersonal violence due to high temperature from the global burden of disease study 2019: A 30-year assessment. *Environmental Research 243*, 117826.

Appendix

A Summary statistics

Table A.1: Summary statistics

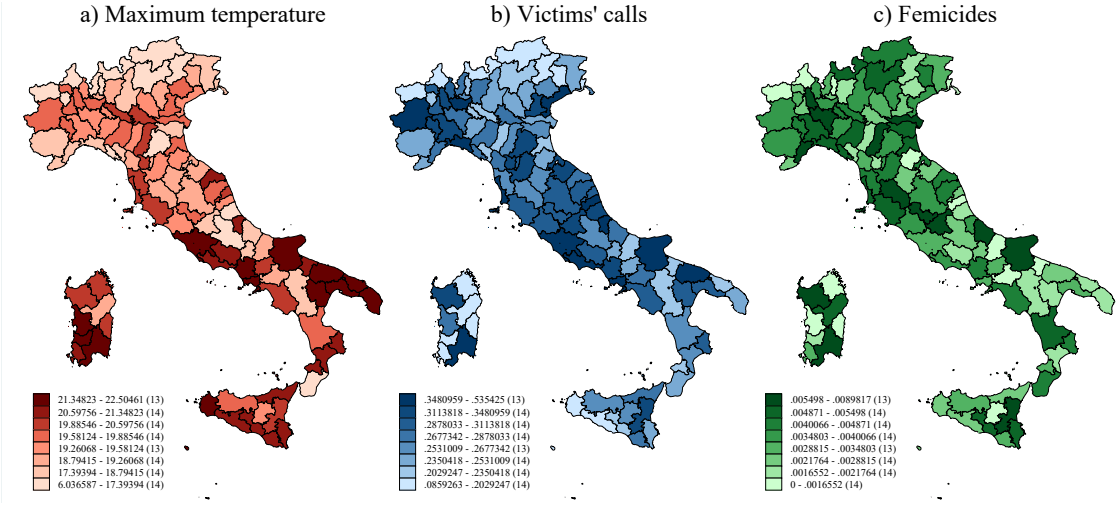
	Average	Std. Dev.	Min.	Max.
a) Outcome variables				
Weekly victims' calls per 100,000 inhabitants	0.324	0.295	0.000	4.625
Weekly femicides	0.044	0.223	0.000	4.000
b) Covariates (weekly averages)				
Maximum daily temperatures (°C)	19.724	7.732	−8.021	39.569
Minimum daily temperatures (°C)	10.561	6.762	−16.003	27.851
Average daily temperatures (°C)	14.979	7.158	−12.067	32.409
Wind speed (m/s)	2.431	0.754	0.404	12.640
Precipitation (mm/m^2)	2.185	3.055	0.000	47.986
$PM_{2.5}$ (mg/m^3)	0.013	0.006	0.001	0.208
Ozone (mg/kg)	0.071	0.025	0.002	0.148
# of observations				55,905
# of weeks				522[(a)]
# of provinces				109[(b)]

Notes: Summary statistics are weighed by provincial population retrieved from the Atlante Statistico dei Comuni of Istat.

[(a)] The meteorological data were not available on all the weeks of the observed time window for the following provinces: Agrigento, Caltanissetta, Catania, Catanzaro, Enna, Messina, Palermo, Ragusa, Reggio Calabria, Siracusa, Trapani, and Vibo Valentia. They had between 411 and 492 weekly observations instead of 522.

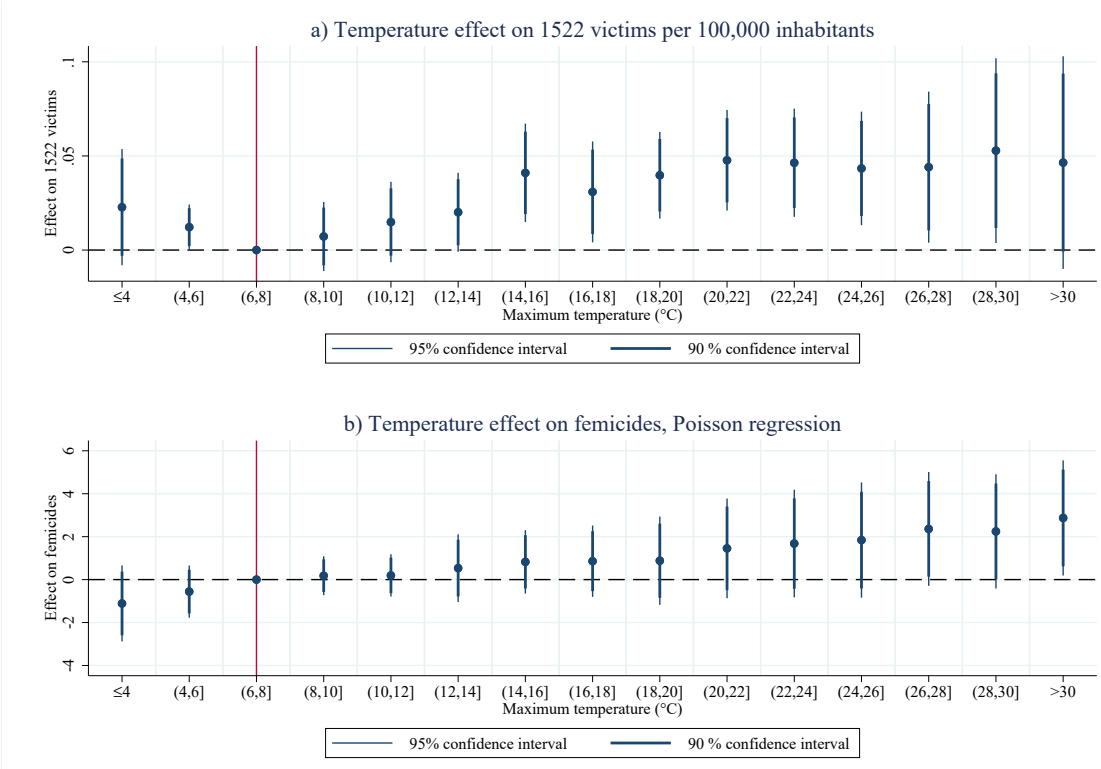
[(b)] We could not use data for the province of Brindisi because information about the wind speed was missing.

Figure A.1: Weekly averages of maximum temperatures (°C), weekly victims' 1522 calls (per 100,000 inhabitants) and weekly femicides (per 100,000 inhabitants) across Italian provinces (2013–2022 averages)



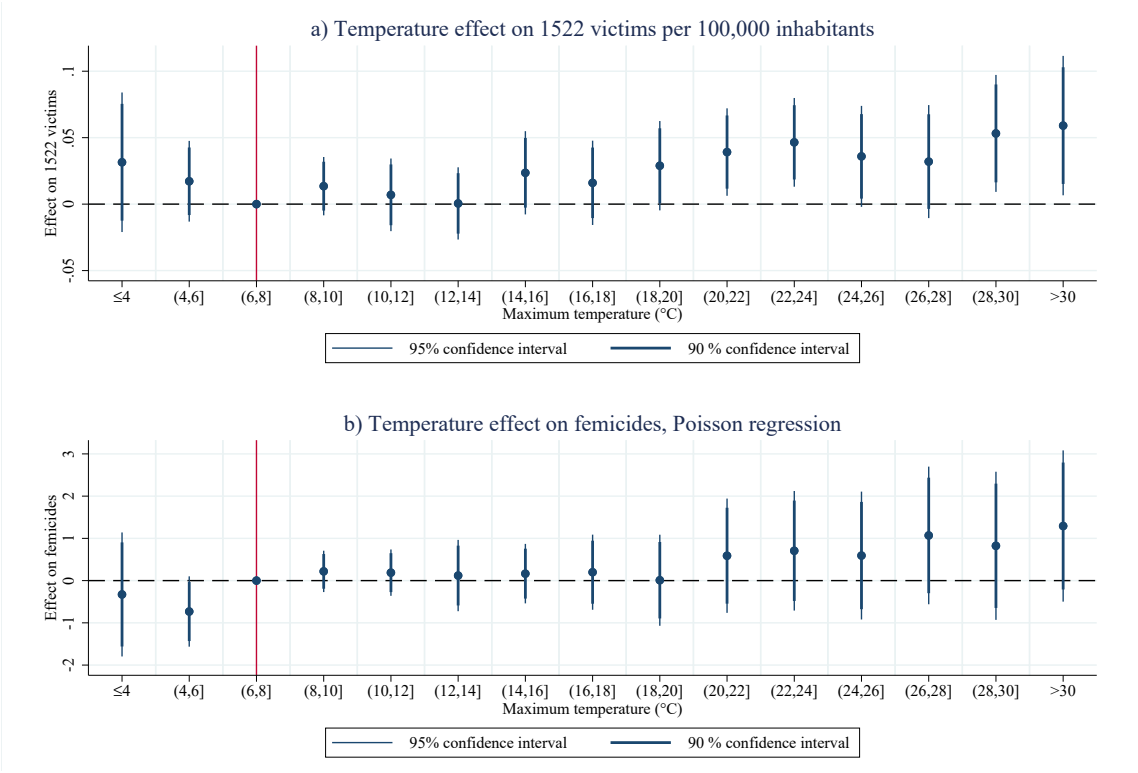
B Sensitivity analyses

Figure B.1: Effect of weekly average maximum temperature on weekly calls to 1522 helpline by victims (panel a) and femicides (panel b) without COVID-19 lockdown period



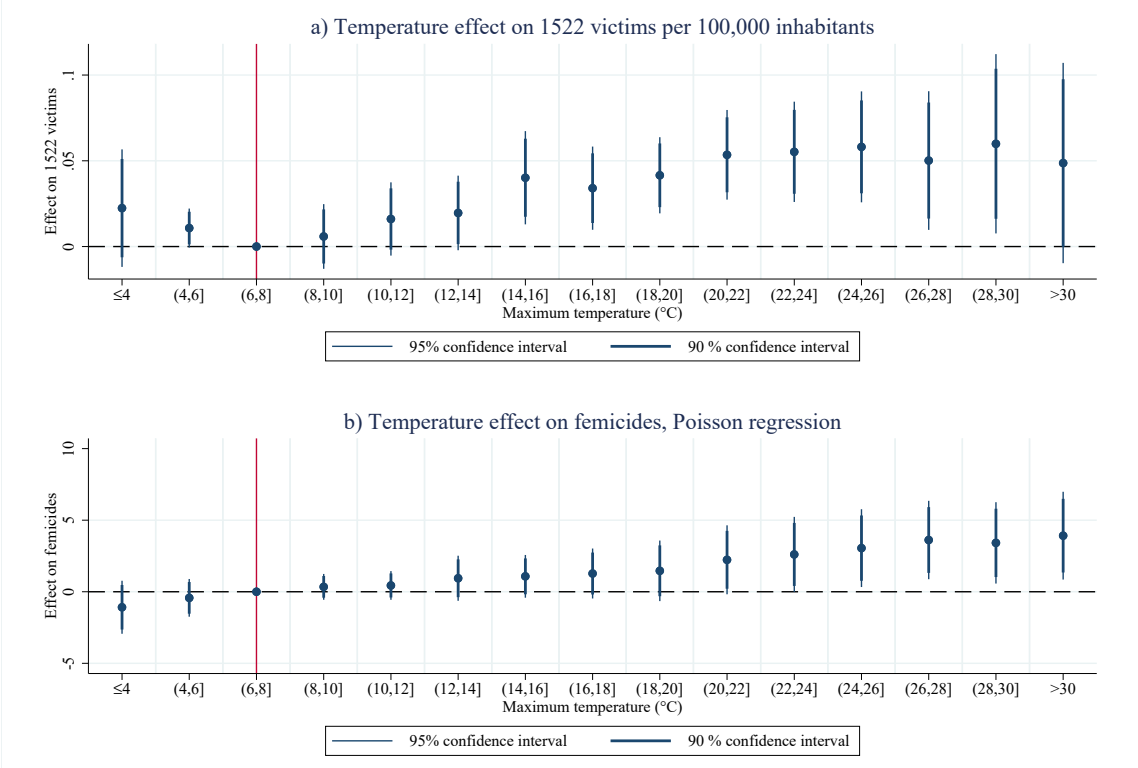
Notes: The vertical segments are 95% confidence intervals. The vertical lines indicate the reference category $(6, 8]$°C, whose coefficient is normalized to zero. Each regression is weighted by the provincial population of the year of the observation.

Figure B.2: Effect of weekly average maximum temperature on weekly calls to 1522 helpline by victims (panel a) and users (panel b), unweighted regressions



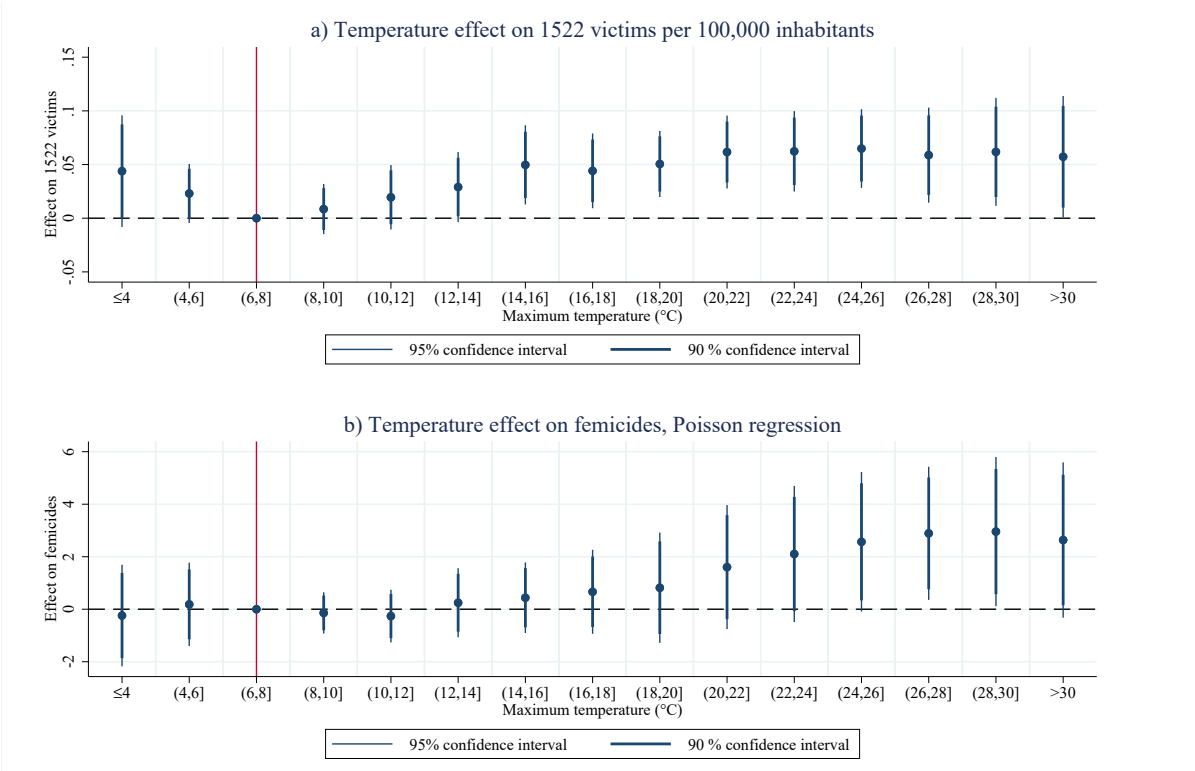
Notes: The vertical segments are 95% confidence intervals. The vertical lines indicate the reference category $(6, 8]$°C, whose coefficient is normalized to zero.

Figure B.3: Effect of weekly average maximum temperature on weekly calls to 1522 helpline by victims (panel a) and on femicides (panel b), controlling for relative humidity



Notes: The vertical lines indicate the reference category $(6, 8]$°C, whose coefficient is normalized to zero. Each regression is weighted by the provincial population of the year of the observation. The average of victims' helpline calls per 100,000 inhabitants is 0.307 at 6–8°C. Confidence intervals are derived from two-way clustered standard errors, with clusters at the level of sequential months and of provinces.

Figure B.4: Effect of weekly average maximum temperature on weekly calls to 1522 helpline by victims (panel a) and on femicides (panel b), controlling for relative humidity interacted with all temperature bins



Notes: The vertical lines indicate the reference category $(6, 8]$°C, whose coefficient is normalized to zero. Each regression is weighted by the provincial population of the year of the observation. The average of victims' helpline calls per 100,000 inhabitants is 0.307 at 6–8°C. Confidence intervals are derived from two-way clustered standard errors, with clusters at the level of sequential months and of provinces.

Table B.1: Estimations results of the main model using different approaches to estimate clustered standard errors

	Victims' calls per 100,000 inhabitants	Femicides per 100,000 inhabitants
Weekly average of maximum daily temperature - Reference: $(6, 8]°C$		
< 4°C	0.0234	−1.1220
	(0.0157)	(0.9045)
	[0.0181]	[0.8603]
	{0.0164}	{0.8994}
$(4, 6]$°C	0.0116*	−0.5559
	(0.0061)	(0.6192)
	[0.0082]	[0.4869]
	{0.0091}	{0.4675}
$(8, 10]$°C	0.0069	0.1796
	(0.0096)	(0.4550)
	[0.0101]	[0.4013]
	{0.0102}	{0.3450}
$(10, 12]$°C	0.0144	0.2047
	(0.0109)	(0.4939)
	[0.0102]	[0.4258]
	{0.0104}	{0.3496}
$(12, 14]$°C	0.0176	0.5056
	(0.0112)	(0.7957)
	[0.0102]	[0.7612]
	{0.0122}	{0.7023}
$(14, 16]$°C	0.0371***	0.7565
	(0.0139)	(0.7251)
	[0.0116]	[0.6777]
	{0.0140}	{0.6038}
$(16, 18]$°C	0.0289**	0.8973
	(0.0135)	(0.8442)
	[0.0137]	[0.7819]
	{0.0143}	{0.6991}
$(18, 20]$°C	0.0398***	0.8671
	(0.0121)	(1.0414)
	[0.0140]	[0.9880]
	{0.0150}	{0.9151}
$(20, 22]$°C	0.0535***	1.5214
	(0.0147)	(1.1694)
	[0.0158]	[1.0819]
	{0.0162}	{0.9971}
$(22, 24]$°C	0.0540***	1.7767
	(0.0158)	(1.2598)
	[0.0162]	[1.1642]
	{0.0169}	{1.0732}
$(24, 26]$°C	0.0545***	1.9542
	(0.0164)	(1.3227)
	[0.0187]	[1.2201]
	{0.0196}	{1.1219}
$(26, 28]$°C	0.0530***	2.4626*
	(0.0202)	(1.3455)
	[0.0216]	[1.2731]
	{0.0219}	{1.1756}
$(28, 30]$°C	0.0630***	2.3382*
	(0.0234)	(1.3301)
	[0.0241]	[1.2442]
	{0.0242}	{1.1221}
> 30°C	0.0574**	2.9346**
	(0.0264)	(1.3453)
	[0.0275]	[1.2601]
	{0.0279}	{1.1293}

Notes: * p-value$<$0.10, ** p-value$<$0.05, *** p-value$<$0.01. In parenthesis (brackets) we report two-way clustered standard errors with clusters at the level of sequential months (weeks) and of provinces. In curly braces, we report standard errors clustered only at the level of provinces. Each regression is weighted by the provincial population of the year of the observation. Each regression includes wind speed, precipitation, $PM_{2.5}$, ozone, sequential week FE and month-year-province FE, and is weighted by the provincial population during the year of the observation.

C Non-linear effect heterogeneity

This section presents a detailed heterogeneity analysis to further probe the mechanisms underlying the temperature-GBV relationship. Building on the baseline estimates, we recover fully non-linear temperature effects using the temperature-bin specification and report them separately for provinces above and below the median of seven contextual dimensions: geographical area, residential air-conditioning penetration, local labor market conditions, educational attainment, migrant presence, prevailing gender norms, and the local availability of anti-violence centers. For each dimension, we report the full set of bin-specific estimates and the corresponding graphical evidence, allowing for a granular assessment of differences in thresholds, magnitudes, and response profiles across contexts.

C.1 Pairwise correlations among heterogeneity dimensions

Table C.1 reports pairwise correlations among the variables used to define the sample splits, namely geographical location (North vs. Center-South), residential air-conditioning (AC) penetration, unemployment, tertiary education attainment, immigrant share, prevailing gender norms, and the availability of anti-violence centers (AVC).

Table C.1: Correlation matrix of the different dimensions of effect heterogeneity

	North	High AC penetration	High unemployment	High tertiary eduction	High fraction of foreigners	High gender norm index	High presence of anti-violence centers
North	1.000						
High AC penetration	−0.077	1.000					
High unemployment	−0.705	0.006	1.000				
High tertiary eduction	0.200	−0.203	−0.235	1.000			
High fraction of foreigners	0.538	0.005	−0.645	0.290	1.000		
High gender norm index	−0.668	−0.077	0.552	−0.235	−0.384	1.000	
High presence of anti-violence centers	−0.028	0.339	0.029	−0.011	−0.085	−0.083	1.000

C.2 Geographical area: Center-South and North

We divide Italian provinces into two macro-regions, North and Center-South, following conventional territorial distinctions in socio-economic and infrastructural development. The macro-regions also differ climatically: the North experiences more continental conditions, with colder winters and greater temperature fluctuations, while the Center-South is warmer and more climatically stable. As a result, extreme heat may be perceived differently, leading to heterogeneous behavioral responses. In the South, people may be more accustomed to high temperatures, whereas in the North, similar heat levels may induce greater stress and discomfort, potentially triggering higher aggression.

Moreover, the North and the Center-South exhibit different baseline levels of GBV, with the Center-South characterized by higher rates, possibly due to socioeconomic and cultural factors.[17] This suggests that the marginal effects of temperature may vary, with temperature spikes acting as a more salient trigger in the North, where GBV may be more latent.

Figure C.1 reports the estimated coefficients by temperature bin, using the 6–8°C interval as the reference category. Results are shown separately for calls to the 1522 helpline (graph a) and for femicides (graph b), distinguishing between Center-South and North. The estimated effects exhibit broadly similar qualitative patterns across regions, as none of the coefficients for Center-South provinces differ significantly from their Northern counterparts. However, some regional differences in magnitude and threshold effects emerge, particularly in the case of femicides (graph b of Figure C.1).

In the North, the impact of weekly average maximum temperature begins to rise from approximately 12°C and becomes significant at the 10% level when temperatures are above 20°C. In contrast, in the Center-South, the estimated effect, relative to the 6–8°C baseline, reaches the same magnitude and significance level when temperatures are above 30°C. This divergence suggests that what drives the relationship between temperature and GBV may not be the absolute level of heat, but rather its deviation from local climatic norms and baseline temperature conditions. Southern provinces are typically exposed to higher average temperatures and, therefore, people may exhibit greater physiological and behavioral adaptation to moderate heat. In these areas, a shift from 6–8°C to 20°C may be perceived as relatively mild and insufficient to generate significant discomfort

[17] In our sample, the weekly number of victims' 1522 calls (per 100,000 inhabitants) was 0.304 in the North and 0.342 in the Center-South. The weekly number of femicides (per 100,000 inhabitants) was 0.040 in the North and 0.046 in the Center-South.

or behavioral disruption. Conversely, femicides increase more markedly in provinces with higher air-conditioning penetration and more conservative gender norms, consistent with differential household heat exposure and normative constraints shaping escalation to lethal violence. These findings align with the hypothesis that populations regularly exposed to warmer climates are partially adapted, for example through thermoregulation, air conditioning use, or behavioral strategies like adjusted daily routines, so that only large departures from climatological norms lead to significant consequences for interpersonal dynamics.

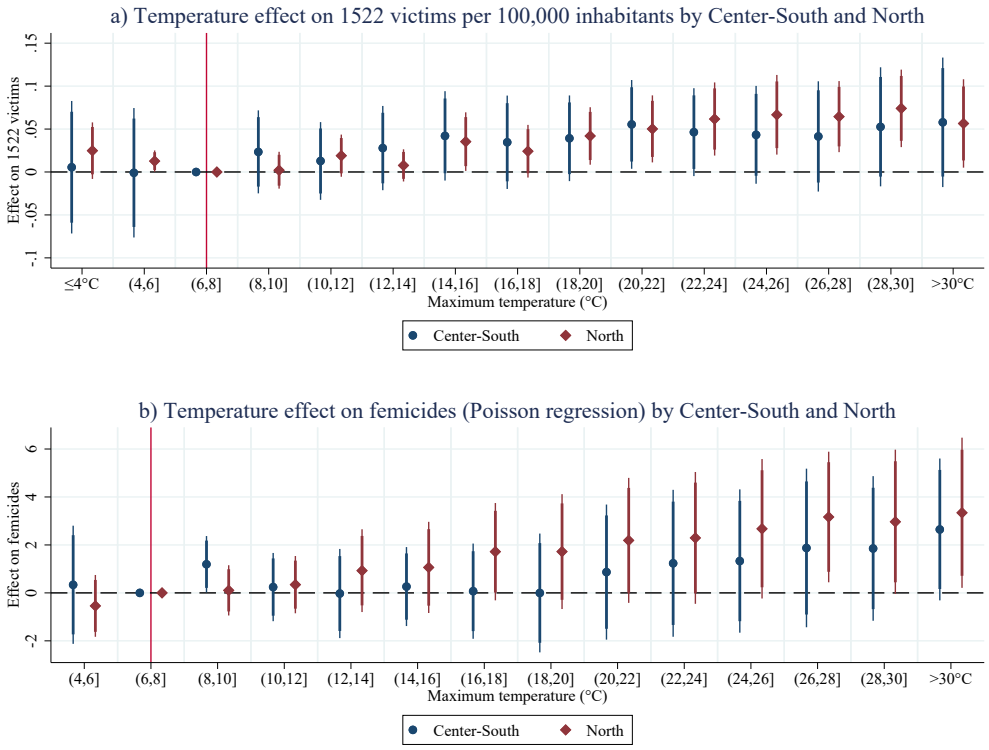
This pattern contrasts with previous empirical evidence on the temperature-violence relationship in other geographical contexts. For instance, US-based studies have documented that the effects of moderate and warm temperatures on crime are very similar across climate zones, suggesting no clear differences in temperature effects that can be attributed to seasonal adaptation (Ranson, 2014). Similarly, the meta-analysis by Choi et al. (2024) finds that a 10°C increase in short-term mean temperature is associated with a 9% increase in the risk of violent crime, while evidence for property crimes is more mixed.

C.3 High and low air conditioning penetration index

To account for differences in environmental comfort that may moderate the impact of high temperatures, we use regional data on air conditioning (AC) penetration in residential buildings, as reported by Istat (2022). The share of households with air conditioning varies significantly across regions, potentially influencing individual heat exposure and behavioral responses.

Figure C.2 reports the estimated coefficients by temperature bin, using the 6–8°C range as the reference category. Graph a refers to calls to the 1522 helpline, graph b to femicides. They distinguish between provinces with high and low levels of AC penetration. The relationship between temperature and calls to the 1522 helpline appears qualitatively and quantitatively similar across groups, with no statistically significant differences between areas with high and low AC penetration when comparing the coefficients directly. However, statistically differences across groups emerge when we examine femicides. In provinces with high AC penetration, femicides increase steadily with temperature, peaking at around 30°C. Conversely, in provinces with low AC penetration, no clear temperature-femicide relationship is observed.

Figure C.1: Effect of weekly average maximum temperature by geographical area



Notes: The vertical lines indicate the reference category $(6, 8]$°C, whose coefficient is normalized to zero. In graph b, The results for the first temperature bin ($\leq$ 4°C) is not displayed because not identified for provinces in the Center-South, where rarely weekly average maximum temperatures are below 4°C. Each regression is weighted by the provincial population of the year of the observation. None of the displayed coefficients for provinces in the Center-South are significantly different from those for provinces in the North. The average of the dependent variable, weekly 1522 helpline calls by victims per 100,000 inhabitants, at the reference bin for each graph is as follows: a) 0.343; b) 0.295. Confidence intervals are derived from two-way clustered standard errors, with clusters at the level of sequential months and of provinces.

In areas with low AC availability, higher ambient temperatures may push individuals out of their homes, increasing visibility and the likelihood of third-party intervention, thereby limiting the escalation of violence to lethal outcomes. In contrast, in areas with widespread AC, people are more likely to remain indoors to avoid the heat. This increased proximity to potential aggressors, combined with reduced social oversight, may elevate the risk of fatal escalation.

This suggests that, while AC can buffer the psychological stress associated with heat, it may also increase the lethality of violent incidents by fostering prolonged, unsupervised cohabitation during hot periods. These offsetting behavioral effects imply that adaptation technologies, while beneficial in many respects, may not substitute for robust violence-prevention infrastructure. Complementary measures, such as the strengthening of support services and outreach efforts during extreme heat events, may be essential to mitigate the unintended social costs of climate adaptation.

C.4 Socio-economic conditions

Drawing on data from the Istat Labour Force Survey (2013–2022), we classify provinces based on a set of socio-economic indicators that may affect both exposure to and vulnerability to violence. These include the unemployment rate, the share of the working-age population with tertiary education and the proportion of foreign-born residents.

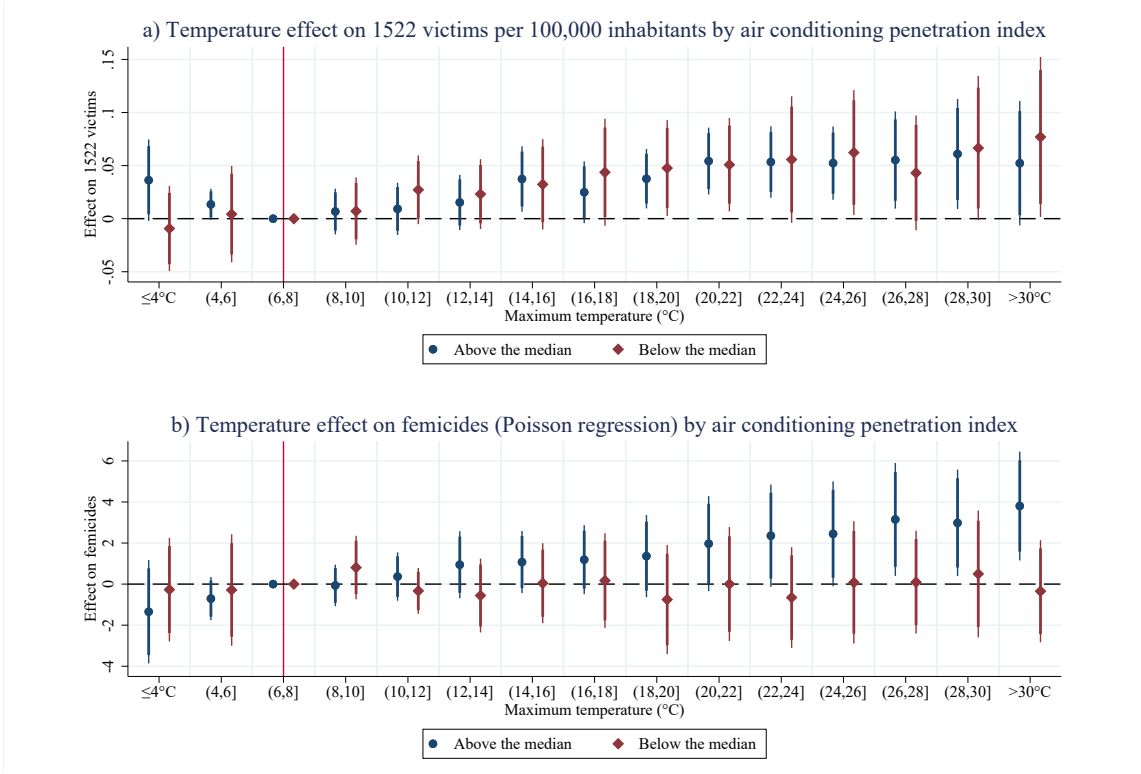
High and low unemployment rate over the observed time period

Poor labor market conditions increase psychosocial distress,[18] financial strain and relationship conflict, all of which may amplify the effects of temperature stress and lead to more violent behavior during episodes of extreme heat. Moreover, in areas with higher unemployment, people, especially men, may spend more time at home. On the one hand, this increases the opportunities for domestic conflict; on the other hand, it reduces the possibility for victims to report a violent incident.

Figure C.3 reports the estimated coefficients for victims' calls to the 1522 helpline (panel a) and femicides (panel b), with estimates disaggregated by provinces with average unemployment rates above and below the median unemployment rate.

[18] See the meta-analysis in Picchio and Ubaldi (2024) for a survey on the impact of unemployment on psychological health, with men being particularly affected.

Figure C.2: Effect of weekly average maximum temperature by air conditioning penetration index



Notes: The vertical lines indicate the reference category $(6, 8]$°C, whose coefficient is normalized to zero. Each regression is weighted by the provincial population of the year of the observation. The average of the dependent variable, weekly 1522 helpline calls by victims per 100,000 inhabitants, at the reference bin for each graph is as follows: a) 0.331; b) 0.286. Confidence intervals are derived from two-way clustered standard errors, with clusters at the level of sequential months and of provinces.

The influence of temperature on help-seeking behavior appears to vary substantially with local labor market conditions. In provinces with low unemployment rates, the causal effect of temperature on victims' calls to the 1522 helpline increases steadily, peaking at temperatures above 28°C. At that level, the number of calls is approximately 30% higher than at 6–8°C. This pattern is markedly attenuated in areas with high unemployment, suggesting that economic conditions may shape the capacity or willingness to report domestic violence during heat stress events.

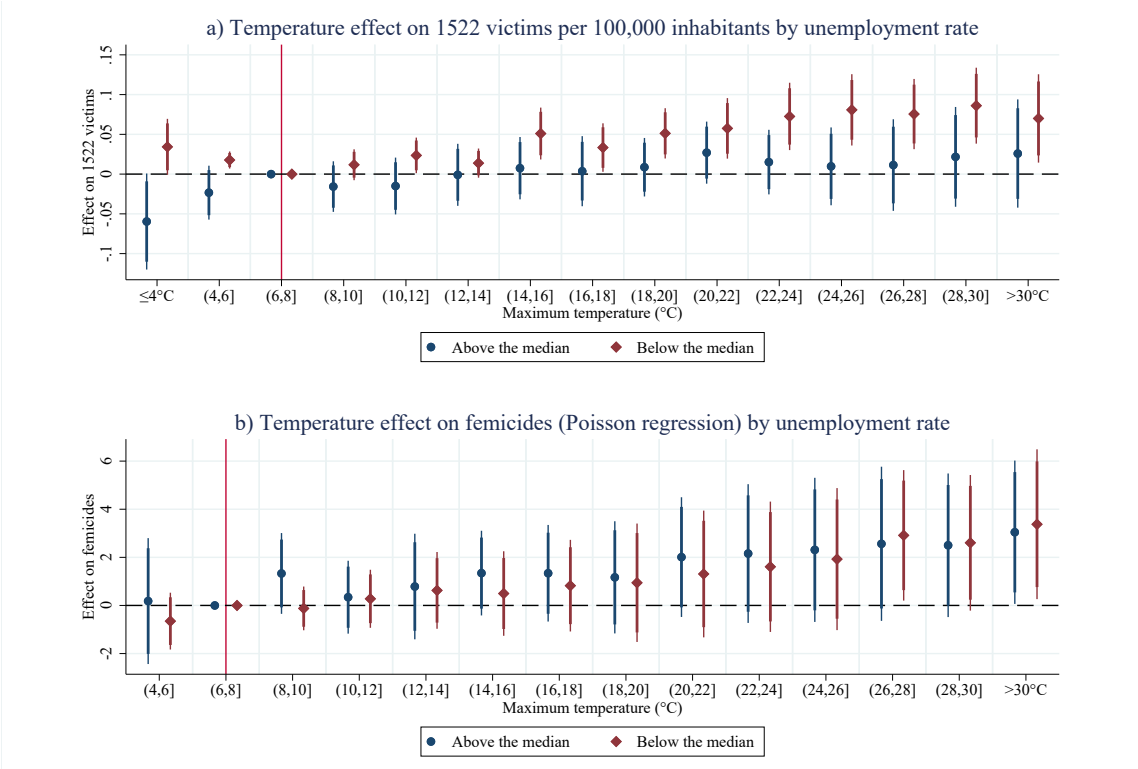
Several mechanisms may account for this disparity. In areas with lower unemployment, individuals may benefit from greater economic independence, mobility, and access to information and services, which collectively reduce the opportunity cost-and perceived risk-of seeking help. Conversely, in high-unemployment contexts, victims may face heightened financial dependency, reduced privacy, and limited access to external support networks, which can suppress help-seeking even when conflict intensity is comparable or higher.

When turning to femicides, however, the results show no meaningful difference between high and low unemployment areas. This suggests that while economic context affects the visibility and reporting of domestic violence, it does not substantially alter the risk of its most severe outcomes. In both groups, extreme heat appears to raise the incidence of femicides to a similar extent.

This contrast aligns with prior research indicating that unemployment can influence both the frequency and the escalation dynamics of IPV. For example, Anderberg et al. (2016) show that economic interdependence and relative bargaining power matter: when men face unemployment, they may restrain abusive behavior to maintain relationships; when women lose economic autonomy, they become more vulnerable and IPV increases, potentially offsetting temperature-induced triggers. Similarly, Schneider et al. (2016) find that unemployment and economic hardship at the household level are positively related to abusive behavior: macroeconomic downturns raise IPV primarily through non-lethal episodes, while the risk of femicide remains relatively stable across economic cycles. Further supporting this interpretation, Tur-Prats (2021) emphasizes that the unemployment–IPV relationship is highly context-dependent and mediated by prevailing gender norms. Her evidence shows that female unemployment shocks are associated with stronger increases in IPV in more patriarchal settings, primarily affecting non-lethal forms of violence. This framework is consistent with our findings: while economic conditions and gender norms may influence reporting behavior and the prevalence of IPV, they do not

appear to differentially affect the escalation to femicide. In the Italian context, provinces with persistently high unemployment often overlap with more traditional gender norms and weaker support infrastructures, which may inhibit help-seeking without necessarily altering the risk of extreme outcomes.

Figure C.3: Effect of weekly average maximum temperature by unemployment rate (above and below the median unemployment rate)



Notes: The vertical lines indicate the reference category $(6, 8]$°C, whose coefficient is normalized to zero. In graph b, The results for the first temperature bin ($\leq$ 4°C) is not displayed because not identified for provinces in the Center-South, where rarely weekly average maximum temperatures are below 4°C. Each regression is weighted by the provincial population of the year of the observation. The average of the dependent variable, weekly 1522 helpline calls by victims per 100,000 inhabitants, at the reference bin for each graph is as follows: a) 0.331; b) 0.286. Confidence intervals are derived from two-way clustered standard errors, with clusters at the level of sequential months and of provinces.

High and low fraction of the active population with tertiary education over the observed time period

Figure C.4 displays estimated coefficients of the temperature effect on calls to the 1522 helpline (graph a) and femicides (graph b), with estimates disaggregated by provinces

with a share of tertiary-educated individuals above or below the median over the observed period.

We find that provinces with lower levels of tertiary education exhibit a sharper increase in both helpline calls and femicides as temperatures rise. In contrast, provinces with higher educational attainment experience a markedly attenuated response to temperature increases. These patterns suggest that education may serve as a protective factor, moderating behavioral and social reactions to environmental stressors such as heat.

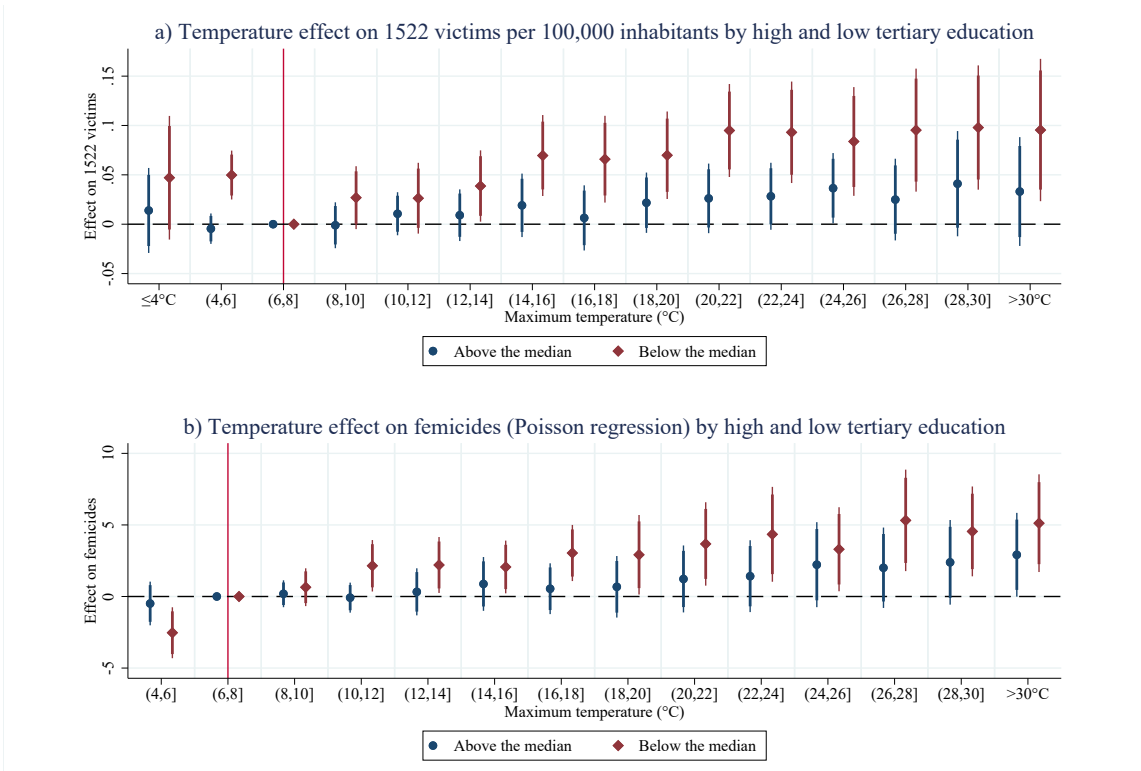
Several mechanisms could explain this differential vulnerability. Higher educational attainment is typically associated with more stable employment, improved housing conditions, better economic security, greater awareness of available support services and better conflict resolution skills. Together, these factors may reduce both the likelihood and severity of domestic tensions triggered by heat stress, and limit their escalation into violence.

Moreover, the higher volume of helpline calls in low-education provinces may reflect not only a greater incidence of GBV, but also a heavier reliance on national services due to underdeveloped local support systems. In these contexts, the 1522 helpline may represent a critical, sometimes sole, resource for victims seeking assistance. Thus, the increase in calls may simultaneously indicate heightened vulnerability and structural service gaps, reinforcing the notion that educational disadvantage operates through multiple, interrelated channels.

This interpretation aligns with a growing body of empirical research on intimate partner violence. Boyle et al. (2009), for instance, show that women with higher levels of education are significantly less likely to experience IPV, highlighting education as a key protective factor at both the individual and community level. Similarly, Heise and Kotsadam (2015) document that women's tertiary education is consistently associated with lower IPV prevalence across countries, particularly in settings characterized by entrenched patriarchal norms and high gender inequality. While this literature focuses on non-lethal forms of violence, it is consistent with our findings that education strengthens individual and community capacity to cope with stressors, thereby lowering the probability that heat-related shocks translate into both increased reporting and more severe violent outcomes.

Taken together, these findings suggest that education strengthens both individual and community capacity to cope with climate-related stressors, reducing the risk that heat translates into GBV.

Figure C.4: Effect of weekly average maximum temperature by tertiary education (above and below the median fraction of the active population with tertiary education)



Notes: The vertical lines indicate the reference category $(6, 8]$°C, whose coefficient is normalized to zero. In graph b, The results for the first temperature bin ($\leq$ 4°C) is not displayed because not identified for provinces in the Center-South, where rarely weekly average maximum temperatures are below 4°C. Each regression is weighted by the provincial population of the year of the observation. The average of the dependent variable, weekly 1522 helpline calls by victims per 100,000 inhabitants, at the reference bin for each graph is as follows: a) 0.349; b) 0.287. Confidence intervals are derived from two-way clustered standard errors, with clusters at the level of sequential months and of provinces.

High and low fraction of foreigners (citizenship) over the observed time period

The proportion of foreign-born residents may also be relevant, as migrants often face poorer socio-economic conditions and may hold different cultural attitudes toward gender-based violence, including the reporting of both partner and non-partner violence.

Figure C.5 displays the estimated coefficients for victims' calls to the 1522 helpline (graph a) and femicides (graph b), disaggregated by provinces with a share of foreign residents above or below the median over the observed period.

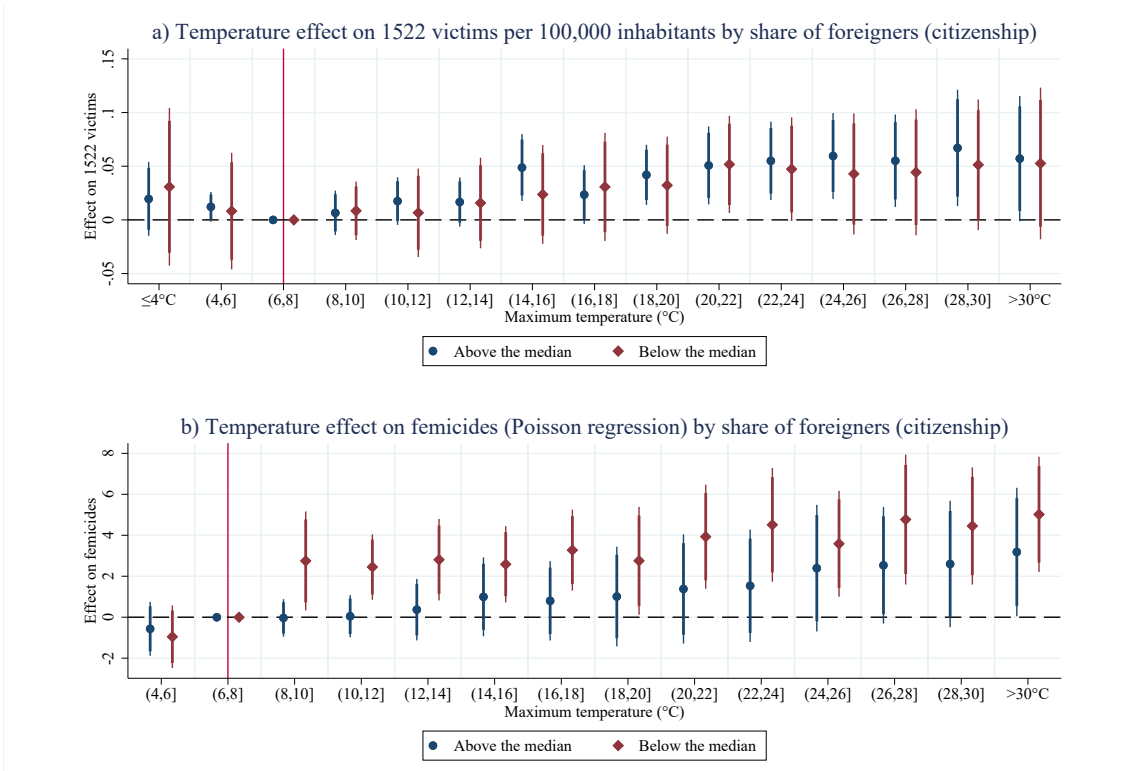
The results for help-seeking behavior reveal a broadly consistent response to temperature increases across both demographic contexts. In provinces with both high and low shares of foreign residents, helpline calls begin to rise noticeably once weekly average maximum temperatures exceed approximately 16–18°C. However, the similarity in call-rate slopes across provinces may mask underlying heterogeneity in reporting behavior. Prior evidence indicates that foreign-born women are significantly less likely to seek help from formal institutions, due to language barriers, fear of deportation, and distrust of authorities (Newberry et al., 2025). Population-based data from Sweden further confirm that foreign-born women face heightened threat and victimization risks while remaining institutionally invisible (Fernbrant et al., 2014). These findings suggest that observed similarities in helpline activity may reflect a combination of stronger unreported victimization among migrants and greater institutional access among natives.

In contrast, the femicide estimates display a more nuanced divergence. Between 14°C and 24°C, the coefficients are consistently higher in provinces with lower shares of foreign residents, although not statistically significant. This suggests that moderate heat may be more strongly associated with lethal outcomes in native-dominated areas. While the mechanisms require further investigation, the result underscores the need to interpret aggregate femicide patterns in light of demographic composition and institutional responsiveness.

C.5 Sensitivity to GBV and its prevalence

To assess how social norms and institutional capacity relate to our outcomes, we use two complementary indicators. First, we employ the Gender Norms Index (GNI) developed by Carrer and De Masi (2024), which captures societal attitudes toward gender roles across multiple dimensions. Provinces are categorized as having high or low GNI, allowing us to explore the role of prevailing gender norms. Second, we use updated data on the presence

Figure C.5: Effect of weekly average maximum temperature by fraction of foreigners (above and below the median fraction of foreigners)



Notes: The vertical lines indicate the reference category $(6, 8]$°C, whose coefficient is normalized to zero. In graph b, The results for the first temperature bin ($\leq$ 4°C) is not displayed because not identified for provinces in the Center-South, where rarely weekly average maximum temperatures are below 4°C. Each regression is weighted by the provincial population of the year of the observation. The average of the dependent variable, weekly 1522 helpline calls by victims per 100,000 inhabitants, at the reference bin for each graph is as follows: a) 0.330; b) 0.311. Confidence intervals are derived from two-way clustered standard errors, with clusters at the level of sequential months and of provinces.

of Anti-Violence Centers (CAVs), sourced from the official 1522 portal and aggregated at the provincial level by Cerqua et al. (2024). This mapping enables us to examine the territorial distribution and accessibility of specialized support services, shedding light on the institutional response to GBV across Italy.

Above and below the median of the Gender Norm Index

Figure C.6 displays the results for calls to the 1522 helpline (graph a) and femicides (graph b), with estimates disaggregated by provinces above and below the median of the Gender Norm Index (GNI). The GNI captures territorial variation in conservative gender attitudes across Italy (Carrer and De Masi, 2024).

The temperature-response profiles appear strikingly similar across the two groups. For helpline calls and femicides, both high-GNI (more conservative) and low-GNI (more egalitarian) provinces show a comparable increase in response to rising temperatures, particularly above 18°C. This symmetry suggests that the behavioral response to thermal stress may be relatively unaffected by prevailing gender norms.

While this might seem at odds with prior evidence linking conservative gender norms to higher baseline levels of IPV (González and Rodríguez-Planas, 2020), it aligns with the idea that acute stressors, such as extreme heat, may operate through universal channels, including physiological discomfort, reduced sleep quality, or prolonged co-presence within the home, triggering conflict independently of normative context. These mechanisms are consistent with routine activity and stress-aggression theories, which emphasize situational rather than structural triggers.

Moreover, the absence of heterogenous temperature effects across levels of the GNI is conceptually consistent with the nature of the index itself. As a proxy for deeply rooted normative beliefs, the GNI is better suited to capture long-run, structural determinants of GBV prevalence than short-run behavioral responses to transitory shocks. In this sense, the index may explain geographic variation in baseline risk levels or in reporting behavior, but not necessarily in the marginal sensitivity to climatic shocks. This interpretation is in line with recent evidence emphasizing the persistence and intergenerational transmission of gender norms. For instance, González and Rodríguez-Planas (2020) show that gender norms inherited from countries of ancestry strongly predict the risk of intimate partner violence among first- and second-generation immigrant women in Spain, even after conditioning on host-country institutions and individual characteristics. Their

findings underscore the role of cultural transmission in generating durable differences in vulnerability to GBV, rather than in shaping immediate behavioral reactions. Similarly, Gracia et al. (2025) demonstrate that contextual hostile sexism, distinct from broader gender norms, clusters spatially and is strongly associated with IPV risk. However, they do not find direct evidence that such attitudes moderate climate-related escalations into lethal violence.

In sum, while gender norms remain important for understanding long-term patterns of GBV, their role in moderating the short-term impact of environmental stress appears limited. The findings suggest that norm progressiveness should not be assumed to buffer against heat-related violence. Rather, even more egalitarian provinces require climate-aware prevention strategies, including strengthened support services, surge capacity during heatwaves, and early-warning systems tailored to anticipate spikes in domestic conflict.

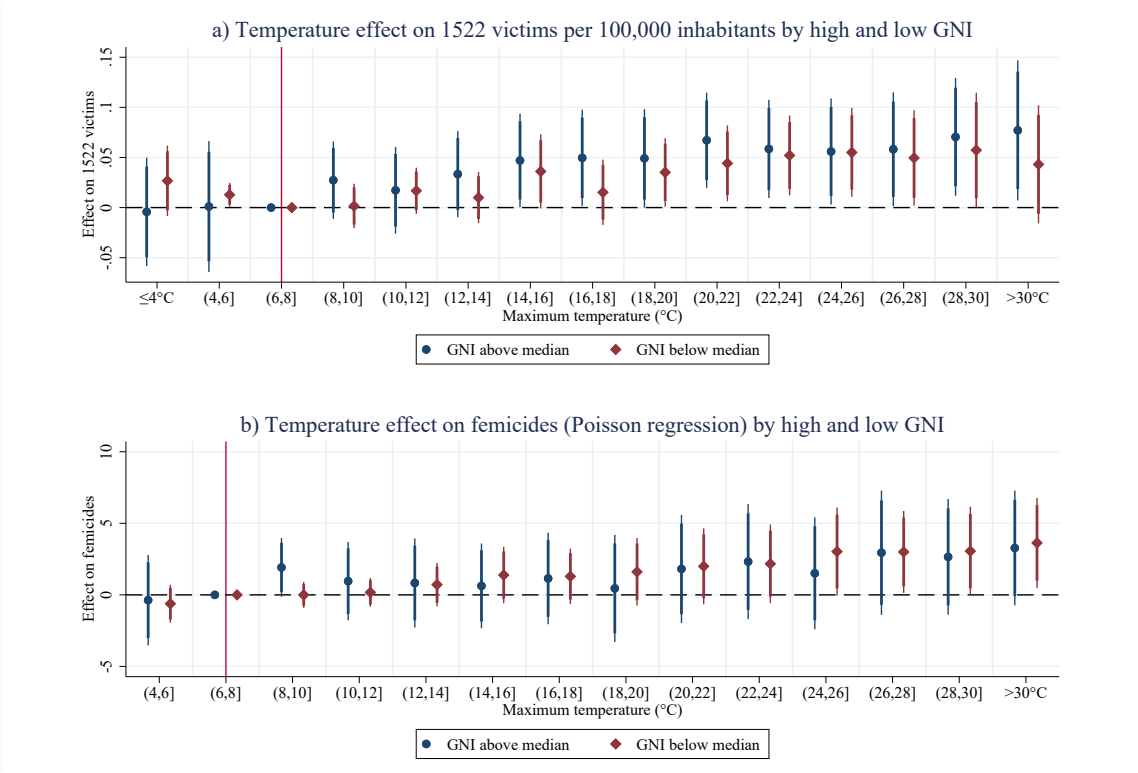
High and low presence of anti-violence centers over the observed time period

Figure C.7 shows the results for calls to the 1522 helpline (graph a) and femicides (graph b), with estimates disaggregated by provinces with a density of anti-violence centers (AVCs) above or below the median, based on the mapping developed by Cerqua et al. (2024).

For helpline calls, the temperature-response profiles appear broadly similar across groups, with no statistically significant differences in most bins. However, above 28°C, a divergence emerges: provinces with fewer AVCs show a sharper increase in calls. Although the difference is not statistically significant, this pattern may signal a compensatory role played by the 1522 helpline in underserved areas. Where local, in-person services are sparse, victims may turn more readily to national hotlines during episodes of heat-induced stress and conflict. In this sense, the helpline may act as a substitute for physical support infrastructure in areas with limited territorial coverage.

The femicide results paint a different picture. While overall differences between high- and low-AVC provinces remain statistically modest, coefficients tend to increase at high temperatures (above 26°C), particularly in areas with greater AVC presence. At first glance, this may appear paradoxical: why would lethal outcomes rise more where services are stronger? One possibility is that the observed effect reflects better case detection in these provinces. Prior evaluations have shown that the expansion of domestic violence

Figure C.6: Effect of weekly average maximum temperature by GNI (above and below the median GNI)

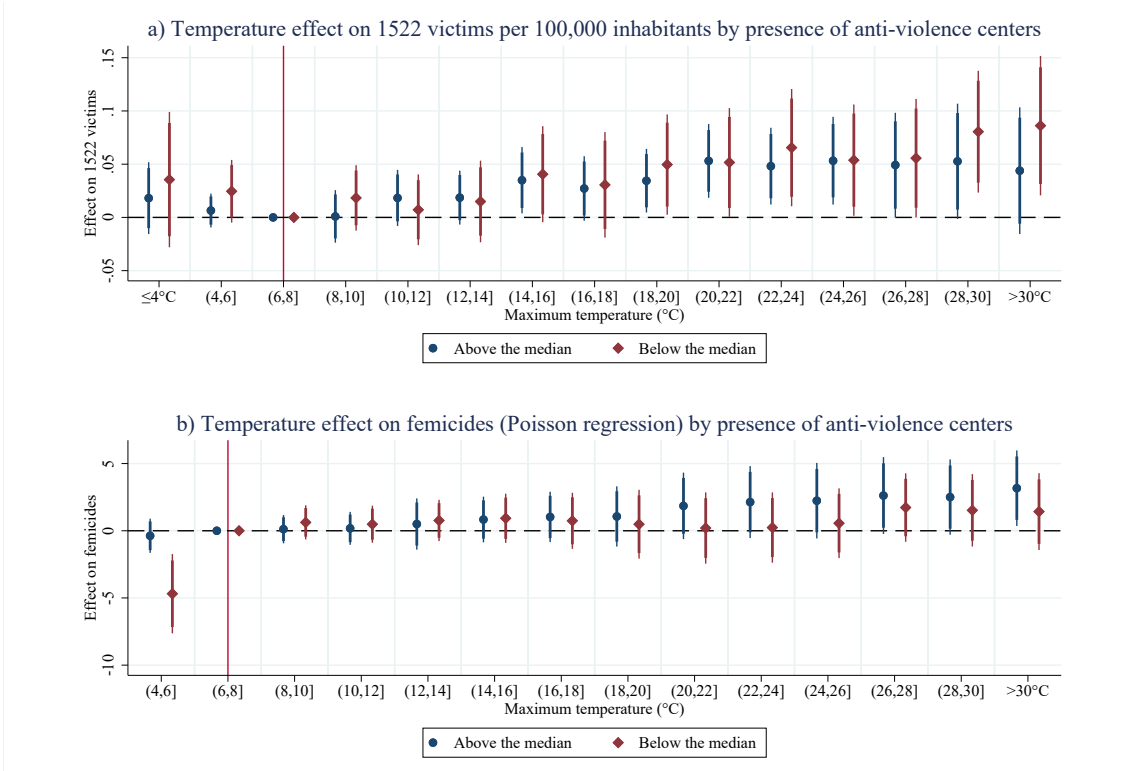


Notes: The vertical lines indicate the reference category $(6, 8]$°C, whose coefficient is normalized to zero. In graph b, the results for the first temperature bin (≤ 4°C) is not displayed because not identified for provinces with high GNI. Most of these provinces are indeed from the South of Italy, where rarely weekly average maximum temperatures are below 4°C. Each regression is weighted by the provincial population of the year of the observation. None of the displayed coefficients for high GNI provinces are significantly different from those for low GNI provinces. The average of the dependent variable, weekly 1522 helpline calls by victims per 100,000 inhabitants, at the reference bin for each graph is as follows: a) 0.312; b) 0.330. Confidence intervals are derived from two-way clustered standard errors, with clusters at the level of sequential months and of provinces.

services often improves reporting and administrative classification, without necessarily indicating an increase in actual incidence (Aizer and Dal Bó, 2009; Wells et al., 2010). The upward shift in femicide coefficients in high-AVC areas may thus reflect institutional engagement and improved surveillance rather than more violence per se.

In sum, while the presence of AVCs does not seem to fundamentally alter the temperature-violence relationship, small differences in the magnitude of responses, particularly with extreme heat, highlight the importance of institutional context. In provinces where access to physical services is limited, the national helpline appears to serve as an essential outlet, especially during environmental shocks. In contrast, provinces with stronger service networks may record more cases due to enhanced detection and case processing, rather than higher true incidence.

Figure C.7: Effect of weekly average maximum temperature on victims' weekly calls to 1522 helpline by presence of anti-violence centers (above and below the median presence of anti-violence centers)



Notes: The vertical lines indicate the reference category $(6, 8]$°C, whose coefficient is normalized to zero. In graph b, the results for the first temperature bin (≤ 4°C) is not displayed because not identified for provinces with high GNI. Most of these provinces are indeed from the South of Italy, where rarely weekly average maximum temperatures are below 4°C. Each regression is weighted by the provincial population of the year of the observation. The average of the dependent variable, weekly 1522 helpline calls by victims per 100,000 inhabitants, at the reference bin for each graph is as follows: a) 0.345; b) 0.265. Confidence intervals are derived from two-way clustered standard errors, with clusters at the level of sequential months and of provinces.