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Measuring the Gender-Climate Nexus

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Abstract*

Every year, 245 million women are victims of intimate partner violence (IPV). Climate change is hypothesized to exacerbate this figure through its disruptive impact on household livelihoods, among other channels. However, little causal evidence exists on this aspect of the climate-gender nexus, partly due to measurement challenges that have contributed to gaps in the literature. In this paper, we use three different IPV data sources to examine the effect of drought in Mexico and the role of agricultural vulnerability in intensifying these effects. We find robust evidence of increases in all measures of IPV in response to local precipitation deficits: as unanticipated exposure to days without rain in the previous month rises, more injuries linked to IPV are recorded in the public health system, police reports increase, and more 911 calls related to IPV are made. The effects are stronger in regions highly dependent on agriculture, particularly when the shock occurs during the growing season. In a country where most agricultural income and land are controlled by men, our results align with theoretical predictions from male-backlash IPV models and extractive violence models. We also find that the impact of drought on IPV is more pronounced in municipalities with low state capacity, though potential differences in reporting behavior between IPV measures complicate comparisons. Our findings underscore the need to design gender-sensitive disaster relief policies, strengthen trust in reporting mechanisms and helplines, and reduce the social acceptability of IPV.

JEL classifications: I15, J16, Q54, D13
Keywords: Drought, Domestic violence, Intimate partner violence, Agriculture, Mexico

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1 Introduction

Intimate partner violence (IPV) is one of the most pressing challenges to women's health worldwide: approximately 245 million women—equating to 10% of those aged 15 and above—are subjected to either psychological, sexual, or physical violence by their partners every year. In Mexico, the focus of our study, the prevalence of IPV reflects global patterns. According to the World Bank Gender Portal, 24% of Mexican women have experienced IPV, closely aligning with the global average of 26% (World Bank, 2022b).

Despite this high prevalence, reporting rates are low: only one in 10 women reported experiencing violence in the past 12 months (ENDIREH, 2021). Thus, efforts to improve policies aimed at protecting women are hampered by a lack of high-quality data. Furthermore systematic data collection is recent in many regions with high prevalence (Cullen, 2023). The effects of IPV reach beyond immediate physical or emotional harm, significantly influencing long-term health outcomes (Campbell, 2002), reducing labor market participation (Bhattacharya, 2015; Sabia *et al.*, 2013), and diminishing overall well-being (Oduro *et al.*, 2015; Adams *et al.*, 2012).

IPV has been poised as a key dimension of the climate-gender nexus. Climate change, which is anticipated to escalate the frequency and severity of extreme environmental events (Arias *et al.*, 2021), interacts with existing inequalities (Keerthiratne and Tol, 2018; Warr and Aung, 2019; Chowdhury *et al.*, 2021)), including gender (Gevers *et al.*, 2020; UN Women, 2022), disproportionately affecting women's mortality (Neumayer and Plümper, 2007), morbidity (Fatema *et al.*, 2019), and housing security (Logie *et al.*, 2017). [1] An environmental hazard of particular concern are droughts, which are among the most expensive natural disasters in the world, with significant costs to ecosystems, agriculture, and human livelihoods (Cook *et al.*, 2018). Climate change is expected to increase drought frequency and severity over much of the globe (Dai, 2013). By 2050, an additional 1 billion people are expected to live with extremely high water stress[2] (Kuzma *et al.*, 2023). This paper seeks to understand the causal impact of drought on IPV in Mexico, a country with both tropical and semi-arid environments, where 40-80% of the population are exposed annually to water stress (Kuzma *et al.*, 2023).

Agriculture is a particularly climate-sensitive sector, and in Mexico, it is also predominantly male-biased in terms of labor composition, as well as land ownership and governance. Women constitute only 12.7% of the country's agricultural laborers. Furthermore, while half of the land is under a communal property and management system known as ejidos, women hold only 26% of ejido rights, and out of the 14.6 thousand ejidos and communities with representative bodies, only

[1] Some ways in which gender norms reduce women's resilience include their lower control over income and assets to face shocks (Van Aelst and Holvoet, 2016; Roncoli *et al.*, 2001) and facing mobility restrictions that limit their access to aid and healthcare (Parmar *et al.*, 2019; Boyer *et al.*, 2020)

[2] Water stress, the ratio of water demand to renewable supply, measures the competition over local water resources. The smaller the gap between supply and demand, the more vulnerable a place is to water shortages.

7.4% are presided over by a woman (Registro Agrario Nacional, 2019). Under these conditions, an average decrease in crop yields resulting from droughts directly reduces the relative income of men compared to women. Economic theories of IPV provide differing predictions on the impact of disasters on IPV. Bargaining power models suggest that a decrease in men's relative income should increase women's bargaining power within the household and consequently decrease domestic violence (Aizer, 2010; Anderberg *et al.*, 2016). On the other hand, extractive violence models argue that reduced income may increase male partners' incentives to use violence as a tool to regain control over household decision-making or extract financial resources, to compel women to work longer hours, or as a response to stress over income loss (Eswaran and Malhotra, 2011; Bobonis *et al.*, 2013; Erten and Keskin, 2018, 2021, 2024).

In our study, we investigate the impacts of drought exposure on IPV in Mexican municipalities. We combine gridded precipitation, and temperature estimates data from NASA Daymet repository (Thornton *et al.*, 2022) to generate disaster exposure measures with high temporal and spatial granularity with administrative data from various sources. The identifying assumption is that these events are unexpected to households once controlling for a battery of geographical and seasonal fixed effects and thus plausibly exogenous. To overcome the measurement challenge, we employ three measures of IPV with distinct strengths and weaknesses. First, we utilize hospital discharge records reported by healthcare institutions from Mexico's largest public health subsystem. We aggregate these data at the weekly level to produce municipality-week measures of the incidence of injuries that can be disaggregated into IPV and nondomestic violence. Second, we incorporate police files from the National Security System (SNSP) for domestic violence data. Finally, through hundreds of information requests to local law enforcement agencies, we collected data from local government hotlines that receive emergency calls about IPV. Overall, two out of three of our gender-based violence (GBV) measures directly capture IPV. Although we can only measure domestic violence in police files without differentiating by sex, public hospital records show that 82% of domestic violence is IPV, and 95% of IPV victims in Mexico are women. Therefore, throughout the document, we will primarily refer to our results as IPV. With the three mentioned measures, we conduct our analyses at the weekly and monthly levels and quantify the effect on violence of each additional extreme day in a given week.

Our findings reveal a robust causal effect of drought on IPV and non-domestic violence towards women and non-domestic violence towards men. The rate of female hospitalizations for non-domestic violence increases by 7.4%, and for male hospitalizations, the increase is 14%. IPV rates display a gendered pattern; female hospitalizations for IPV increase by up to 9% during severe drought periods, while there is no statistical impact on male IPV hospitalizations. Using police reports and 911 hotline calls as alternative dependent variables, we consistently find marked increases in IPV during droughts. Regions with lower state capacity exhibit higher increases in police reports and hospitalizations, suggesting that state capacity influences the deterrence effect

of IPV. In a deterioration of the rule of law, under-reporting biases might increase. With this mechanism operating against our ability to capture increases in crime, detecting such increases in low-state capacity counties—*ceteris paribus*—suggests that the rise in incidence outweighs the possible bias in reporting.

The setting of our study is relevant for this theoretical debate because droughts do not usually destroy infrastructure or property, thereby not affecting some common triggers of violence such as the deterioration of state capacity, destruction of roads, which weakens support systems for women, and emergency displacement (Thurston *et al.*, 2021; Gevers *et al.*, 2020; UN Women, 2022). This unique characteristic of droughts allows us to isolate the economic mechanisms, particularly income loss—or stress due to anticipated income loss, a mechanism especially underscored in the public health literature (Thurston *et al.*, 2021)—to test existing theories of IPV. We examine the mechanisms behind our main findings, highlighting the role of agricultural downturns in a country where the bulk of the workforce and land ownership in this sector is male. We find that droughts significantly increase IPV in regions with high agricultural reliance. Our results align more robustly with the "male backlash" model, where male status inconsistency heightens IPV as men seek to assert control within the household or extract resources to compensate for income losses. We find that effects are more pronounced when the drought hits during the municipality- and crop-specific growing seasons, underscoring the role of immediate economic stress once farmers observe low precipitation levels.

Our work contributes to the literature on IPV measurement, which is an important challenge in identifying its causes. Previous works have utilized survey data (e.g., in Díaz and Saldarriaga (2023); Sviatschi and Trako (2024)), police reports (Miller *et al.*, 2024) hospital records (Aizer, 2010; Sviatschi and Trako, 2024), and recently, emergency calls (Leslie and Wilson, 2020; Agüero, 2021; Miller *et al.*, 2024). While recent papers have highlighted the advantages of hotline calls as a measure of violence against women, in this paper we discuss their advantages and drawbacks by comparing this measure to several years of police reports and hospital records at the national level. We confirm that hospitalizations and police reports experience higher increases in municipalities with low local state capacity. However, further research is required to draw conclusions about 911 calls. In any case, our findings highlight the importance of creating accessible support services for women to seek help and report instances of IPV. This includes the significance of governments gathering and making public measures of IPV.

Our collection of datasets enables us to analyze predominantly public space violence and compare it with IPV, which mainly occurs at home. This lets us show that, while generalized violence responds to droughts, women face an additional burden at home. With these insights, our study contributes to a small but growing body of quantitative analyses that investigate the relationship between droughts and gender violence. This literature has focused on low-income

countries, frequently finding significant impacts (Hirvonen *et al.*, 2023; Epstein *et al.*, 2020; Munala *et al.*, 2023a; Abiona and Koppensteiner, 2018; Cools and Kotsadam, 2017; Cooper *et al.*, 2021). However, middle-income countries, home to 75% of the world's population, remain unexplored. Our findings of the strong effects of droughts on violence in Mexico, the twelfth-largest economy in the world, suggest that women's vulnerability to climate change will not solve itself through economic development. As climate change unravels, more policies addressing the gendered impacts of climate extremes will be required.[3]

We also contribute to understanding the climate-gender nexus through disasters. Thurston *et al.* (2021) finds in a literature review that quantitative studies with a greater geographical scope and use of spatial data are required to understand the magnitude of the problem and the mechanisms behind it. They identify that some authors of quantitative papers present hypothesized pathways from disaster exposure to increased violence against women and girls (VAWG) but fail to test it empirically. While some work has looked at the effects of drought on self-reported measures of IPV using repeated cross-section survey data (Díaz and Saldarriaga, 2023; Cools *et al.*, 2020), most of the current literature comprises qualitative investigations (Ylipaa *et al.*, 2019) and case-specific analyses of individual extreme events (van Daalen *et al.*, 2022). Our findings are consistent with a model in which men react to income loss and stress by exerting more violence toward their partners.

More broadly, we contribute to our understanding of the climate-violence nexus. We find that the effect of drought on violence against women is larger than the climate-conflict estimates reported in many previous studies[4]. We estimate an increase between 9% and 26%—depending on the variable employed to measure IPV—from the sample mean when a full month of unexpected drought hits a municipality. The magnitude of these effects in a middle-income country like Mexico suggests that the effects of gendered violence are a crucial, previously unexplored dimension of the climate-violence literature.

The remainder of this paper is organized as follows. Section 2 provides a theoretical background and context, Section 3 describes the data used in our analysis and presents descriptive statistics. Section 4 lays out our empirical strategies. Section 5 presents our baseline results and analyzes the mechanisms, heterogeneity, and robustness checks. Section 6 concludes.

[3]Figure A.1 shows that Mexico's GDP per capita is between 1.5 and 6 larger than other countries studied in the quantitative drought-IPV literature: 2.8 times the GDP per capita of India, 5.3 times the Sub-Saharan Africa average, and 1.6 times the GDP per capita of Peru, the only other Latin American country studied in this literature.

[4]In a review of this literature, Hsiang *et al.* (2013) find that the effect of temperature is generally larger than the standardized effect of rainfall, and the effect on intergroup violence (e.g., civil war) is larger than the effect on interpersonal violence (e.g., assault). Particularly, for each standard deviation change in climate toward warmer temperatures or more extreme rainfall, median estimates indicate that the frequency of interpersonal violence rises 4% and the frequency of intergroup conflict rises 14%.

2 Context and theoretical background

2.1 Drought in Mexico

Climate change affects regions and demographics differently, with gender and economic status being a relevant factor (Arora-Jonsson, 2011). The global North and South show a pronounced disparity, likely related to fragile institutions and overall higher socioeconomic vulnerability in the South, but also due to differing baseline climates and net local effects of global warming (Arias *et al.*, 2021; Bednar-Friedl *et al.*, 2022). In the case of droughts[5], Zaveri *et al.* (2023) estimate their incidence has increased by up to 233% in certain regions over the past 50 years. This phenomenon has become more prevalent in poor countries, often located in arid regions and particularly vulnerable to dry shocks. Among its impacts, authors estimate that moderate drought reduces developing countries' growth by 0.39% on average, while extreme drought reduces growth by 0.85%. More directly, droughts are linked to malnutrition and lack of educational opportunities for women and children, leading to long-lasting effects on both.

Droughts are the costliest natural disasters, affecting more people than other forms of natural disasters (CONAGUA, 2022). The primary channel through which droughts impact households and the entire economy is through agriculture. Research suggests that 82% of all damage and loss caused by drought is absorbed by agriculture, making it the leading cause of agricultural production loss worldwide (FAO, 2021). In Mexico, our country of interest, 9 out of 10 disasters between 2005 and 2019 were due to hydrometeorological events, which affected 3.4 million hectares of crops and pastures (FAO, 2019).

Droughts are becoming more frequent and affecting a larger number of municipalities and populations across Mexico as climate change unravels. According to estimates by the Central Bank, between May 2018 and May 2021, the percentage of municipalities in drought emergency in Mexico increased from 7.0% to 35.0% in 11 and 23 states, respectively, out of a total of 32. For these same periods, 14.1% and 44.6% of the total population lived in a municipality experiencing a drought emergency, which means that by 2021, about half of the population lived in a municipality facing water shortages (Banxico, 2022). Additionally, water stress levels, referred to as the amount of freshwater withdrawn compared to the available freshwater resources, have increased in Mexico and surpassed almost all other LAC countries (FAO, 2020). According to this source, by 2024, dry shocks have continued to get worse, and more than 60% of the national territory is suffering from droughts that have limited access to water in households (IMCO, 2024).

As the most prominent use of water in Mexico is agricultural (76%), and 23.8% of the national territory is for agricultural use, drought poses a critical threat to the Mexican economy and household wealth. Even though drought impacts are seen across the country, there is heterogeneity

[5]Drought occurs when there is a significant decrease in the amount of rainfall compared to the normal recorded levels.

among regions. Drought impacts are more pressing in the northern, central, and northwest regions, where just 32% of the country's renewable water comes from, but more than 70% of the population lives (CONAGUA, 2022).

Henceforward, as the frequency and intensity of drought increase, several regions globally may experience a decline of up to 6% in their GDP by 2050 due to water-related losses (World Bank, 2023). In this context, in Mexico, almost 60% of the states are expected to face high water stress in 2050, which is a significant increase from 34% in 2020 (S&P, 2023). CONAGUA, the National Water Authority in Mexico, pointed out that an additional aspect that could press drought impacts in Mexico could be the increase in population[6] and urbanization CONAGUA (2022).

2.2 The Gender-Climate Nexus: The case of droughts

Environmental research has examined the interplay between disaster exposure and social inequalities, especially regarding income and race (Keerthiratne and Tol, 2018; Warr and Aung, 2019; Chowdhury *et al.*, 2021). As gender perspective and intersectionality are incorporated into the mainstream policy discourse, international organizations have increasingly raised concerns about the disproportionate impacts of climate change and disasters on women (Gevers *et al.*, 2020; UN Women, 2022). The Intergovernmental Panel on Climate Change (IPCC) underscores gender inequality as a critical dimension of climate vulnerability across regions in the global South (Bednar-Friedl *et al.*, 2022). The disproportionate impact of environmental insults on women can be traced to several additional constraints. For instance, gender norms can considerably limit women's capacity to respond effectively to extreme events, as they often have limited control over income and assets, rendering them more susceptible to shocks (Van Aelst and Holvoet, 2016; Roncoli *et al.*, 2001). Mobility restrictions leading to restricted access to aid and healthcare resources also compound these vulnerabilities (Parmar *et al.*, 2019; Boyer *et al.*, 2020).

A now abundant literature has linked weather anomalies to conflict and crime. [7] Most of this literature has been conducted from a gender-neutral standpoint, in practice often studying male-to-male violence, as when focusing on civil conflict and homicides (e.g., Burke *et al.* (2015)). Furthermore, most climate-violence literature has focused on heat, not water scarcity.[8] In Section 2.1, we discussed how drought in Mexico and other countries in the global South is a concerning aspect of climate change, already causing significant economic losses and affecting families' wealth and health.

Some of the mechanisms explored in the climate-conflict literature might also apply to gender-based violence (GBV). However, recent advances in the economic literature have proposed models

[6] Between 2020 and 2030, the country's population will increase by 11.5 million people (INEGI, 2010).

[7] Recent examples include Blakeslee *et al.* (2021); Heilmann *et al.* (2021)

[8] The literature review conducted by Hsiang *et al.* (2013) identifies about 60 quantitative studies, of which only seven examine drought.

of intrahousehold violence that operate under markedly distinct mechanisms from most forms of interpersonal violence. The following section briefly outlines the gender-specific mechanisms in the climate-violence relationship.

2.2.1 Intra-household violence theory

In an economy where income is earned mainly by men, a reduction in economic activity might increase women's bargaining power, as the production of market goods decreases relative to household goods. Different theories of IPV have divergent predictions of the effect of a woman's bargaining power on IPV. The theory of expressive violence states that abusers enjoy and, in a way, "pay for" violence against their victims; this implies that an increase in the victim's bargaining power reduces IPV (Aizer, 2010; Anderberg *et al.*, 2016), as it increases the probability of leaving an abusive relationship and consequently, the costs of IPV. The theory of instrumental violence suggests that a relative deterioration in men's economic standing increases IPV as an abuser uses violence to reassert control over the bargaining process or extract resources (Eswaran and Malhotra, 2011; Erten and Keskin, 2018, 2021, 2024). A result supporting this hypothesis is found in the study by Sekhri and Storeygard (2014) linking a one standard deviation fluctuation of rainfall below its long-term mean with a 7.8% increase in dowry deaths and a 4.4% increase in domestic violence. Shocks in agriculturally important periods of rain drive their results. In their framework, the farmer can mitigate the costs of this drop in agricultural production by appropriating from others. In the cultural context of the study, a profitable appropriation activity is to engage in domestic violence to seek dowry.

For Mexico, previous research has provided empirical support for the extractive violence theory. Particularly, Angelucci (2008) finds that cash transfer programs targeting women had varying effects on violence against them depending on the transfer size, husbands' education, and spousal age gap. While small transfers to women reduced domestic violence by 37%, large cash transfers led to significant increases in domestic violence due to threats to gender identity stereotypes. In the same line, Bobonis *et al.* (2013) finds that cash transfer programs benefiting women decreased by 40% the likelihood of being victims of physical abuse. Nonetheless, this decrease was accompanied by an increase in the likelihood of receiving violent threats, potentially leading to a different type of violence and compromising Mexican women's emotional health and well-being. Furthermore, Terrazas-Carrillo and McWhirter (2015) find that women's employment status is a significant predictor of domestic violence toward Mexican women. In this context, improvements in women's relative earnings do not always reduce GBV, despite common assumptions.

In a society where aggression is more associated with masculine behavior, the stress-driven aggression often cited in the public health literature (Thurston *et al.*, 2021) will be more prevalent among individuals raised to comply with masculinity (Miedzian, 2002). In the public sphere, the

consequences of such increases in aggression might manifest against men and women, potentially with higher increases for men, since they spend significantly more time outside the home (Aguilar-Gomez *et al.*, 2019) (in Section 5 we show that this is the case). However, in the private sphere, with most households being headed by a heterosexual couple, the receiving end of the consequences of this increased aggression is likely to be concentrated among women.

3 Data and Descriptive Statistics

3.1 Domestic and intimate partner violence data

Measuring accurate statistics of violence against women is a common challenge in this literature. Self-reporting surveys are perhaps the most frequent data source (e.g., in Díaz and Saldarriaga (2023); Sviatschi and Trako (2024); Bhalotra *et al.* (2021)). However, research shows that self-reported domestic violence measures often underestimate the true prevalence of the issue, and the level of misreporting is nonrandom (Ellsberg *et al.*, 2001). Additionally, surveys are not consistently collected over time, which hinders intertemporal and comparative analyses. Another common source to measure violence against women is police records. However, these too suffer from significant underreporting, particularly in developing countries where women distrust the justice system, as police often ignore GBV complaints (Eswaran, 2018; Boesten, 2012; Nguyen, 2019). To address part of this issue, researchers have used hospital administrative data, which are consistently collected over time and do not necessarily rely on self-reporting (Aizer, 2010; Sviatschi and Trako, 2024). Additionally, a proxy that gained popularity during the COVID-19 pandemic, and has been used recently, is emergency calls to hotlines. This measure is considered to capture less severe violence, thereby providing a broader picture of the issue (Agüero, 2021; Leslie and Wilson, 2020; Miller *et al.*, 2024).

In Mexico, only 7.1% of women who have experienced domestic violence have sought help or reported the incident to the authorities (ENDIREH, 2021). To address this challenge and obtain a comprehensive understanding of trends in violence against women in Mexico, we use three data sources with distinct strengths and weaknesses: public hospital records, police files, and hotline calls.

3.1.1 Hospital records

First, we leverage detailed anonymized records from all hospitals and emergency departments in Mexico's largest public health subsystem.[9] This dataset encompasses all injuries involving any contact with the public health system, from a simple consultation at a pharmacy to hospitalization. Victim characteristics and the date of occurrence are captured for all incidents. To construct this

[9] We employ data from roughly 800 Ministry of Health hospitals, which serve approximately 70% of the population.

dataset, information from admission and discharge forms completed by physicians and nurses is compiled and verified by the Ministry of Health (MoH) through the General Directorate of Health Information. Detailed ICD-10-based diagnosis codes allow us to identify IPV. Specifically, the codes in the category Y070 label intentional injuries where the spouse or partner is the perpetrator of maltreatment. Similarly, we construct variables indicating cases of non-domestic violence against women and men, as well as parental maltreatment against boys and girls using their respective ICD-10 codes. Using detailed information on the place and date of occurrence, we aggregate these records at the municipality-week level.

It is important to note that hospital records are our only data source that is disaggregated by the sex of the victim and contains a unique code for IPV (separating it from other forms of domestic violence, such as child maltreatment). Furthermore, hospital records inherently minimize underreporting bias when compared to other sources due to the decoupling of the patient's decision to seek medical care from the formal recording of the incident as domestic violence, irrespective of their intent to report violence. Once in the healthcare setting, the interaction between the patient and the healthcare provider——where the patient recounts the incident and the provider documents the account—occurs independently of any decision to engage with law enforcement or any other arm of the state apparatus. Subsequently, a coder enters the recorded details into the dataset after the patient's encounter has concluded. This two-step process ensures that the incident is captured based on medical assessment and does not require or cause a police report.

3.1.2 Police files

We employ crime reports from the National Security System (SNSP) between 2015 and 2021. SNSP statistics are gathered from local and state police departments, standardized for consistency across regions, and verified for accuracy through cross-referencing and consultation with local authorities. These data are aggregated at the municipality-month level. As discussed above, police records do not disaggregate these data by the victim's sex or by their relationship to the perpetrator in a way that does not allow us to distinguish among types of domestic violence.

3.1.3 Hotline calls

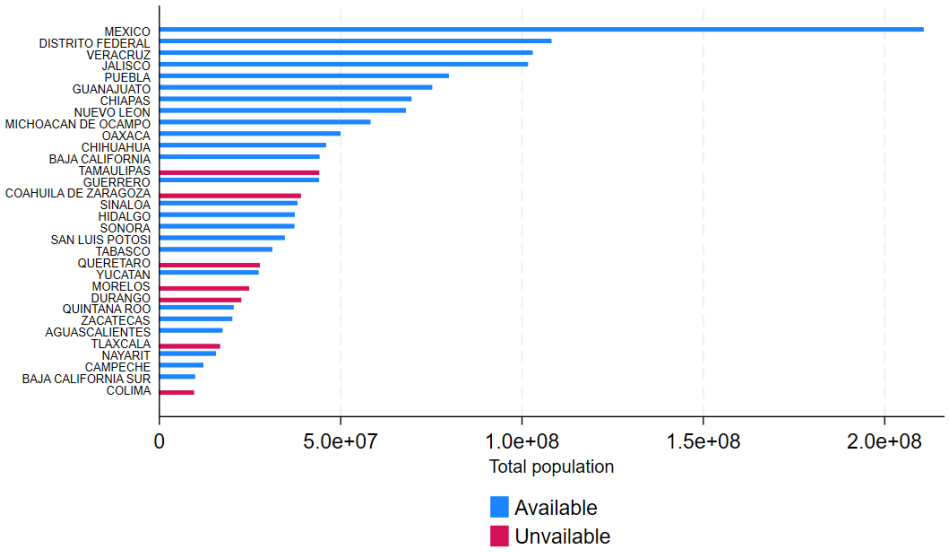
The analysis also incorporates data from hotline calls. Since 2016, protocols have been developed in 911 lines to receive and channel domestic violence calls and record this data. This program, a collaboration between SNSP and the National Women's Institute, aims to ensure that victims receive timely access to legal, psychological, and shelter services through referrals to local women's institutes.

Mexico's 911 system operates on a decentralized basis, resulting in a lack of a unified national data repository. Instead, data management falls under the purview of individual states and, in

some instances, municipalities, necessitating direct information requests to local authorities via the national transparency portal.[10] Consequently, we submitted 564 information requests across 32 states and 125 municipalities, receiving responses from 25 states that collectively represent 76% of the national population. The outcome of these efforts is illustrated in Figure 1, where Panel a) maps data availability (indicated in blue) across Mexican states, ordered by population size. Panel b) outlines the range of years for which data were provided. Our dataset, once again, does not include the sex of the victim. However, it does allow us to have a specific measure of IPV that encompasses violence perpetrated by a partner regardless of the cohabitation/marriage status. Precisely, the data separate between domestic and non-domestic IPV, and we add these two measures to have a variable as comparable as possible to the ICD-10-based measure we obtained from hospital data.

[10]The national transparency portal in Mexico (Plataforma Nacional de Transparencia) is an online platform designed to facilitate public access to government-held information. It allows users to submit requests for data or documents to any federal, state, or municipal government entity to enhance transparency and accountability across public administrations.

a) 911 call data availability by state



b) Coverage period

State	Availability
Aguascalientes	2005-2021
Bajacalifornia, Sonora	2006-2021
Chiapas	2007-2021
Baja California Sur	2015-2021
Nuevo Leon, Veracruz	2016-2021
Distrito Federal, Puebla, Sinaloa, San Luis de Potosi, Campeche, Quintana Roo	2017-2021
Mexico, Guanajuato, Michoacan, Guerrero, Hidalgo, Tabasco, Yucatan, Nayarit	2018-2021
Jalisco, Chihuahua	2019-2021
Oaxaca	2010-2021
Zacatecas	2011-2021

Figure 1: 911 data availability

Note: Panel a) shows the availability of hotline data by state. States are sorted by population size according to the 2010 Census. Panel b) Shows the specific years available for each state that provided information through the transparency platform.

3.1.4 Descriptive statistics

While neither police records nor hotline data register the sex of the victim, we know from public hospital records that 82% of domestic violence is IPV and that 95% of IPV victims in Mexico are women. Therefore, throughout the results analyses, we will primarily refer to our results as IPV.

Intimate partner violence is a highly feminized crime and the most common form of violence

against women, as shown in Table 1. The table is also informative in terms of illustrating the "iceberg" of domestic violence. Every month in Mexican municipalities, 208 emergency calls per 100,000 inhabitants are made on average in response to IPV and 67 incidents are reported to the police. Every week, 23 women per 100,000 inhabitants seek healthcare due to violence perpetrated by their partner.

Table 1: Violence data and descriptive statistics

Panel A: Hospital weekly records rate per 100,000 inhabitants					
	N	Mean	SD	Min	Max
Female victims of assault	1,003,808	2.55	11.5	0	1149
Male victims of assault	1,003,808	3.0	12.74	0	658
Female victims of IPV	1,003,808	5.71	29.2	0	3349
Male victims of IPV	1,003,808	0.11	1.85	0	554
Female victims of child maltreatment	1,003,808	0.42	4.01	0	707
Male victims of child maltreatment	1,003,808	0.09	1.70	0	455
Female victims of sexual violence	1,003,808	0.28	2.82	0	233
Male victims of sexual violence	1,003,808	0.025	0.78	0	220
Panel B: Monthly crime reports rate per 100,000 inhabitants					
	N	Mean	SD	Min	Max
Domestic Violence	193,380	66.77	213	0	8940
Panel C: Monthly hotline data rate per 100,000 inhabitants					
	N	Mean	SD	Min	Max
IPV	110,174	208	1225	0	185913

Notes: Panel A) Hospital Discharge Subsystem (SAEH) (2012-2019), weekly data from 75% of Mexican municipalities. Panel B) National Security System (SNSP) (2015-2021), monthly data from all Mexican municipalities. Panel C), Mexico's 911 System (2016-2021) Monthly data from municipalities with available data as described in Figure 1, covering the place of residence of 76% of the national population.

3.2 Drought

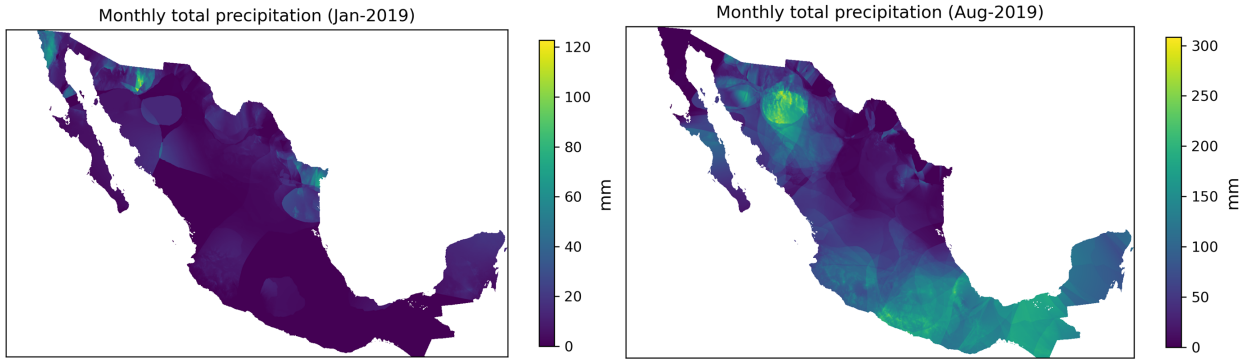
We construct a measure of exposure that counts the anomalous days without rain in various reference periods (e.g., past week, past month). Anomalous days are unexpected days without rain in a specific municipality and week of the year. We use precipitation data from Daymet (Thornton *et al.*, 2022), a data product provided by NASA's Oak Ridge National Laboratory (ORNL). This dataset provides data on a 1 km x 1 km gridded surface over continental North America since 1980. The estimates are generated through the interpolation and extrapolation of daily meteorological observations, with model inputs encompassing a digital elevation model, derived horizon files, and a land-water mask. The resulting output provides gridded estimates of total daily precipitation. We selected this source of weather information not only because it has a high spatial resolution but

also because it has the best performance for daily precipitation in Mexico (Rincón-Avalos *et al.*, 2022).

We also process the average daily maximum temperature to control for this factor. We spatially average Daymet pixels using municipality boundaries to estimate total precipitation levels and maximum temperature for each municipality's surface from 2012 to 2021. Appendix Figure A.2 illustrates the Daymet resolution compared to one of the smallest municipalities in Mexico.

The amount of precipitation and temperature varies throughout the year and across the Mexican territory (Figures 2 and A.3), supporting the external validity of our analyses. The dry season spans approximately from November to April and is characterized by lower precipitation levels across most of the country, with January (left) exemplifying this period's conditions. Conversely, most of the country's rainy season extends from late May to October, when rainfall significantly increases. Figure 2 (right) shows that monthly total precipitation can reach 300 milliliters per month.

Figure 2: Precipitation data



Source: ORNL DAAC- Daymet Version 4 Revision 1; authors' formulation.

3.3 Local characteristics

Municipality boundaries are obtained from the 2010 Geostatistical Framework version 5.0 (INEGI, 2010) [11]. We use individual-level occupation data from the Mexican Census conducted in 2010 (INEGI, 2010) to distinguish between agricultural and non-agricultural municipalities. From this Census, we define agricultural municipalities as those where the percentage of the population working in agriculture is above the national median (39 percent). The distribution of this variable is shown in Appendix Figure A.4. The municipality-level population used to calculate violence rates is also obtained from this source.

[11]The 2010 map is divided into 2,546 municipalities. Since some municipalities were created after this framework, all databases were adjusted to maintain these 2,456 municipalities.

3.3.1 Municipality-specific growing seasons

To examine whether potential income loss in agriculture is a source of increased domestic violence, we construct a municipality-specific indicator of whether the shock coincides with the growing season of the municipality's main crops in terms of total revenue. To identify the main crop, we employ data from the yearly statistical reports published by the Agricultural and Fishery Information Service SIAP (2024). This report contains municipality-by-crop-by-cycle yields and revenue. We identified the municipality's main crop-cycle[12] based on the aggregate revenue between 2010 and 2018. Next, we identify the relevant growing season for each crop using the manuals for growing each crop published by the National Institute of Forestry, Agricultural and Livestock Research (INIFAP). We complemented this information with technical documents from the USDA and the FAO. A detailed description of the data sources employed to identify the growing season of each crop is displayed in Table A.1.

3.3.2 State capacity

We construct a state capacity index with municipal-level variation. Based on previous works seeking to capture subnational differences in state capacity, our index is based on two core dimensions: administration and extraction (Soifer, 2012).

We employ sewerage and tap water coverage and local state employees per capita as proxies for administration capabilities. Data for these variables come from the Censo de Población y Vivienda 2010 reported by INEGI. Extraction capacity is proxied with fiscal autonomy, measuring municipality taxes collected as a share of total resources. This information is obtained from Finanzas Públicas Estatales y Municipales (EFIPEM). All variables are standardized and then used to create an additive index. This index then ranges between -3.13 and 1.65, where lower numbers indicate worse state capacity.

4 Empirical framework

The first step in our empirical strategy is to quantify the causal impact of drought on IPV. We follow the standard climate econometrics literature (Dell *et al.*, 2014; Hsiang, 2016) and create a municipality-level drought exposure metric that counts unexpected days without rain within specific reference periods. We estimate the following equation:

$$DV_{mt} = \sum_{b=1}^{5} \chi_b \mathrm{D}_{b,mt} + \Lambda_{mt} + \gamma_s(t) + \delta_{my} + \theta_t + \varepsilon_{mt} \tag{1}$$

[12]Different regions might grow the same crop at different cycles due to agro-climatic differences. For instance, as shown in Table A.1, the majority of counties' most important non-perennial crop is corn grain, but not all of them grow between April and October

In equation 1, the dependent variable, DV_{mt}—the IPV hospitalization, calls or police reports per 100,000 inhabitants in municipality m, and time (week or month) t—is modeled as a flexible semi-parametric function of drought D_{mt}. Specifically, $\mathrm{D}_{b,mt}$ are dummy variables indicating the number of abnormal days without precipitation in the past month/four weeks, which allows for potential non-linearities. For the monthly variables (police records and hotline calls), D_{mt} represents the days without rain within the current calendar month. For hospital records, which are on a weekly timescale and matched to weekly weather indicators, we use the sum of days without rain over the past four weeks (weeks $w \in [0, -3]$), so $D_{mt} = \sum_{w=0}^{3} Daysnorain_{m,t-w}$.[13] We define these unexpected days based on deviations from historical precipitation norms for each municipality and time of the year, incorporating municipality-by-year and date-fixed effects. The methodology is designed to leverage exposure to precipitation levels below those to which regions have historically adapted. Λ_{mt} includes controls for other extreme weather events in time t (days above/below the 5th and 95th percentile of temperature and days above the 95 percentile of precipitation). We also include state-specific time trends $\gamma_s(t)$ to capture regional development patterns that could correlate with precipitation trends. δ_{my} are municipality-year fixed effects and θ_t are date fixed effects.

Municipality fixed effects capture time-invariant characteristics specific to each municipality, such as local institutions, socio-economic conditions, and cultural factors that might influence IPV rates. These effects account for any persistent differences across municipalities, including baseline climate and prevalence of drought. Interacted with the year, we allow more flexibility for these different conditions to change yearly. Date fixed effects (θ_t) control for standard shocks that affect all municipalities simultaneously, such as national holidays, economic downturns, or significant political events. By including these, we adjust for temporal variations that could confound the relationship between drought and IPV. Lastly, state-specific time trends ($\gamma_s(t)$) address regional patterns that evolve, such as infrastructure improvements, economic development, demographic changes, and even region-specific global warming, ensuring that our results are not driven by long-term trends within states that could be correlated with both drought and IPV. Our identification assumption is that we are capturing anomalous drought days——deviations from expected precipitation (i.e., precipitation that could be predicted by the fixed effects described above)——which are therefore orthogonal to other relevant drivers of IPV.

5 Results

We begin our analysis with the results from equation 1, which flexibly estimates the relationship between the intensity of anomalous drought conditions over the past month and the rate of IPV.

[13] Since these two measures (days in the past four weeks vs. days in the current month) have different upper limits (28 vs. 31), we use different bins to accurately capture their variability.

The dependent variable in this analysis is operationalized through three distinct measures, each representing a different type of interaction between public services and IPV victims: hospital records, police reports, and hotline calls. As discussed above, for hospital records and hotline calls, we can obtain IPV rates, but for police reports, the data aggregates all forms of domestic violence. Only in the case of hospital records are we able to separate incidents by the sex of the victim.

5.1 Hospital records

Figure 3 shows the impact of anomalous drought conditions in the preceding four weeks on the municipality-level rate of hospital admissions for assault cases involving female victims (a) and male victims (b) in a given week. The y-axis represents the total anomalous days without rain in that week and the three previous ones, grouped in bins. The omitted category includes weeks with exposure to less than a total of 10 anomalous days of drought during the previous weeks $t - w, w \in 0, -3$. The figure shows a monotonic relationship between drought and violence against men, while nondomestic violence against women plateaus after 19 days of drought. The rate of female hospitalizations for non-domestic violence increases by 0.2 when the number of days of drought in the past four weeks exceeds 26. This amounts to a 7.4% increase from the sample mean of 2.5 weekly cases per 100,000 inhabitants. The male non-domestic violence rate displays a rise of 0.43 in the driest bin, which amounts to a 14% increase from a sample mean of 3.0 weekly cases per 100,000 inhabitants. Overall, drought impacts nondomestic violence against men and women, with a stronger increase for men but significantly affecting all the population.

Intimate partner violence tells a different story, displaying a markedly gendered relation to drought. The number of victims hospitalized every week in the municipality increases as the intensity of the unexpected lack of rain experienced in the preceding four weeks increases (Figure 4 (a)). There is an average increase in hospitalizations of female victims of IPV, up to 9% of the sample mean, which represents 5.2 weekly cases per 100,000 inhabitants. On the other hand, there is no statistically significant impact on male hospitalizations for IPV (Figure 4 (b)). We find no discernible impacts on hospitalizations for child maltreatment, as shown in Appendix Figure A.5.

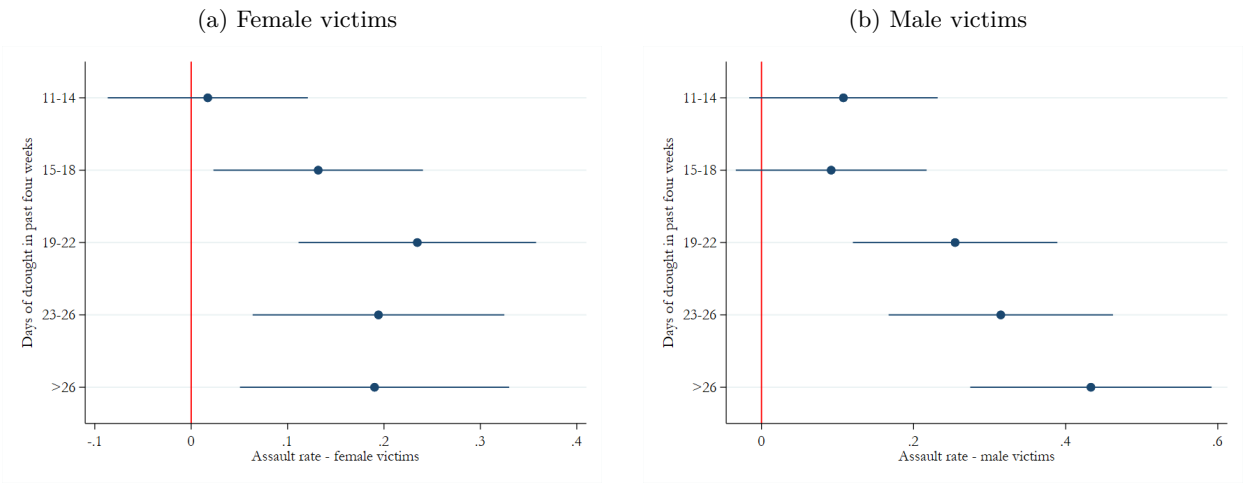


Figure 3: Anomalous days of drought and non-domestic violence

Notes: The dependent variables are weekly hospital admissions within the Mexican public health system from 2012 to 2019, categorized according to ICD-10 codes. The regression model adjusts for other extreme weather events, including days with temperatures above or below the 5^th and 95^th percentiles and days exceeding the 95^th percentile of precipitation. The model incorporates municipality-year and date fixed effects, state-specific time trends, and controls for municipality population sizes. Error bars represent 95% confidence intervals.

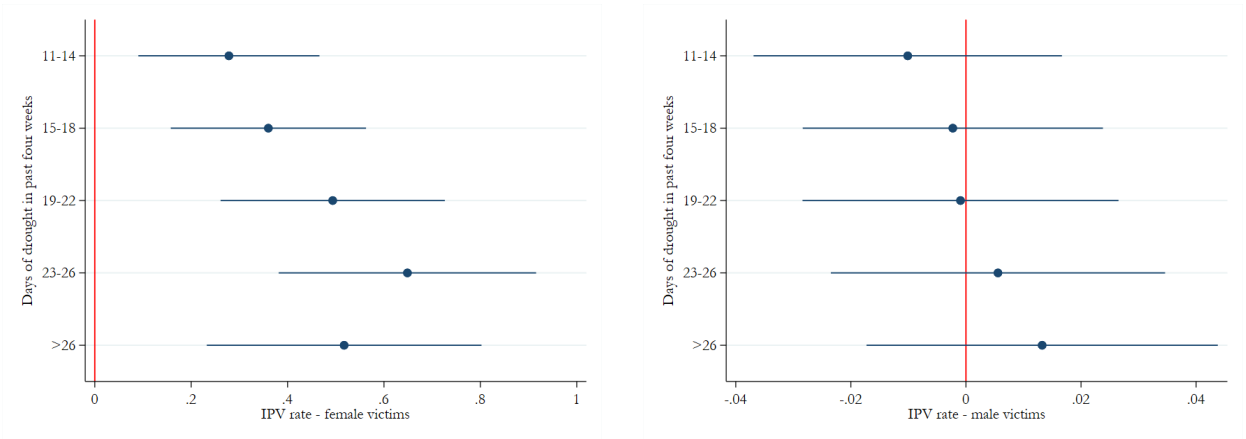


Figure 4: Anomalous days of drought and IPV

Notes: The dependent variables are weekly hospital admissions within the Mexican public health system from 2012 to 2019, categorized according to ICD-10 codes. The regression model adjusts for other extreme weather events, including days with temperatures above or below the 5^th and 95^th percentiles and days exceeding the 95^th percentile of precipitation. The model incorporates municipality-year and date fixed effects, state-specific time trends, and controls for municipality population sizes. Error bars represent 95% confidence intervals.

The differential impact of drought on non-domestic violence can be understood through the lens of economic and psychological theories. Economic distress induced by drought may heighten household stress and conflict due to financial insecurity, as discussed in the economic literature on

resource scarcity and violence in Section 2.2. Men may exhibit increased aggression as a coping mechanism for stress and financial pressures, behavior consistent with the social stress theory, which posits that environmental stress can exacerbate aggressive behaviors (Jia, 2014). This type of violence may manifest against both male and female victims. The more marked increase for men could be due to the fact that they spend more time in public spaces, leading to more interactions that can potentially end in violence. Finally, in a model of rational criminal behavior, the relative returns to criminal activity increase when income from legal activities decreases. If some of these additional crimes committed involve violence as a means of coercion, there is an expected increase in aggressions against men and women, with men once again being disproportionately impacted as they occupy more public spaces.

5.2 Police files and hotline calls

Hospital records of IPV only capture cases severe enough to warrant an encounter with the health system and thus represent "the tip of the iceberg" of the problem. Hence, in this Section, we employ two additional data sources to show that our results using hospital records are robust to other measures of IPV.

Alternative measures have their drawbacks, too. First, in Mexico, IPV is rarely reported to the police. The impunity rate for this crime is 98.6% nationally, and it surpasses 90% in every state (ENVIPE, 2022). Second, as noted before, from police reports and hotline calls, we cannot distinguish the sex of the victim. There is no reliable data on the percentage of IPV victims or witnesses who call 911 during or after an episode. However, in principle, this data might suffer from fewer biases than the police reports since it connects women with more services and can be made by a witness, such as a neighbor or relative.

The results of implementing equation 1 using monthly data from the sources discussed above are shown in Figure 5. Police files and hotline calls exhibit consistent patterns in response to the number of unexpected days without rain in the current month. In the highest bin, indicating more than 28 days without rain, police reports and hotline calls increase by 18 files per 100,000 inhabitants and 44 calls per 100,00 inhabitants per month. These marked increases diverge 26% and 21%, respectively, from the sample mean.

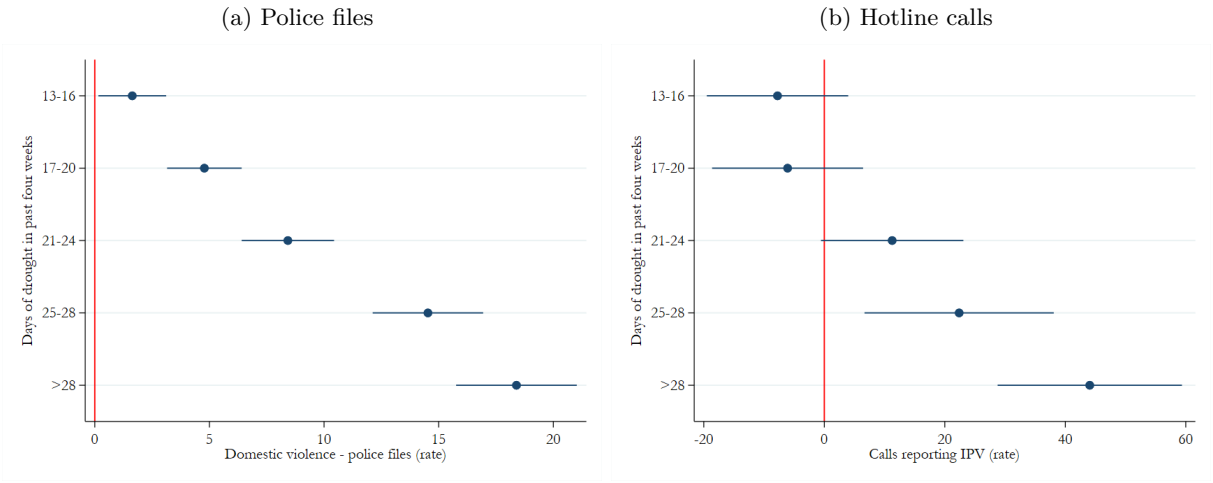


Figure 5: Anomalous days of drought and domestic violence

*Notes:*The dependent variables are monthly police files (a) and IPV hotline calls (b), grouped based on their date of occurrence. Police records cover 2015-2021, and hotline calls include 2016-2021. The regression model adjusts for other extreme weather events, including days with temperatures above or below the 5^th and 95^th percentiles and days exceeding the 95^th percentile of precipitation. The model incorporates municipality-year and date fixed effects, state-specific time trends, and controls for municipality population sizes. Error bars represent 95% confidence intervals.

Hotline calls face a significant challenge due to insufficient geographical coverage, limiting the ability to conduct representative regional heterogeneity analysis. As an emerging data source, only eight out of 32 states provided data over a sufficiently long period (2016-2021) to enable a fixed effects estimation that captures the impact of extreme events. However, this dataset offers the advantage of including reports on various forms of violence, which, due to their prevalence, significantly affect women's everyday lives. It reveals a larger portion of the proverbial iceberg. Figure 6 examines the incidence of some of these crimes. While reports of rape and sexual harassment do not appear to be influenced by drought conditions, reports of sexual abuse increase monotonically, with coefficients becoming statistically significant in months with more than 25 days of drought. The rise in sexual abuse reports is particularly concerning: according to Mexican legislation, the distinction between sexual abuse and rape hinges on whether there was vaginal, anal, or oral penetration[14], but both acts involve non-consensual sexual contact. Needless to say, both crimes can inflict significant trauma on women.

[14]Articles 178 and 179 of the penal code.

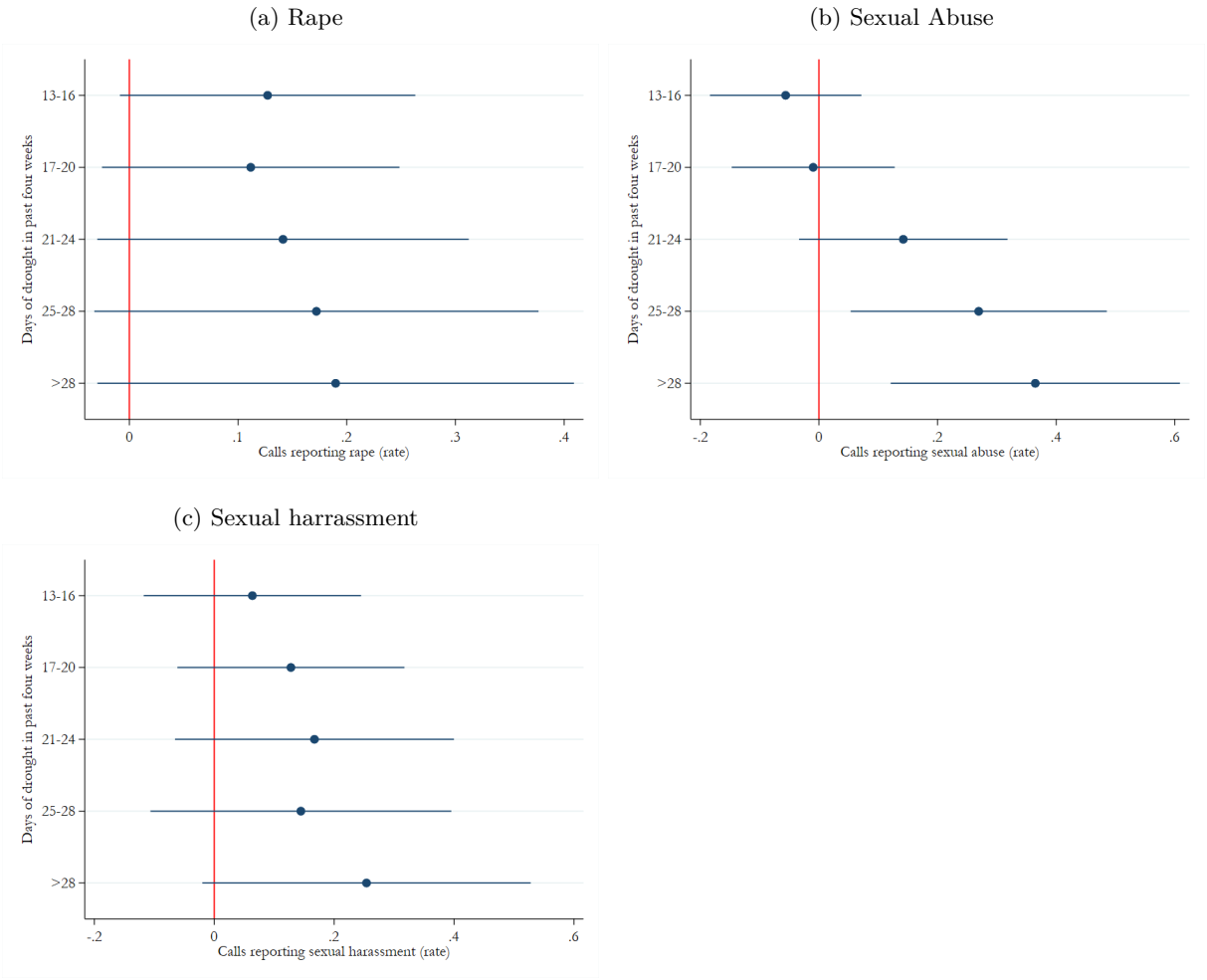


Figure 6: Anomalous days of drought and other forms of GBV

Notes: The dependent variables are expressed as a rate per 100,000 inhabitants. Hospital records cover 2012-2019, police records cover 2015-2021, and hotline calls include 2016-2021. The regression model adjusts for other extreme weather events, including days with temperatures above or below the 5^th and 95^th percentiles and days exceeding the 95^th percentile of precipitation. The model incorporates municipality-year and date-fixed effects and state-specific time trends. Error bars represent 95% confidence intervals.

Altogether, we find a robust relationship between drought and IPV. Analogously to the temperature-violence link identified in Mexico (Baysan *et al.*, 2019), the contemporary and linear response of crime to drought identified in this paper suggests that psychological factors have potential explanatory power.[15]. However, as discussed in Section 2.2, mechanisms driving violence against women may differ from typical inter/intragroup violence. In the following sections, we provide suggestive evidence that potential agricultural income loss is a potential mechanism driving

[15](Baysan *et al.*, 2019) find that the response of suicide to temperature in Mexico strongly matches the responses of interpersonal and intergroup violence to temperature: the response is linear, contemporary, standard across regions, not mediated by observable economic factors or access to a conditional cash transfer program, and only barely affected by growing season temperatures. The authors do not examine the role of drought.

our results. We also examine the correlation between local state capacity and IPV reports.

5.3 Mechanisms

5.3.1 The role of agriculture

While agriculture currently amounts to less than 5% of global GDP, in developing countries, a significant portion of the population depends on farming for their livelihood, amounting to 25% of GDP in low-income countries and 9% in middle-income countries (World Bank, 2022a). However, evidence indicates that women face more barriers in accessing land, cash, credit, information, and extension services. Quisumbing and Doss (2021) show that in only 3 out of 104 countries do women come close to being half of the agricultural holders.[16] In 72% of the countries, women represent fewer than 25% of agricultural holders. Gender disparities also affect market access, both for acquiring inputs and for selling outputs. For instance, women typically have smaller plots than men, and within households, men's plots are often prioritized (Udry, 1996). This significant gender gap in agricultural production can have implications for how agricultural shocks, such as droughts, impact GBV.

In Mexico, women only make up around 12.7% of the country's agricultural laborers (ONU; ILO, 2012), 26% of ejido rights owners, 20% of ejido board members (Registro Agrario Nacional, 2019), and are much less likely participate in commercial farming than their male counterparts (Croppenstedt *et al.*, 2013). Hence, a potential reduction in crop yields might, on average, lead to a decrease in male-to-female income ratios. The pronounced impact on female victims of IPV may find theoretical support in the "male backlash" hypothesis, where male-biased economic shocks such as droughts exacerbate IPV due to men reacting to perceived threats to their traditional authority or economic power within the household (Eswaran and Malhotra, 2011; Bobonis *et al.*, 2013; Erten and Keskin, 2018, 2021, 2024). Furthermore, the extractive violence theory suggests that in times of economic distress, such as during a drought, men may increase coercive control over women to secure their labor in water collection and household goods management, or to supplement household income(Angelucci and Heath, 2020). If uncertainty of crop success raises stress levels, IPV risk may also increase (Caruso *et al.*, 2016; Munala *et al.*, 2023b; Sekhri and Storeygard, 2014).

If, as hypothesized, the "male backlash" and extractive violence mechanisms play a role in explaining our findings, one would expect the impact of drought on IPV to be stronger in agricultural regions and when its timing hurts agricultural production the most. To assess regional heterogeneities, we estimate the following model:

[16]The holder has the economic rights to the plot, typically meaning that they control the production processes and outputs.

$$DV_{mt} = \sum_{b \neq 1} \chi_{1b}^{agri} \mathrm{D}_{b,mt} \times \mathbb{1}(\text{shareagri}_{m,0} \leq \hat{shareagri}_{p50}) + \sum_{b \neq 1} \chi_{2b}^{agri} \mathrm{D}_{b,mt} \times \mathbb{1}(\text{shareagri}_{m,0} > \hat{shareagri}_{p50}) + \Lambda_{mt} + \gamma_s(t) + \delta_{my} + \theta_t + \varepsilon_{mt} \quad (2)$$

Where the weather shock interacts with an indicator variable $\mathbb{1}(\text{shareagri}_{m,0} > \hat{shareagri}_{p50})$, which defines a municipality as an "agricultural region" if the proportion of its population engaged in agricultural activities surpasses the median of the national distribution. In Mexico, the median municipality has 39% of its labor force in agriculture (Figure A.4).

The results of estimating equation 2 are displayed in Figure 7. In regions with high agricultural reliance, there is a positive and statistically significant relationship between the number of drought days and the incidence of (a) hospital admissions due to IPV injuries and (b) police files initiated due to domestic violence. This reaches its maximum in the highest drought category ($\geq$26 days), where the estimated increase in IPV rate amounts to approximately one hospitalization per week and almost 20 police reports of domestic violence per 10,000 inhabitants.[17] Conversely, in municipalities with low agricultural reliance, the pattern for hospital records is much flatter. The estimates hover around 0-0.5 across all drought categories. For the case of police files, there is an increasing pattern that becomes statistically significant after 25 days of drought but reaches only 10 reports per 10,000 inhabitants in the highest bin. These results suggest that agricultural dependence potentially mediates the relationship between environmental shocks and domestic violence.

To further examine the potential link between income loss in agriculture due to environmental shocks and increased IPV, we test whether the timing of unexpected low precipitation coinciding with the growing season exacerbates its impact on IPV. To this end, we constructed a municipality-specific monthly indicator for the growing season of the municipality's primary crop, as measured by total revenue based on data from the Agricultural and Fishery Information Service (SIAP, 2024), as described in Section 3.3.1.

The relationship between IPV and agricultural income shocks is modeled through an econometric framework detailed in Equation 3, where DV_{mt} represents the incidence of IPV in month t and municipality m. This equation includes interactions between drought intensity—categorized into five bins—interacted with a dummy variable indicating whether the observed month falls within the growing season of the municipality's main crop GS_m. Controls for unobserved municipality characteristics, state-specific linear time trends, and month-year fixed effects are also

[17] As discussed in Section 5.2, the incomplete coverage of 911 data complicates regional comparisons, so they are excluded from these analyses.

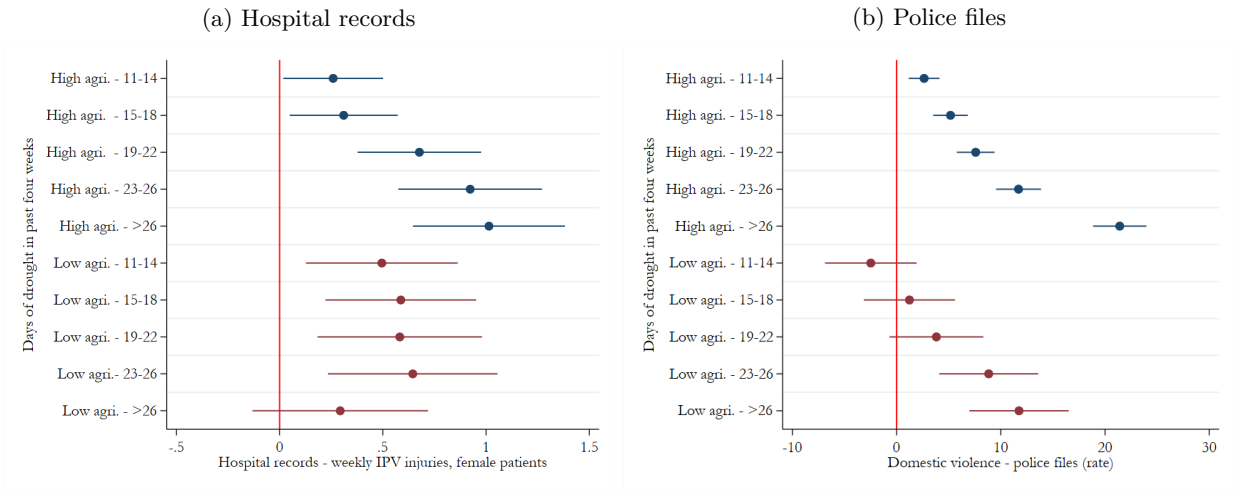


Figure 7: Heterogeneous effects by agricultural reliance

Notes: The dependent variables are the weekly hospital visits at the municipality level (a), and the monthly police files (b) expressed as a rate per 100,000 inhabitants. The regression model adjusts for other extreme weather events, including days with temperatures above or below the 5^{th} and 95^{th} percentiles and days exceeding the 95^{th} percentile of precipitation. The model incorporates municipality-year and date-fixed effects and state-specific time trends. Error bars represent 95% confidence intervals.

included to isolate the effect of drought during critical agricultural periods. For this analysis, we focus on regions with high agricultural reliance.

$$DV_{mt} = \sum_{b \neq 1} \chi_{1b}^{GS} \mathrm{D}_{b,mt} \times \mathbb{1}(\text{month}(t) \in GS_m) + \sum_{b \neq 1} \chi_{2b}^{GS} \mathrm{D}_{b,mt} \times \mathbb{1}(\text{month}(t) \notin GS_m) + \Lambda_{mt} + \gamma_s(t) + \delta_{my} + \theta_t + pop_{mt} + \varepsilon_{mt} \quad (3)$$

We find suggestive evidence that the timing of drought relative to the agricultural calendar is relevant to their effects on household dynamics. However, the results are not entirely consistent between data sources, and estimates become noisier with the further sample splits required for this analysis. Figure 8 (a) shows the impact of drought intensity on IPV hospitalizations in municipalities with high agricultural reliance, differentiating between periods within the growing season and those outside of it, as described in equation 3. When a shock happens within the growing season, there is a statistically significant positive relationship between the number of drought days and the incidence of IPV injuries. For the highest drought category ($\geq$26 days), the estimated increase in IPV injury rate reaches approximately 0.7 cases per week. Conversely, for shocks happening outside the growing season, there is no clear relationship between drought days and IPV injuries.

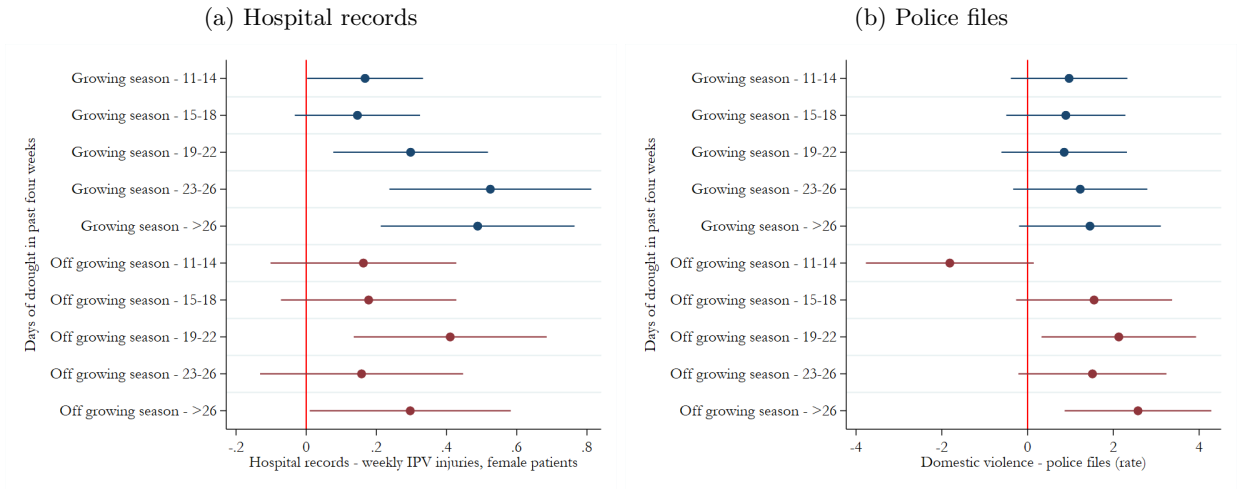


Figure 8: Agricultural regions, drought during the growing season

Notes: The dependent variable measures the weekly hospital visits at the municipality level (a), and the monthly police files (b), expressed as a rate per 100,000 inhabitants. Hospital records cover 2012-2019. The regression model adjusts for other extreme weather events, including days with temperatures above or below the 5^th and 95^th percentiles and days exceeding the 95^th percentile of precipitation. The model incorporates municipality-year and date-fixed effects and state-specific time trends. Error bars represent 95% confidence intervals.

Figure 8 (b) conducts the same analysis using police files. In this case, we find that effects during the growing season are not stronger, and in fact, we lose statistical significance in identifying the pattern seen in the entire sample, pointing to the limitation of using monthly data that do not clearly distinguish among different types of violence.

5.3.2 State capacity and crime reporting

The relationship between state capacity and IPV figures is *a priori* ambiguous. On one hand, in municipalities with low state capacity, individuals might be less inclined to report IPV, anticipating that their reports will yield no substantive outcomes. This anticipation could lead to underestimating the true effect of environmental stressors on IPV in these areas. In Mexico, the dark figure statistic, which captures the share of crimes that go unreported, is 93%. For sex crimes such as rape and sexual harassment or intimidation, only 11% and 2% of cases, respectively, are reported (ENVIPE, 2022). On the other hand, high state capacity might have a deterrent effect on potential aggressors. In areas where the state is more capable of enforcing laws and protecting citizens, perpetrators may face a greater risk of detection and punishment, potentially reducing the incidence of IPV and its responsiveness to drought.

Under typical conditions, we observe distinct patterns between IPV measures and state capacity consistent with the behavioral biases discussed above. A relevant point of comparison is homicides, a variable much less susceptible to underreporting bias and often used as a benchmark, which are slightly higher in areas with high state capacity but only marginally so. All of our three

measures have much higher baseline levels in areas with better state capacity, with the rate of IPV reports, in particular, being over seven times higher in municipalities with high state capacity. From the two mechanisms discussed above—reporting bias versus deterrence effect—assuming our SCI is a good proxy, Table 2 suggests that at baseline, the underreporting bias (HSC/LSC) is stronger for all variables, but it is the strongest for hotline calls.

Table 2: Summary statistics by state capacity

	Hospital Visits	Police Files	Hotline Calls	Homicide Rate
Low State Capacity	3.35	26.77	52.29	23.47
High State Capacity	8.07	106.77	380.62	29.01
Full Sample	5.7	66.78	211.62	26.57
HSC/LSC	2.4	3.9	7.27	1.23
Temporality	Weekly	Monthly	Monthly	Monthly

Notes: All variables are expressed in rates per 100,000 inhabitants. The first three columns are based on the analytical sample used in our regression analysis for each variable. The homicide rate is obtained from INEGI 2014 estimates.

To further explore how the performance of local institutions affects the relationship between drought and our three measures of IPV, we include in our baseline specification an interaction term between drought exposure and a binary variable that identifies whether a municipality's SCI is below or above the national median. We estimate the following equation:

$$DV_{mt} = \sum_{b=1}^{5} \chi_{1b}^{SCI} \mathrm{D}_{b,mt} \times \mathbb{1}(SCI_{m,0} > \hat{SCI}_{p50}) + \sum_{b=1}^{5} \chi_{2b}^{SCI} \mathrm{D}_{b,mt} \times \mathbb{1}(SCI_{m,0} \leq \hat{SCI}_{p50}) + \Lambda_{mt} + \gamma_s(t) + \delta_{my} + \theta_t + \varepsilon_{mt}$$

In this equation, DV_{mt} represents the rate of IPV within a given municipality m and time period t (either weekly or monthly). Our parameters of interest are the interactions between drought conditions ($D_{b,mt}$) and the state capacity indicators, χ_{1b}^{SCI} and χ_{2b}^{SCI}.

Our empirical findings indicate that the impacts of drought on police reports and hospital records more clearly arise in municipalities with low state capacity. This finding is intuitive because, by exploiting an exogenous weather shock, we hold state capacity—and thus reporting bias—constant, as it is unlikely that droughts acutely erode municipal capacity. This suggests that crime increases more during droughts in low-state capacity areas due to a weaker deterrence effect. While the heterogeneity in 911 call responses is constrained by their limited geographic coverage and

should be interpreted cautiously, there appears to be a slightly stronger relationship between calls and drought in higher-state capacity areas. However, as discussed above, this increase is from a much higher baseline incident count. Further research is needed to determine whether this pattern reflects the incomplete coverage of 911 data, differences in awareness or trust in emergency services, or actual disparities in response capabilities across regions. Nevertheless, our findings underscore the need to develop multiple access points for women to receive medical, legal, and emergency assistance when experiencing IPV.

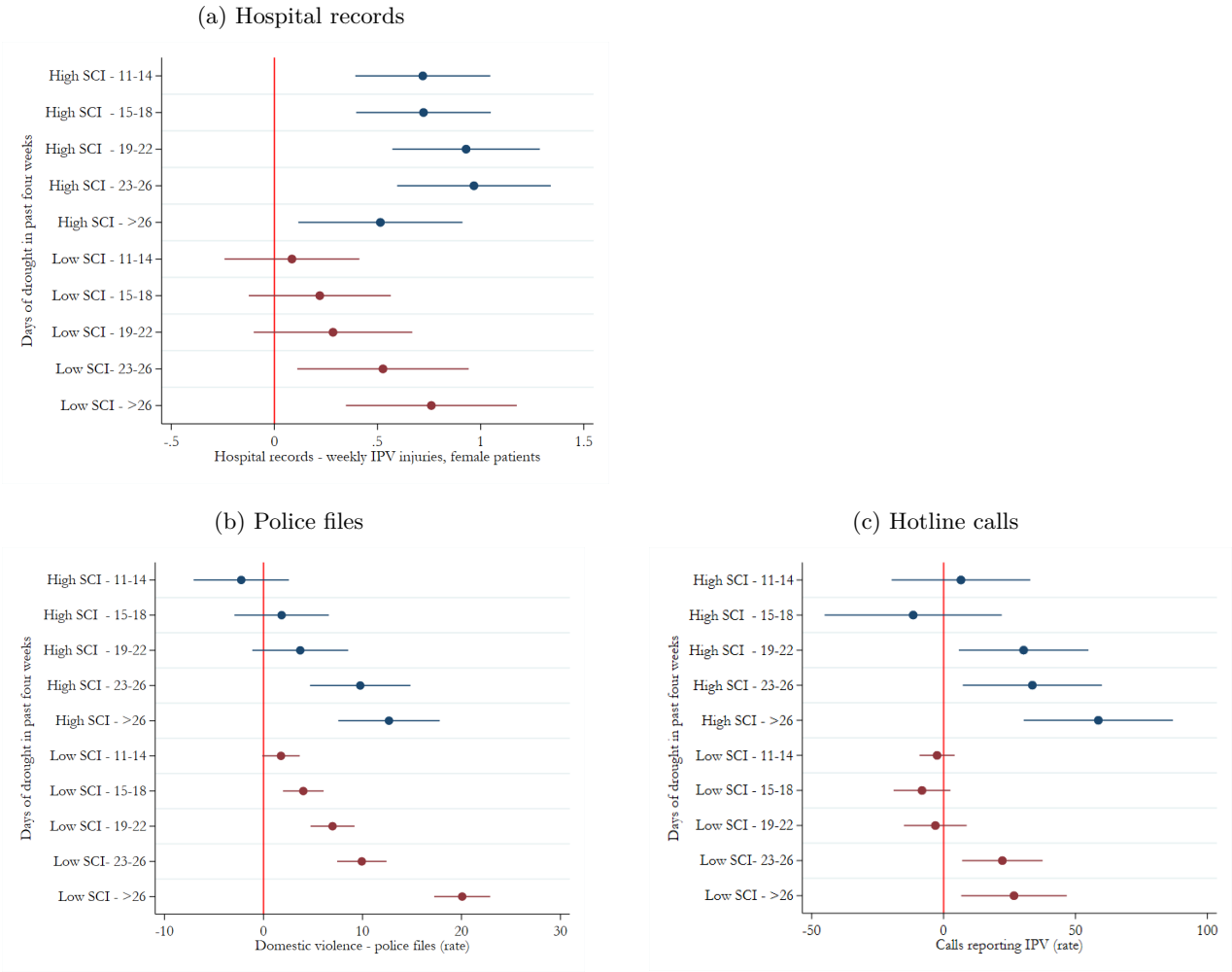


Figure 9: Heterogeneous effects of drought by state capacity

Notes: The dependent variables are the weekly hospital visits (a), monthly police files (b), and hotline calls (c), grouped based on their date of occurrence, expressed as a rate per 100,000 inhabitants. Hospital records cover 2012-2019, police records cover 2015-2021, and hotline calls include 2016-2021. The regression model adjusts for other extreme weather events, including days with temperatures above or below the 5^th and 95^th percentiles and days exceeding the 95^th percentile of precipitation. The model incorporates municipality-year and date-fixed effects and state-specific time trends. Error bars represent 95% confidence intervals.

5.4 Robustness checks

To validate the consistency of our main findings, we employ a binned specification linking the average precipitation in a given week and the incidence of our dependent variables of interest. We use the same fixed effects as in our baseline specification and control for temperature.

Figure 10 displays the results for non-domestic violence, with panels (a) and (b) showing the effect of anomalous drought days on weekly hospital admissions for assault cases involving female and male victims, respectively. The results indicate a positive relationship between the number of anomalous drought days and the number of hospital admissions for assault cases, with a somewhat stronger pattern for male victims, consistent with our main findings. Figure 11 focuses on IPV, with panels (a) and (b) showing the relationship between weekly average precipitation and IPV hospital admissions for female and male victims, respectively. The results show that lower precipitation levels are associated with higher IPV hospital admissions for female victims, while no significant relationship is observed for male victims, as in our main specification.

(a) Assault rates - female victims

(b) Assault rates - male victims

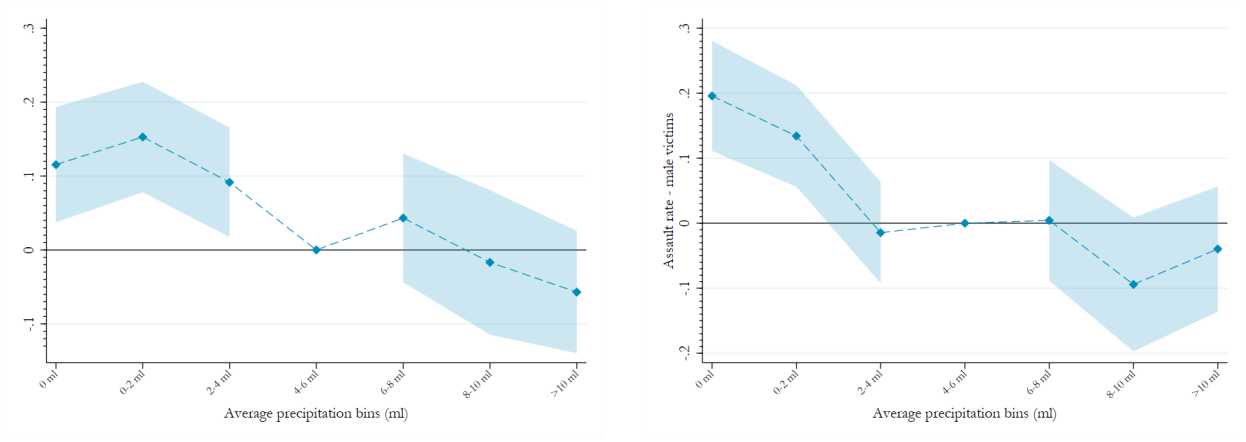


Figure 10: Anomalous days of drought and non-domestic violence

Notes: The dependent variables are weekly hospital admissions within the Mexican public health system from 2012 to 2019, categorized according to ICD-10 codes. The regression model adjusts for average temperature. The model incorporates municipality-year and date fixed effects, state-specific time trends, and controls for municipality population sizes. Error bars represent 95% confidence intervals.

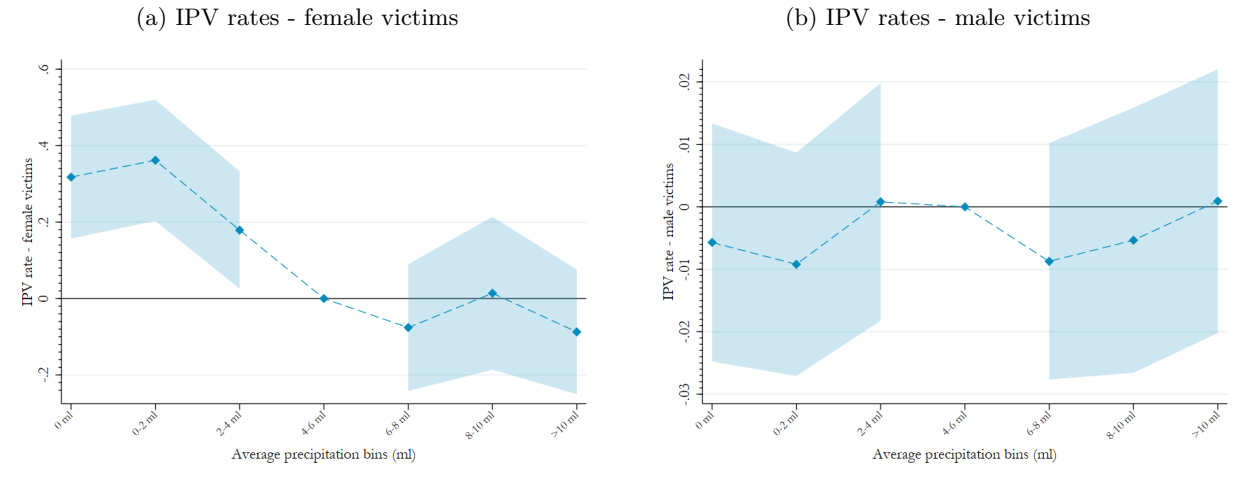


Figure 11: Weekly average precipitation and IPV

Notes: The dependent variables are weekly hospital admissions within the Mexican public health system from 2012 to 2019, categorized according to ICD-10 codes. The regression model adjusts for average temperature. The model incorporates municipality-year and date fixed effects, state-specific time trends, and controls for municipality population sizes. Error bars represent 95% confidence intervals.

6 Conclusion

We find robust evidence of an increase in domestic violence in Mexico when households face drought conditions. Our findings are robust to utilizing three data sources: hospital records, police files, and 911 calls. Our results suggest that a lower municipal state capacity level is related to a greater IPV drought impact due to a weaker deterrence effect.

While accounting for 8% of national GDP, agriculture is an essential source of livelihood for millions of people across the country. It is also a highly climate-sensitive industry and a male-dominated sector. Our results indicate that drought-induced disruptions intensify IPV more in agriculturally intensive areas and when it hits during the growing season. We hypothesize that adverse weather events may challenge the conventional role of men as primary earners, potentially leading to increased violence as a response mechanism. Overall, our evidence aligns more with stress-related or extractive violence in response to drought during the growing season in agricultural regions than with economic models of expressive violence.

Mexico is a middle-income country, to the best of our knowledge, wealthier than every other country where the link between drought and IPV has been studied. This fact suggests that economic growth itself will not shield women from the exacerbated climate impacts they face. While there might be a human rights basis for policy intervention to hasten this convergence, in a world with limited resources, there might be more scope for government intervention in dimensions of gender inequality that are unlikely to diminish in the medium term under current economic growth trends.

Thus, our findings have several policy implications with external validity and relevance for a high share of the global population. First of all, disaster response programs should consider the disparate impacts that women face, incorporating IPV prevention and attention protocols into emergency response systems, especially for drought. Our findings also underscore the need to strengthen trust and use of women's emergency resources. Better reporting and use of helplines and other resources will generate better data that can contribute to diagnosing vulnerability and target interventions. Finally, unlike other forms of violence that may be climate-sensitive, more policing is unlikely to mitigate the effects of weather extremes on violence against women since this type of violence usually does not take place in public spaces. In Mexico, more than 9 out of 10 cases of IPV against women happen at home (ENDIREH, 2021). Changing social roles regarding the acceptability of domestic violence and the male role as primary earners could be a significant step in mitigating the climate-gender nexus.

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A Online Appendix

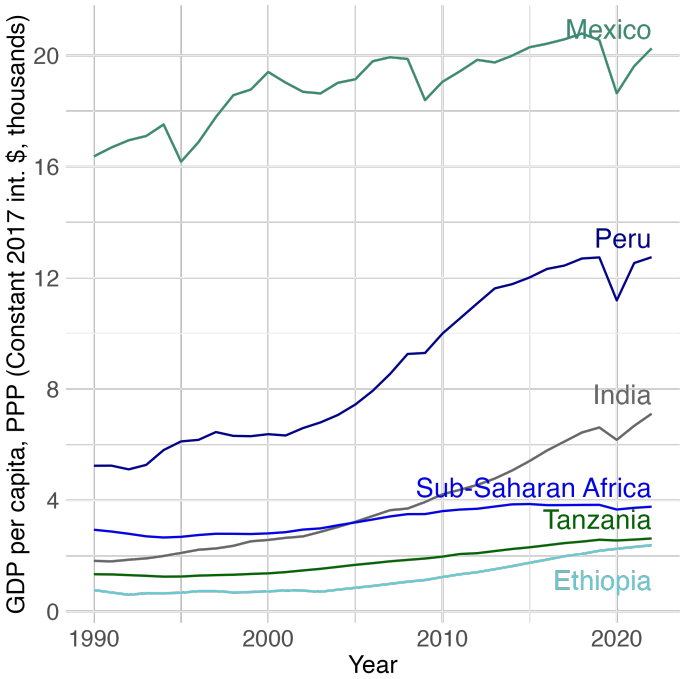


Figure A.1: Level of economic development of countries with quantitative studies of the causal impact of droughts on IPV

Notes: The published referenced works are include Sekhri and Storeygard (2014) (India), Cools and Kotsadam (2017) (Sub-Saharan Africa) and Díaz and Saldarriaga (2023) (Peru). Working papers referenced include Abiona and Koppensteiner (2018) (Tanzania) and Hirvonen *et al.* (2023) (Ethiopia).

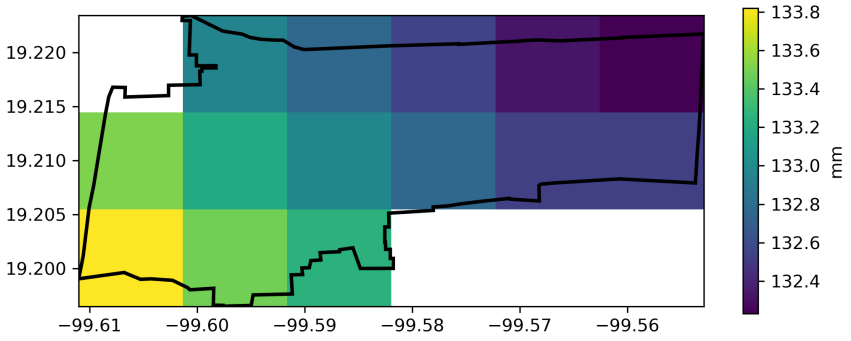


Figure A.2: Total precipitation, August 2019: Mexicaltzingo, State of Mexico

Notes: Authors' formulation using gridded estimates from ORNL DAAC- Daymet Version 4 Revision 1.

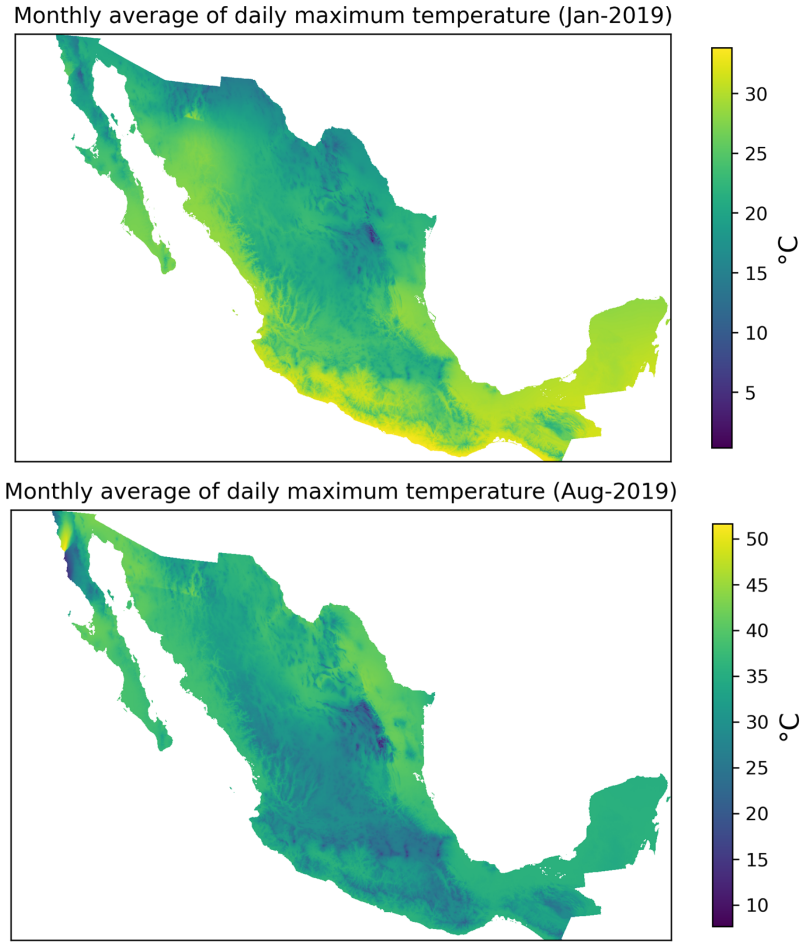


Figure A.3: Temperature data

Source: ORNL DAAC- Daymet Version 4 Revision 1; authors' formulation.

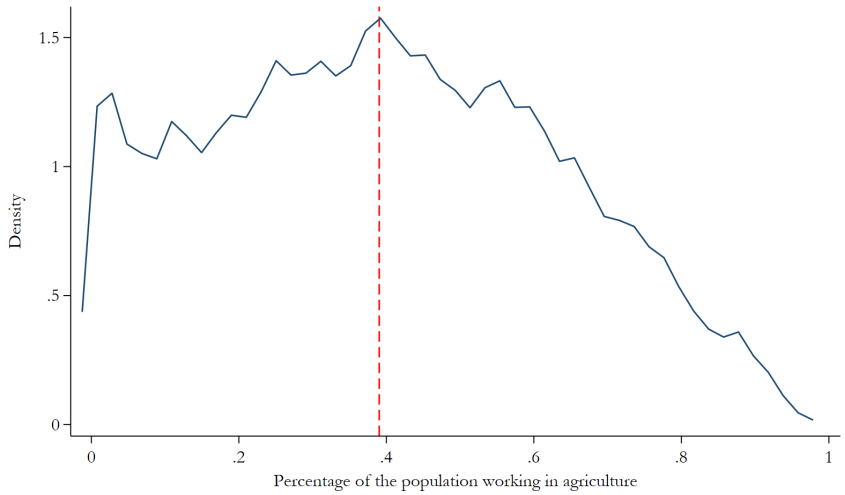


Figure A.4: Percentage of population working in agriculture

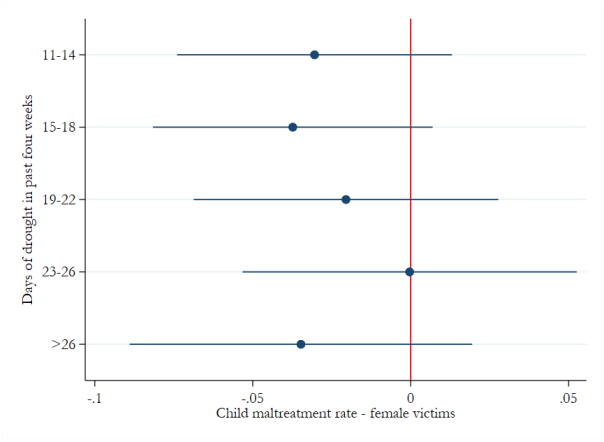
Source: 2010 Census, Mexico.

Table A.1: Municipality-specific growing seasons based on main crop

Crop	**# of counties**	**Growing season**	**References**
Corn grain	1590	April-October	USDA (2024)
Corn grain	88	November-March	USDA (2024)
Green forage sorghum	68	March-July	INIFAP (2024d)
Green forage corn	66	April-October	INIFAP (2015b)
Red tomato (jitomate)	66	July-September	INIFAP (2012)
Bean	57	April-September	INIFAP (2013a)
Sorghum Grain	47	June-October	USDA (2024)
Potato	38	March-June	ICAMEX (2023b)
Green chili	31	March-July	Hewage *et al.* (2022)
Barley grain	30	May-September	USDA (2024)
Red tomato (jitomate)	28	September-November	ICAMEX (2023a)
Wheat grain	22	November-April	USDA (2024)
Green chili	19	September-January	Hewage *et al.* (2022)
Dry chili	18	March-July	Bosland and Walker (2014)
Sorghum grain	17	January-May	FAO (2022)
Watermelon	16	January-April	INIFAP (2024c)
Green forage oats	14	April-July	INIFAP (2013b)
Seed cotton	13	April-July	USDA (2024)
Wheat grain	13	April-August	USDA (2024)
Zucchini	11	February-March	INIFAP (2024b)
Pastures and rangelands	11	October-December	INIFAP (2015a)

Notes: Municipality-level main crop based on yearly total revenue of non-perennial crops between 2010 and 2018 (SIAP, 2024). For readability, the growing season is displayed for crops that are the main source of revenue for at least 10 counties. Other references utilized to construct the dataset are available upon request, most of them from the crop-specific manuals in the INIFAP portal (INIFAP, 2024a)

(a) Female victims



(b) Male victims

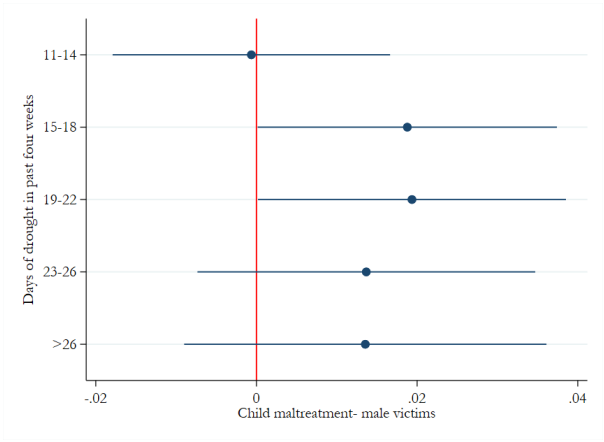


Figure A.5: Anomalous days of drought and child maltreatment

Notes: The dependent variables are weekly hospital admissions within the Mexican public health system from 2012 to 2019, categorized according to ICD-10 codes. The regression model adjusts for other extreme weather events, including days with temperatures above or below the 5^th and 95^th percentiles and days exceeding the 95^th percentile of precipitation. The model incorporates municipality-year and date fixed effects, state-specific time trends, and controls for municipality population sizes. Error bars represent 95% confidence intervals.