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> **Extreme Weather Events** and Violence against Children



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Julian Roeckert, Kati Kraehnert, and Roman Hoffmann

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Extreme Weather Events and Violence against Children

Abstract

This study examines the impact of extreme weather events on violence against children inflicted by adult household members. Ourfocus is on Mongolia, where winter disasters cause high livestock mortality that exert economic stress on pastoralist households. The analysis builds on three cross-sectional Multiple Indicator Cluster Surveys. The identification strategy utilizes spatial variation in the intensity of three winter disasters. Exposure to extreme winter conditions significantly increases the probability of children from pastoralist households to become victim of psychological and physical violence. Increased alcohol consumption, shifts in attitudes toward male dominance, and reduced life satisfaction among adults are likely mechanisms.

JEL-Codes: I31, J12, J13, Q12, Q54

Keywords: Extreme weather events; violence against children (VAC)

August 2024

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1. Introduction

Violence against children¹ is a public health and human rights issue that prevails worldwide. It is estimated that annually, at least one billion children aged 2-17 years are victims of physical, sexual, or emotional violence (Hillis et al. 2016). Children in low- and middleincome countries bear a particularly heavy burden, with prevalence rates highest in Asia. Violence against children has devastating consequences for affected individuals and society at large (Doyle and Aizer 2018; Peterson et al. 2018). Exposure to violence during childhood has been shown to increase the risk of various physical health conditions (e.g., diabetes, poor lung functioning, malnutrition, vision, and oral health problems) (Monnat and Chandler 2015), psychological problems (e.g., educational difficulties, depression, posttraumatic stress disorder, and attachment disorder) (Bhuller et al. 2024; Cicchetti et al. 2016), and behavioral problems (e.g., criminality, drug and substance use, perpetration of maltreatment, and unhealthy sexual practices) (Currie and Tekin 2012; CWIG 2019) in later life.

Another risk to the well-being of children is climate change. Children in low- and middleincome countries are particularly affected as these countries face heightened exposure and vulnerability to extreme weather events and often lack the resources, institutions, and infrastructure to effectively cope with such risks (Hanna and Oliva 2016; IPCC 2014; World Bank 2010). Although a growing body of literature documents the impacts of climate change on child health, there is limited evidence on its effects on family functioning and intra-family conflict (Helldén et al. 2021). In particular, the impact of extreme weather events on children's exposure to violence inflicted by their parents has received little scientific attention (Cerna-Turoff et al. 2019; Cerna-Turoff et al. 2021b; Datzberger et al. 2023). A comprehensive understanding of violence against children in the context of extreme weather events is critical, as such events are expected to increase in intensity and frequency under global warming (IPCC 2012; World Bank 2010).

This study is among the first to bring these two topics together: We empirically investigate the impacts of extreme weather events on violence against children. Our focus is on Mongolia, a

¹ The WHO defines *violence against children* as "all forms of violence against people under 18 years old, whether perpetrated by parents or other caregivers, peers, romantic partners, or strangers" (WHO 2022). The term *child abuse* generally refers to deliberate acts of commission, which include "words or overt actions that cause harm, potential harm, or threat of harm to a child" (Leeb et al. 2008, p. 11), while the term *child maltreatment* is defined more broadly as including acts of child abuse as well as child neglect describing "the failure to provide for a child's basic physical, emotional, or educational needs or to protect a child from harm or potential harm" (Leeb et al. 2008, p. 11). The items of interest in this study, deliberate acts of psychological and physical violence, are covered by all three terms. In the following, we use the above terms interchangeably.

country that has been repeatedly hit by extreme weather events in recent decades. In Mongolia, extreme weather events occur in the form of winter disasters caused by a complex interplay of a diverse set of weather conditions, including cold spells and/or snowfall anomalies. These winter disasters cause mass livestock mortality, with detrimental impacts on the rural population living off livestock rearing. Since livestock serves as the primary income source, consumption base, and means to store wealth, sudden livestock losses exert economic stress for pastoralist households.

Our analysis builds on data from the Multiple Indicator Cluster Survey (MICS) supported by UNICEF. Using the Parent-Child Conflict Tactics Scales (CTSPC), the Mongolian MICS records information on violence against children, including deliberate acts of psychological and physical violence, inflicted during the last month by adults living in the same household. Pooling three cross-sectional MICS rounds implemented in 2010, 2013, and 2018, our sample comprises more than 8,500 children aged 2-14 years. Our identification strategy exploits spatial variation in the intensity of extreme winter conditions occurring several months before each MICS round. In the time window of interest, three winter disasters of different severity struck Mongolia, including the 2012/13 winter, in which extreme winter conditions occurred only in locally confined areas, and the 2009/10 winter, which represented a once-in-50-years disaster. We measure spatial disaster intensity with district-level livestock mortality calculated from the annual Mongolian Livestock Census.

Results from fixed effects estimations show a statistically significant and sizeable effect of exposure to extreme winter conditions on the probability of children from pastoralist households becoming victims of violence. The effects are observed for both psychological violence as well as minor and severe forms of physical violence. We estimate that a 10 percentage point increase in district-level livestock mortality caused by extreme winter conditions leads to a 1.4 and 0.6 percentage point increase in the probability of a child in an affected district being exposed to minor and severe forms of physical violence, respectively. The results are insensitive to model variations as well as various robustness and falsification tests. Further findings indicate that children's age is a significant moderating factor, with older children living in severely affected areas facing an over-proportionate risk of victimization. Increased alcohol consumption among men, shifts in attitudes toward male dominance within the household among men, and reduced life satisfaction among both men and women are identified as likely mechanisms explaining the rise in violence against children. Moreover, children in affected districts spent more time with domestic tasks, possibly freeing up adults'

time to engage more intensely in income-generating activities.

Our study contributes to two distinct bodies of literature. First, our study speaks to the literature on the economics of child mental health (Currie 2024). Few existing studies have examined the relationship between extreme weather events and violence against children, and most of them face methodological limitations (Cerna-Turoff et al. 2019). One exception is the study by Evans et al. (2023), showing that hot spells increase the prevalence of child maltreatment in the US. Using a similar approach as Evans et al., our analysis exploits plausibly exogenous variation in the occurrence of extreme weather events across time and space, which allows identifying effects with a high degree of internal validity. Our study thus documents a negative impact of climate change on a dimension of human well-being that so far has been largely overlooked.

Second, our study contributes to the broader literature linking the impacts of climate change to interpersonal violence. While most existing studies focus on criminal acts, such as assault, murder, and property crimes, intra-household violence has only been addressed in a small number of studies focusing on violence in intimate partnerships (Abiona and Koppensteiner 2016; Burke et al. 2015; Sekhri and Storeygard 2014; Weitzman and Behrman 2016). By examining violence against children inflicted on them by their parents, our study adds a further dimension to this body of literature, thus broadening the understanding of the spectrum of violence known to be affected by extreme weather events.

The remainder of this study is structured as follows. Section 2 summarizes the state of knowledge. Section 3 provides contextual information on winter disasters and violence against children in Mongolia. Section 4 introduces the data and Section 5 outlines the identification strategy. Section 6 presents findings and robustness tests, which are discussed in Section 7. Section 8 concludes.

2. State of knowledge: Climate change impacts on children

The literature examining the effects of climate change on children's health and well-being has expanded rapidly in recent years, with an increasing number of studies documenting the presence of both direct and indirect impacts (Garcia and Sheehan 2016; Helldén et al. 2021; Sanson et al. 2018). Direct impacts on children's physical health include the increased risk of early childhood fatalities and injuries, heat-related illnesses, as well as infectious, gastrointestinal, waterborne, and parasitic diseases (Sanson et al. 2018; Sheffield and

Landrigan 2011). Also, exposure to extreme weather events during pregnancy and early childhood has been linked to child development (de Oliveira et al. 2023; Groppo and Kraehnert 2016a; Skoufias and Vinha 2012; USGCRP 2016) and mental health problems (Dean and Stain 2010; Gibbons 2014; Goenjian et al. 2001; Majeed and Lee 2017). More indirectly, climate change can have detrimental effects on children by causing disruptions in the attainment of education (Baez et al. 2010), economic hardship for affected households (Leichenko and Silva 2014), and forced migration (Hoffmann et al. 2020).

Climate change has also been shown to increase the likelihood of various forms of violence. For example, intergroup conflict, such as riots and civil wars, can be causally linked to global warming in selected contexts (Burke et al. 2015; Hsiang et al. 2013). Existing studies examining the impact of climate change on interpersonal conflict primarily focus on various forms of crime, such as assault, murder, and property crime (Blakeslee and Fishman 2018; Ranson 2014). A small body of literature studies intra-household violence in the context of extreme weather events and other natural hazards, where the focus is primarily on violence occurring in intimate relationships. Based on data from DHS and LSMS, studies document that rainfall shortages in India (Sekhri and Storeygard 2014) and Tanzania (Abiona and Koppensteiner 2016), as well as the 2010 earthquake in Haiti (Weitzman and Behrman 2016) increased the prevalence of violence against women perpetrated by their male partners. In a cross-country analysis of Sub-Saharan Africa, Cools et al. (2020) do not find systematic evidence for an effect of drought on intimate partner violence.

Few studies consider the consequences of extreme weather for violence against children (see Cerna-Turoff et al. 2019; Cerna-Turoff et al. 2021b; Datzberger et al. 2023 for reviews). A study by Evans et al. (2023), which follows a rigorous study design, finds that exposure to heat increased the prevalence of child maltreatment in the US, while cold periods had the reversed effect. Using administrative data from child protective service agencies, the authors estimate that an additional heat day with temperatures exceeding 35 °C increased child maltreatment by 0.5% compared to a day with a maximum of 15-20 °C. Other studies in this field face methodological limitations, such as identifying credible control groups, which complicate causal inferences. For instance, Catani et al. (2008) assess the impacts of a tsunami in Sri Lanka, analyzing data on 296 children from exposed communities only. Victimization, which includes children being exposed to physical, emotional, or sexual abuse and witnessing intimate partner violence between parents, is analyzed using a simple regression framework with children's self-reported tsunami exposure as the independent

variable. Using a similar approach, Biswas et al. (2010) study the occurrence of physical and emotional violence against children, inflicted on them by their caregivers, using survey data of 638 women, all residing in areas highly affected by the 2007 floods in Bangladesh. Studying the relation between exposure to disaster and child maltreatment in the US, Becker-Blease et al. (2010) apply partial correlation analysis to data on 2,030 children obtained from phone surveys. They show that self-reported disaster exposure, i.e., children reporting having experienced fire, explosion, flood, tornado, hurricane, earthquake, or other disasters, is associated with worse mental health, heightened aggression, and increased risks of victimization among children.

While a substantive body of research has identified correlates between violence against children and socio-economic and demographic factors (Cerna-Turoff et al. 2021a; Meinck et al. 2015; Palermo et al. 2019; Ravi and Ahluwalia 2017), virtually all of these studies are conducted in non-disaster settings. When it comes to child-level characteristics, evidence suggests that boys (Tang 1998; UNICEF 2014) and younger children, especially those in middle childhood (Hunter et al. 2000; Jackson et al. 1999), tend to be more exposed to physical and psychological violence, with some variation across geographical contexts and types of violence (UNICEF 2014). Furthermore, at the household-level, substance use by caregivers (Collins and Messerschmidt 1993; Dube et al. 2001), traditional gender norms and harmful power dynamics (Pearson et al. 2022), and caregivers' dissatisfaction with life (Plant et al. 2016) increase the risk of violence against children.

3. Violence against children and winter disasters in Mongolia

In Mongolia, children's rights were poorly prosecuted during the rule of the communist political system. Structural problems included the lack of an integrated protection system, the absence of multi-sectoral and multi-agency cooperation, and the lack of human capacity, especially trained social workers (Apland et al. 2021; United Nations Committee on the Rights of the Child 1996). With the beginning of the economic and political transition in the early 1990s, children's rights were given more attention. In 1990, the Mongolian government ratified the United Nations Convention on the Rights of the Child (CRC), which recognizes the freedom from violence as a fundamental human right of children; and in 1996, the National Council for Children, which oversees policies and programs aimed at child rights, was founded (EVAC 2020). In 2016, the Mongolian government ratified two interconnected laws, the revised Law on the Rights of Children, and the Law on Child Protection (LCP). In

2017, the revised Law of Combatting Domestic Violence was enacted.² These three laws constitute the main legislation through which the CRC is implemented in Mongolia (Apland et al. 2021). In a report assessing the implementation of the LCP, Apland et al. (2021) stress the need for action in several areas, including the development of child protection services and the mobilization of social work capacities and financial resources. Furthermore, they criticize that the LCP is implemented primarily through government institutions based in urban centers, failing to adequately protect children in rural areas. In particular, the mobility of nomadic households, who often move their campsites in search of suitable pastureland, imposes challenges for monitoring and enforcing child rights in rural areas.

In Mongolia, livestock rearing has a long tradition and continues to be the most important source of income for rural households. As of 2023, of all households living outside the capital city, about 47% owned livestock and 36% relied on animal husbandry as their main livelihood (Mongolia 2024). Pastoralist households typically rear a mixture of the five dominant species: sheep, goats, cattle, camels, and horses (Hiraga et al. 2020). Grazing animals on open rangelands, most pastoralist households are semi- or fully nomadic, moving their herds on seasonal migratory routes (Teickner et al. 2020). Livestock is used as a source of livelihood and a means of storing household wealth. Meat, milk, and other dairy products sourced from livestock feed the family, while by-products, most importantly cashmere wool, and living animals are sold to generate cash. Animals are also commonly used as collateral for loans.

The most significant risk to pastoralist households in Mongolia and other Central Asian countries is winter disasters, referred to as *dzud* in Mongolian, that cause mass livestock deaths within weeks due to starvation or freezing (Murphy 2011). The underlying weather phenomena causing *dzud* winters differ across years. Moreover, in some years, several mutually reinforcing adverse weather conditions occur in a single winter. Those include extremely low temperature during winter, dropping below -40 °C, which causes livestock to freeze to death; excessive snowfall, which prevents livestock from reaching the grass underneath the snow and causes livestock deaths due to starvation; lack of snowfall, resulting in poor pasture conditions and causing livestock to starve to death; snowfall in combination with fluctuations in temperature above and below freezing point, which causes the snow to

² This law prohibits treating children in inhumane or aggressive ways. Its wide definition of violence covers the use of violence, abuse (physical, sexual, psychological), neglect, and exploitation of children in the family and in educational and health settings. The law also establishes reporting obligations of teachers and social workers and defines responsibilities of helpline workers and the police (Apland et al. 2021; Mongolian Government 2016).

melt and then ice over, thereby creating an ice cover that prevents animals from reaching the grass underneath and die of starvation; and lack of rainfall during the previous summer that results in poor pasture conditions (Government of Mongolia 2015; Mogge et al. 2024). These diverse triggering weather conditions set winter disasters apart from other types of extreme weather events that are caused by a single underlying weather condition, such as drought, heat waves, or flooding.

Historically, winter disasters have been a recurring challenge for the herding economy in Mongolia. Their occurrence has become more frequent and disastrous in recent decades and this trend is predicted to accelerate under climate change (Bayasgalan et al. 2009). While the exact timing of *dzud* conditions varies across years, the most challenging period for pastoralists is late winter and early spring, February to May, when hay and fodder reserves tend to run out, and weakened animals are more susceptible to extreme weather conditions. The most extreme *dzud* in 50 years, which is also one of three winters considered in this study, hit Mongolia in 2009/10. Within few weeks, extreme cold combined with excessive snowfall caused the death of more than 10 million livestock, about 25% of the country's total livestock mortality across the country in this winter: While 40% of pastoralist households lost more than half of their herd, in some areas, livestock mortality remained close to the long-term average (UNDP NEMA 2010). The strong variation in spatial intensity is a particular feature of winter disasters.

Existing research on Mongolia documents that exposure to winter disasters worsens the nutritional status of children from pastoralist households (Groppo and Kraehnert 2016a), the attainment of education for children from pastoralist households (Groppo and Kraehnert 2016b), and life satisfaction among adults from pastoralist households (Fluhrer and Kraehnert 2022).

4. Data

Household survey data

The UNICEF-supported MICS initiative is a large-scale household survey program collecting internationally comparable data on the health and well-being of children and women in over 100 countries. In each participating country, cross-sectional rounds are implemented roughly every 5 years. In Mongolia, MICS have been implemented by the National Statistics Office of

Mongolia (NSO) since 1996. In its 2010 round, the Mongolian MICS started recording violence against children with a comprehensive survey module that has remained constant over time. In this study, we draw on the cross-sectional MICS rounds of 2010, 2013, and 2018, which comprise a sample of around 10,500, 15,500, and 14,500 households, respectively. The Mongolian MICS data are representative for urban and rural areas as well as for each of the country's five regions.³ In each round, data collection took place between September and December, with most interviews conducted in October and November. The winter disasters studied here occurred between December and May, with most livestock dying between February and May. Hence, MICS data were collected about four to ten months after the height of each winter.

The MICS questionnaire includes a detailed module on violence against children, using a shortened version of the Parent-Child Conflict Tactics Scales. In epidemiological research on child maltreatment and in clinical screening, the CTSPC is a widely used survey instrument for eliciting psychological and physical aggression inflicted on children by their parents. It was developed by sociologist Murray A. Straus in the 1990s as an extension of the Conflict Tactics Scales, which was initially designed to assess violence within intimate partner relationships (Straus et al. 1998; Straus 1979). It is argued that, compared with other measures, the CTSPC is less likely to suffer from under-reporting and bias caused by differing interpretations of violence, as it utilizes multiple questions that inquire about concrete acts of violence (Cools and Kotsadam 2017; Cotter et al. 2018). In the MICS questionnaire, parents or other adult caregivers are asked about various disciplinary measures applied in the month preceding the survey, used by themselves or another adult household member, to address behavioral issues of children.⁴ The questions are asked in relation to one specific child of age

³ Administratively, Mongolia is divided into the capital city and four regions, with the latter consisting of 21 provinces (*aimags*). Provinces are subdivided into 331 districts (*soums*), which are further subdivided into 1,639 sub-districts (*bags*). The MICS sample was selected in two stages, with slight differences across rounds over time. In the first sampling stage, in each region, primary sampling units (PSU) were drawn in urban and rural domains proportional to the size of the population, with the smallest administrative sub-division (*kheseg* in the capital city, sub-districts in the remaining country) used as PSU. In the second sampling stage, 25 households from each PSU were selected, using random systematic sampling. The underlying household listings were based on the national population and household registry that was updated by governors of selected PSUs before the survey implementation. In the 2018 round, representativeness was not only assured on the level of regions, but also on the level of eight selected target provinces.

⁴ For 88.5% of the children in our main sample, the questions on violence were answered by the biological parent, and in 11.5% by another caregiver. For 93% and 96% of sample children, the biological father and mother live in the same household, respectively. For the sake of simplicity, we use the term parent in the following when referring to the respondent of the violence module or to the perpetrator of violence.

2-14 years living in the household.⁵ Table 1 displays the survey items of the CTSPC instrument used in MICS Mongolia.

We construct seven outcome variables from the CTSPC instrument, following the existing literature on violence against children (e.g., Lansford and Deater-Deckard 2012; Palermo et al. 2019; UNICEF 2014). The first outcome (any violence binary) is an indicator variable taking the value one if a child was exposed to at least one item measuring psychological aggression or physical assault in the month preceding the survey interview. This was the case for 45% of children from pastoralist households in the pooled data from the MICS rounds of 2010, 2013, and 2018 (table 2). The second outcome (psychological violence binary) is an indicator variable taking the value one if a child was exposed to at least one form of psychological aggression, i.e., items 1 or 2 in table 1. On average, 36% of children from pastoralist households were exposed to psychological violence across the three MICS rounds considered here. As a refinement, the third outcome (psychological violence count) captures the number of different forms of psychological aggression a child was exposed to last month, which ranges from zero to two. The fourth outcome (physical violence binary) is an indicator variable measuring if a child was exposed to any form of physical assault (items 3-8 in table 1), which was the case for 26% of MICS sample children from pastoralist households. Again, the fifth outcome (physical violence count) is a count variable of the number of different forms of physical assault a child suffered from, ranging from zero to six. The sixth outcome (*minor physical violence binary*) is defined as an indicator variable taking the value one if a child was exposed to corporal punishment, i.e., items 3-5 in table 1. Lastly, the seventh outcome (severe physical violence binary) takes the value one if a child was exposed to physical maltreatment last month, i.e., items 6, 7, or 8. On average, 5% of sample children from pastoralist households were exposed to severe physical violence. Table A1 in the Appendix displays summary statistics, separately for each MICS round. Overall, the high prevalence of violence against children observed in this sample is similar to rates reported for other Asian countries (Hillis et al. 2016).

The MICS also collect ample information on the socio-demographic characteristics of surveyed households and their members. In the baseline model, we restrict the sample to

⁵ If more than one child in this age range lives in the household, a random selection process is applied during the survey interview to select one child. In the 2010 and 2013 MICS rounds, questions were asked in relation to children aged 2-14 years. In the 2018 MICS round, the age group was expanded to additionally include children aged one year. To ensure comparability across survey rounds, we dropped households from the 2018 round in which the CTSPC items were asked in relation to a child aged one year.

children from pastoralist households, as this socio-economic group directly depends on weather conditions for their livelihood and, thereby, is likely to be most immediately affected by severe winter conditions. We define pastoralist households as those owning at least one animal of the five commonly reared species and living in one of Mongolia's 21 provinces (i.e., not in the capital city of Ulaanbaatar). Our main sample, containing pooled MICS rounds of 2010, 2013, and 2018, comprises 8,533 children aged 2-14 years.

For each sample household, information is available on the household's district of residence at the time of the survey interview. This allows us to match the survey data with secondary data measuring the intensity of winter disasters across districts and years, as is described in the next sub-section. One shortcoming of the MICS data is that adults' duration of residence in their current location was only recorded from the 2018 round onwards. Hence, we are constrained to assume that a household's district of residence at the time of the survey is identical to its district of residence during the winter disaster that occurred several months before the survey interview. The sample considered here likely misses children from households experiencing very high disaster-induced livestock losses that gave up herding and moved to urban areas immediately after a winter disaster. Potential biases due to selective migration are discussed in Section 7 below.

Intensity of winter disasters

In the analysis presented here, we consider three distinct winter disasters with various levels of intensity. In each winter, different and, at times, multiple underlying weather conditions occurred. For example, while excessive snowfall was among the factors causing mass livestock mortality during the 2009/10 winter, snowfall was close to the long-term local average during the 2012/13 winter. During the 2017/18 winter, it was the interplay between snowfall and fluctuations in temperatures during winter that caused livestock starvation. Consequently, no single weather variable exists that would capture the spatial intensity of all three winters considered here. Identifying a single proxy measuring the spatial intensity of *dzud* is a recurrent challenge in research on Mongolia that considers multiple winter disasters in a single analysis (Groppo and Kraehnert 2016b; Roeckert and Kraehnert 2022). Climate scientists have no agreement on which weather variables can accurately measure this complex phenomenon (Nandintsetseg et al. 2018a; Palat Rao et al. 2015; Tachiiri et al. 2008).

Our approach is to proxy the spatial intensity of winter disasters with district-level data on livestock mortality, calculated from the annual Mongolian Livestock Census. Livestock mortality is an immediate measure for the spatial variation of winter disasters in Mongolia (Murphy 2011). Accordingly, the Mongolian index-based livestock insurance program uses district-level livestock mortality as its index, with mortality rates of 5 or 6% triggering insurance payouts to insured pastoralist households (Skees and Enkh-Amgalan 2002). At the national level, livestock deaths typically range in the hundreds of thousands in average years, while in *dzud* years, livestock losses frequently run into the millions (Mongolia 2024).

Starting in 1918, the Mongolian Livestock Census records detailed information from every pastoralist household on the number of animals currently owned as well as the number of animals that died in the previous 12 months. Data collection is implemented by the NSO each year in December, when most pastoralist households are at their winter campsite. We draw on anonymized and publicly available⁶ data, aggregated to the district level, to construct livestock mortality rates for the years and districts covered by MICS.⁷ More specifically, livestock mortality rates are calculated as the ratio of the number of adult livestock dying of unnatural causes in the current year to the total number of livestock in the previous year, treating livestock of different species as equal.⁸

District-level livestock mortality rates in districts covered by MICS reached a maximum of 69%, 15%, and 27% in 2010, 2013, and 2018, respectively. Figure 1 visualizes the spatial variation in district-level livestock mortality in the years of interest. It is visible that the catastrophic winter of 2009/10 led to high livestock mortality in large parts of the country, while extreme winter conditions occurred more locally confined in the 2012/13 and 2017/18 winters. In all three winters, a large heterogeneity in livestock mortality rates is observed across space. For example, during the 2009/10 winter, winter conditions varied strongly in eastern parts of the country, with some districts exhibiting livestock mortality rates above 30%, while other districts in the same region experiencing mortality rates below 4%. A study by Roeckert and Kraehnert (2022) does not find evidence for positive autocorrelation in

⁶ Data are available at https://www.1212.mn.

⁷ Livestock Census data is missing in two survey districts for one year, which would reduce the sample by 45 children. To avoid this reduction, we impute the missing data as follow: For one district, we replace missing livestock mortality data with the average from surrounding areas; for the other district, we replace missing total livestock holdings with the previous year's value adjusted for losses in the year where data is missing. All results are robust to this imputation.

⁸ Unnatural causes of death include death due to *dzud*, heavy rain, fire, lightning, wild animal predation, and accidents (Mongolia 2024). When calculating district-level livestock mortality rates, we excluded livestock deaths caused by infectious and non-infectious diseases, which the Mongolian Livestock Census records as separate category. The publicly available data is not disaggregated by species for all years.

livestock mortality rates across provinces over the 1992-2018 period. This suggests that winter disasters do not tend to occur in the same areas in consecutive years.

5. Empirical strategy

To identify the effects of extreme weather events on violence against children, we follow the approach by Dell et al. (2014) and exploit plausibly random variation in extreme winter conditions, treating each occurrence as a random draw from the distribution observed in a specific region over time. Pooling cross-sectional survey data from three years, we estimate the impact of winter disasters of varying intensity on the incidence of violence against children with the following model:

$$VAC_{ihdrym} = \beta_0 + \beta_1 disaster intensity_{dy} + \beta_2 C_{iy} + \beta_3 C_{hy} + \alpha_r + \mu_y + \lambda_m + \varepsilon_{ihdrym}$$

where *VAC* measures various forms of psychological and physical violence experienced by child *i* living in household *h*, district *d*, and region *r*, and whose parents were interviewed in year *y* and month *m*. Acts of violence were inflicted on children by their parents or other adult caregivers living in the same household in the month preceding the survey, recorded four to ten months after the height of each winter disaster. The determinants of violence against children are estimated as a function of *disaster intensity*_{*dy*}, approximated with secondary data on district-level livestock mortality, as well as vectors of control variables at child (C_{iy}) and household level (C_{hy}). To account for unobserved heterogeneity, fixed effects at the level of regions (α_r), survey rounds (μ_y), and interview month (λ_m) are used. Survey round fixed effects account for aggregate changes over time. Region fixed effects absorb time-invariant characteristics, such as societal norms toward violence against children. Lastly, interview month fixed effects control for the variation that may arise from the timing of the interviews. Standard errors are clustered at the district level, i.e., the level where disaster intensity is measured.⁹ The coefficient of interest, β_1 , measures the average impact of winter disasters on children residing in the same district.

The intensity of the extreme winter conditions is measured at the district level, the smallest unit for which information on household location is available in the MICS data.¹⁰ In

⁹ When instead clustering standard errors at the district-year level, both standard errors and effect sizes of disaster intensity are very similar to the baseline results (table 3).

¹⁰ In 2010, the number of registered pastoralist households in a district ranged between 100 and 2,120 (Mongolia 2024).

Mongolia, every household is required to register in one district to gain access to basic amenities, such as education and healthcare. Mongolian legislation restricts internal migration of individuals and households outside of their district of residence, which also applies to pastoralists. Pastoralist households wishing to graze their animals outside their district of residence need permission, which comes along with the payment of fees (Ahearn 2018; Goodijk and Tumendemberel 2011). Because of those restrictions, the population in districts is relatively stable over time, which makes districts an appropriate level of measuring the spatial intensity of winter disasters.

The control variables capture factors identified by the existing literature to either increase or lower the risk of children being exposed to violence inflicted on them by their parents (Cerna-Turoff et al. 2021a; Palermo et al. 2019; UNICEF 2014). Only controls that are unlikely to be systematically influenced by extreme winter conditions are chosen. At the child level, we employ variables for the sex and age (and its square) of the child. At the household level, controls include the number of adults and minors in the household, the highest educational level reached by any adult household member, the sex and age (and its square) of the household head, as well as whether the household's location is in the province center, district center, or in a rural area. Table 2 displays summary statistics for the three survey rounds.

As a refinement, we restrict the sample to children from households with larger herds to exclude periodic and part-time herders from the analysis. As a placebo test, we estimate the effects of winter disasters on violence against children for the sample of children from non-pastoralist households that, by definition, did not face any disaster-induced livestock losses. Moreover, we test the sensitivity of the results to a cold wave measure calculated from weather data, the inclusion of characteristics of respondents of the CTSPC survey module, province fixed effects, region-survey round fixed effects, linear time trends at the level of regions, and using Conley standard errors. Lastly, we explore whether there is evidence of pre-existing trends in violence against children that may bias the results.

In subsequent heterogeneity analyses, we investigate how violence against children interrelates with observed characteristics at the child and household level, exploring whether effects differ by child age, sex, and household location. Furthermore, we explore possible channels explaining the increase in violence against children, including alcohol consumption, attitudes toward gender norms, and life satisfaction among adult household members as well as health issues, the disruption of education, and labor among children. The analysis of

mechanisms is confined to 2010, marked by the most severe winter disaster, as those additional outcomes were not consistently recorded across MICS rounds.

6. Results

Baseline results

Table 3 displays results of the baseline model that examines the impacts of winter disasters on seven measures of psychological and physical violence against children inflicted by adults living in the same household. The database consists of the pooled cross-sectional MICS rounds of 2010, 2013, and 2018. The sample is restricted to children aged 2-14 years living in pastoralist households outside the capital. All models are estimated with linear OLS to facilitate the interpretation of effect sizes.¹¹

We find that the exposure to winter disasters in Mongolia increases the incidence of violence against children living in pastoralist households. The estimated coefficient of the disaster intensity measure, livestock mortality in a child's district of residence, is statistically significant at the 1% or 5% level and positive in all specifications. An increase in district-level livestock mortality by 10 percentage points is associated with a 1.3 percentage point increase in the probability of a child experiencing violence in the month before the interview (col. 1), holding all else constant.

The magnitude of the effects is substantial. With district-level livestock mortality being as high as 69%, the incidence of violence against children living in the most affected district increases by about 9 percentage points compared to children living in districts unaffected by winter disasters. When distinguishing between different forms of violence, we find that the incidence of both psychological and physical violence increases in strongly affected areas, with effect sizes being of similar magnitude (col. 2 and 4). Results are confirmed when considering as outcome the count of the number of different forms of psychological violence (col. 3) and physical violence (col. 5) a child was exposed to. Exposure to winter disasters also has statistically significant effects on the sub-categories of physical violence: An increase in district-level livestock mortality by 10 percentage points leads to an increase in the probability of children being subject to minor forms of physical violence by 1.4 percentage points (col. 6) and to severe forms of physical violence, such as hitting the child with an

11

Results are qualitatively similar when using logit for binary outcomes and poisson for count outcomes.

object, on the face or head, or beating the child up, by 0.6 percentage points (col. 7).

In figure 2, we restrict the sample to children living in households that possess more than 100 animals.¹² In Mongolia, a herd size of 100 animals, irrespective of the species, is regarded the minimum to derive a livelihood in the herding economy without additional income sources (Goodland et al. 2009). This sample restriction excludes periodic and part-time pastoralists with marginal herd sizes. Periodic herders come in and out of the animal husbandry sector, depending on their economic situation, and often use pastoralism as a fallback option. Part-time pastoralists supplement their income from mining or temporary employment in urban centers with income from animal husbandry (Goodland et al. 2009). The effects of disaster intensity on violence against children are more pronounced in the sample of children living in households with larger herds, with a 10 percentage point increase in disaster intensity leading to a 3.1 and 2 percentage point increase in the probability of children being subject to psychological and physical violence, respectively. When comparing the estimates for children from households with larger herds to the full sample of children living in pastoralist households, the null hypotheses of equal coefficients for disaster intensity is rejected in a Wald chi square test, with chi-square statistics exceeding 5.5 for any violence and psychological violence. This finding further underlines that children from households whose livelihood directly depends on weather conditions are particularly at risk of experiencing violence following winter disasters.

Placebo test: Estimates for children from non-pastoralists households

Next, we explore whether the effects of winter disasters on violence against children are specific to the population of pastoralists. Table A3 in the Appendix presents results from estimating the model for the sample of children from households that do not own livestock and reside outside the capital city. Most of these households work in the service sector or in mining; along with animal husbandry, these are the predominant employment sectors outside the capital.

In the sample of children from non-pastoralist households, disaster intensity is not a statistically significant predictor of any of the measures of violence against children, with p-values (far) above 0.26 in all specifications. We take results from this test and the results for children from wealthier pastoralists as suggestive evidence that violence against children was

12

Results are displayed in tabular form in table A2 in the Appendix.

not caused by extreme winter conditions *per se*, to which all children were exposed to.¹³ Rather, we interpret these results as indication that winter disasters increase the incidence of violence against children in pastoralist households through the channel of disaster-induced livestock losses. Since pastoralists' immediate livelihood depends on livestock, extreme winter conditions have a direct impact on their income, wealth, and food consumption, thereby creating economic stress.

Robustness test: Measuring disaster intensity with weather data

In Central Asia, winter disasters are triggered by diverse and sometimes interacting weather phenomena, which makes the modeling of those events with weather data challenging. This is particularly the case if several winter disasters occurring in different years are analyzed jointly. In the baseline results presented above, disaster intensity is measured with aggregate livestock mortality derived from Mongolian Livestock Census data.

To test for the sensitivity of results, we rerun our main models, now using weather data to measure the spatial intensity of winter disasters. The 2009/10 winter and, to a lesser extent, the winters of 2012/13 and 2017/18 were marked by record low temperatures, falling below -40 °C in parts of the country (Sternberg 2010). These temperature anomalies caused numerous animals to freeze to death. To measure temperature anomalies, we adopt a method developed by Miller et al. (2021), originally designed to capture heat waves, and construct for each of the three winters a cold wave measure. This measure captures both abnormally cold temperatures and the prolonged prevalence of cold.

A dual cold threshold is defined for each day and district in the 2009/10, 2012/13, and 2017/18 winters, with the winter period defined as November 1 to April 30. For the first threshold, the temperature on a given day needs to be 1.5 standard deviations or more below the 30 year (1989-2018) average temperature at this locality. For the second threshold, the temperature on a given day needs to be among the 90 coldest recorded at this locality over the last 30 years. The index takes positive values when temperature drops below the dual threshold for an individual day, while it further increases when consecutive abnormally cold days are observed in the winter period.¹⁴ Thus, the index assigns greater weight to disasters

¹³ A similar approach, estimating effects separately for pastoralists and non-pastoralists, has been applied by Groppo and Kraehnert (2016b).

¹⁴ For each day in the winter period, the long-term average temperature is calculated as the mean temperature occurring that day as well as the 15 days prior and the 15 days after that day during the 1989-2018

characterized by prolonged cold compared to winters with isolated cold days.

To construct the cold wave measure, we draw on ERA5 reanalysis data (Hersbach et al. 2023), aggregated to the level of districts. Specifically, we utilize the minimum air temperature, measured at two meters above the ground at noon of each winter day. In the winters of 2009/10, 2012/13, and 2017/18, the cold wave measure ranged from 1-106, 0-53, and 0-43, respectively.

Table A4 in the Appendix shows results when employing the cold wave measure as proxy for disaster intensity. Panel A presents results for the full sample, consisting of all three MICS rounds, while panel B presents results when the sample is restricted to the 2010 MICS round, mirroring the fact that the cold wave measure is best suited to capture the intensity of the 2009/10 winter disaster. When considering all three winter disasters combined (panel A), we find that exposure to prolonged cold significantly increases the probability that children experience physical violence. The cold wave measure is not statistically significant at conventional levels for the incidence of psychological violence or any violence. When considering the 2009/10 winter disaster (panel B), the cold wave measure is statistically significant and meaningful for all seven measures of violence against children.¹⁵ These findings confirm our baseline results. Yet, aggregate livestock mortality remains our preferred disaster intensity measure, as it is better suited to compare the effects across winter disasters that were characterized by different weather phenomena.

Robustness tests: Alternative specifications

Next, we explore the sensitivity of the results to changes in the control variables and fixed effects employed. For space reasons, table A5 in the Appendix only displays results for the outcomes *psychological violence binary* and *physical violence binary*. In a first step, we explore potential effects of changes in the survey design across MICS rounds. In the 2010 and

period. In the first step, an indicator variable is constructed that takes the value one for each day in the winter period that falls below the location-specific threshold and is also among the 90 coldest days. In the second step, an evolving index accumulates values if consecutive days remain colder than the dual threshold: the first abnormally cold day is assigned a value of one; if followed by another such day, the value increases to two on the second day; if a third consecutive cold day occurs, the index takes the value of three and so on. Conversely, when temperature rises above the threshold, the index resets to zero, reflecting relief from cold conditions. The index for a given year and district is calculated by summing the accumulated values over all days of that winter period.

¹⁵ We obtain similar results when varying the second threshold of the cold wave measure to the historically 60 or 180 coldest days.

2013 MICS rounds, the CTSCP module was asked as part of the household questionnaire. With this, any adult household member could respond to the questions. Indeed, in 2010 and 2013, around 40% of respondents of the CTSCP module were male household heads. In the 2018 round, the CTSCP module was shifted to the child questionnaire that was administered to mothers or other female caregivers. In columns 1 and 2, we include additional control variables for the sex and age (and age squared) of the person responding to the CTSCP module. Results are comparable to the baseline estimates in terms of effect size and level of significance. Next, we estimate the model with region-specific linear time trends (col. 3-4), to allow for differential trends in violence against children at the level of regions, and with region-survey round fixed effects (col. 5-6) to account for unobserved heterogeneity within each region-survey round. Also, we test the model with province fixed effects instead of region fixed effects (col. 7-8). In all these tests, the effects of exposure to disaster intensity remains positive, comparable in magnitude, and significant at least at the 10% level.

Robustness test: Conley standard errors

Next, we give more attention to the fact that disaster intensity is a spatial process. Table A6 in the Appendix displays results when estimating the model with Conley standard errors (Conley 1999) that address potential spatial autocorrelation in the district-level livestock mortality data. Following Mogge et al. (2023), we employ Conley standard errors with a distance linear decay in the correlation structure and a 320km distance cutoff that allows each sample district to have at least five neighbors in its own spatial cluster.¹⁶ For all seven outcomes, results from the baseline estimations are confirmed.

Pre-existing trends in the prevalence of violence

One potential threat to our identification strategy is the existence of pre-disaster trends in the prevalence of violence against children. We explore this possibility in table A7 in the Appendix, where our focus is on the 2009/10 winter, the most severe of the three winters considered here. Data from one additional MICS round, implemented in 2005, are used in this exercise in order to test for trends before the 2009/10 winter disaster. Yet, this comes with two limitations: First, in the 2005 MICS round, the CTSPC module contained a shorter list of

¹⁶ The distance measure is calculated as the distance between district centers. The minimum, mean, and maximal distance between district centers in the pooled sample is 262km, 657km, and 2,178km. Results are not sensitive to excluding the linear decay option or varying the distance cutoff between 100 and 1000km.

survey items measuring psychological and physical violence, which may result in underreporting of incidences of violence in 2005 compared to later MICS rounds; and second, disaggregated geographical identifiers for the location of survey households are not available in the 2005 round. Hence, in this exercise, the level of analysis is MICS survey clusters, defined as rural area, district center, and province center in each surveyed province, with a total of 235 survey cluster observations. The outcome is defined as the percent of children from pastoralist households per survey cluster experiencing violence last month.

The coefficient of interest is the interaction term between disaster intensity in 2010 and indicator variables for each MICS round. Estimates from OLS with survey round fixed effects indicate that, in line with expectations, the interaction effect between disaster intensity in 2010 and the 2010 round indicator significantly increases the prevalence of psychological violence against children (col. 2), while the effect is still marginally significant (p=0.12) when considering as outcome *any violence* (col. 1). Importantly, disaster intensity in 2010 has no systematic effects on the prevalence of violence against children in the 2005, 2013, and 2018 MICS rounds. We interpret this as suggesting that potentially confounding pre-existing trends are not a major concern in our analysis.

Heterogeneity analysis

Next, we examine the differential impacts of winter disasters on violence against children along several child and household characteristics. The characteristics of interest are interacted with the centered measure of disaster intensity, while all characteristics are also included individually in the extended model. Table 4 shows results.

With respect to the sex of the child, results indicate that boys are, on average and holding all other factors constant, significantly more likely to become victim of both psychological and physical violence than girls (col. 1-2). This finding is in line with the existing evidence from non-disaster contexts (e.g., Tang 1998; UNICEF 2014). Yet, the exposure to extreme winter conditions does not have heterogenous effects on the risk of victimization for girls and boys.

With respect to child age, findings indicate that children in the youngest age group, aged 2-4 years, are, on average, significantly more likely to experience physical violence than their older peers (col. 4). This finding aligns with the previous literature, documenting that young age is a risk factor for physical violence in many regions of the world (Jackson et al. 1999; UNICEF 2014). The exposure to winter disasters has differential effects for children of different ages: Shock intensity significantly increases the risk of physical and psychological violence among older children, while no significant effect is observed for the youngest age group.

As a last dimension of heterogeneity, we explore household location in province centers, district centers, and rural areas (col. 5-6). The location of residence significantly correlates with the incidence of psychological violence, with children living in district centers and rural areas being less likely to experience violence than their peers in provincial centers. Synthesis studies indicate that the existing evidence regarding the effects of urbanicity on violence against children in non-disaster contexts is mixed (Akmatov 2011; Maguire-Jack et al. 2021). We do not find evidence that disaster intensity has different impacts for different strata of residence. However, those results should be interpreted cautiously due to the specificities of the sample defined here. Since our baseline sample is restricted to children from pastoralist households, a high share (about 56%) of sample households live in rural areas, whereas households with children aged 2-14 in rural areas only make up for 27% of the complete MICS sample. At the same time, all provincial centers outside the capital city are typically small, with some centers having less than 10,000 inhabitants. Due to their dependency on pastureland, pastoralist households in the province center stratum are likely to reside in the rural surroundings of agglomerations.

Mechanisms at the adult level

Lastly, we explore possible mechanisms explaining the observed increase in violence against children. We first consider mechanisms at the adult level, focusing on the role of alcohol consumption, attitudes toward violence against women, attitudes toward male dominance, and life satisfaction. All these factors have been identified in existing studies as risk factors for intra-household violence. For instance, substance abuse is associated with both violence against children (Collins and Messerschmidt 1993; Dube et al. 2001) and economic hardship (Dee 2001). Male dominance within the household has been shown to be systematically associated with intra-household violence (Fleming et al. 2015), while violence against women and children is found to frequently co-occur within the same family (Pearson et al. 2022). Low levels of satisfaction with employment among caregivers is associated with an increased risk of child abuse (Plant et al. 2016).

Our outcomes of interest are (i) whether an individual consumed any alcohol last month, (ii) whether an individual considers wife beating justified in at least one of six hypothetical

scenarios,¹⁷ (iii) whether an individual considers it desirable that the husband has the sole decision-making power in the household in at least one of six hypothetical scenarios,¹⁸ (iv) and an individual's satisfaction with life, the job, and own income on a 5-point Likert scale. The survey items employed to construct these outcomes were not consistently recorded in all three MICS rounds. Consequently, we chose to only consider the 2010 MICS round because that year had the most severe winter conditions of the three years considered here. The sample for the mechanism analysis comprises adult respondents living in pastoralist households outside the capital.¹⁹ Summary statistics are displayed in table A8 in the Appendix.

Results from OLS estimates²⁰ are shown in table 5. The same measure of disaster intensity, district-level livestock mortality, as in the child-level analysis is employed, along with household-level controls, region fixed effects, and interview month fixed effects. In order to explore potential differences by sex, the centered measure of disaster intensity is interacted with an indicator variable for female respondents. Turning to alcohol consumption (col. 1), we find that the effect of disaster intensity differs by sex. For men, disaster intensity is significantly and positively correlated with the probability of having consumed alcohol in the past 30 days.²¹ While at average conditions, alcohol consumption among women is significantly lower compared to men, this gap widens with increasing disaster intensity.

Results for attitudes toward violence against women are displayed in col. 2. For men, exposure to disaster is significantly and positively correlated with the acceptability of wife beating. Female respondents have, in general, a significantly higher probability to consider wife beating justified than men, while the size of the effect is very small. However, the interaction effect between disaster intensity and being female is highly significant, negative, and large, indicating that exposure to higher disaster intensity correlates with lower

¹⁷ In the survey, both married and unmarried men and women are asked whether they think it is justified for a husband to beat his wife in specific situations, such as when she burns food or neglects her children.

¹⁸ Those scenarios include making major household purchases, determining the number of children to have, and deciding whether a wife should pursue paid work.

¹⁹ Note that in the mechanism analysis, we do not condition the sample to households with co-habiting children aged 2-14 years for sample size reasons. If, for the sake of comparability with the child-level analysis, we restrict the sample to households with co-habiting children aged 2-14 years, the sample reduces to around 3,600 observations. Most findings on mechanisms hold for this smaller sample.

²⁰ Results point into the same direction when we use probit for binary outcomes or ordered probit for life satisfaction outcomes instead.

²¹ This result is confirmed if we instead measure alcohol consumption with an ordinal variable that takes the value zero if an individual reports not having consumed alcohol in the past month, the value one if an individual reports alcohol consumption on up to five days, and the value three if an individual reports alcohol consumption on more than five days.

acceptability of wife beating among women compared to men.

Exposure to higher disaster intensity is also significantly and positively correlated with the probability that men consider male dominance within the household justified, holding all else constant (col. 3). Men and women do not significantly differ in their attitudes toward male dominance in general. Yet, exposure to higher disaster intensity has differential effects for men and women, with disaster intensity being significantly and negatively correlated with women's attitudes toward male dominance.

With respect to life satisfaction, we find that for men, disaster intensity is significantly and negatively correlated with their satisfaction with job (col. 5) and income (col. 6), while no systematic correlation is detected for men's satisfaction with life in general (col. 4). In none of the three life satisfaction outcomes, the interaction term is statistically significant at conventional levels, indicating that the correlation between disaster intensity and life satisfaction does not differ systematically for men and women.

Mechanisms at the child level

Lastly, we turn to another set of potential mechanisms measured at the child level. We explore whether the exposure to winter disasters increased the incidence of violence against children through health issues among children (which may come with additional expenditures and more care work), the disruption of children' education, and child labor as indicator for economic hardship of the household. More specifically, the outcomes of interest are (i) whether a child was sick with cough or diarrhea in the two weeks before the survey interview, (ii) whether a child is currently attending school, and (iii) whether a child was involved in tending the household's livestock or working in the family business, fetching water or firewood, or in other domestic chores in the last seven days. The data for this mechanism analysis is again the 2010 MICS round. Summary statistics are displayed in table A9 in the Appendix.

Results obtained with OLS are presented in table 6. We do not find evidence that the exposure to the 2009/10 winter disaster is systematically correlated with health issues among children four to ten months after the height if the disaster (col. 1-2) or the disruption of schooling (col. 3). Similarly, there is no evidence that living in more disaster-affected areas is correlated with children spending more time with tending the household's animals or working in the family business (col. 4), activities that are often done by boys. However, the exposure to the

2009/10 winter disaster is significantly and positively correlated with the time children spent with both fetching water or firewood (col. 4) and other domestic chores (col. 5). This could possibly indicate that in response to this winter disaster, adults allocated more time to incomegenerating activities, while children were involved more strongly in domestic tasks to replace adults.

7. Discussion

The MICS program consistently elicits violence against children in a large number of countries, using a shortened version of the widely used CTSPC. This makes MICS data a valuable source to examine violence against children across countries and contexts. These strengths notwithstanding, MICS data come with several limitations, which are important for the interpretation of our results.

First, the survey items of the CTSPC are self-reported by parents or other adult caregivers. Individuals may underreport or omit incidences of violence due to problems with memory recall, social desirability, or fear of consequences (Cotter et al. 2018). Although the high reported prevalence of violence against children in Mongolia suggests a sufficient willingness to disclose violent acts, prevalence rates should be interpreted as minimum estimates, with the actual presence of violence against children likely being higher than reported. Furthermore, our results may be biased if the exposure to winter disasters is correlated with differential reporting of violence against children. Unfortunately, the MICS data do not allow to test for this possibility.

A second limitation of our study is the timing of the implementation of MICS in relation to winter disasters. With all three MICS rounds considered here implemented four to ten months after the height of each winter, our study can only shed light on the effects of winter disasters in a narrow time window. We expect the prevalence of violence against children to be higher at the height of winters when livestock mortality unfolds and pastoralists face uncertainty about whether or not they will manage to keep enough animals alive to stay in the animal husbandry sector in the medium term. Hence, our baseline estimates should be regarded as lower bound estimates of the full impacts of winter disasters on child violence. This limitation also applies to the mechanism analysis.

A third limitation is a potential bias due to disaster-induced migration. Directly addressing this concern is not possible, as MICS only recently started collecting information on adult's

duration of residence in their current location. In the 2018 MICS round, 10.2% of male adult survey respondents who were interviewed in the capital had moved here between 2010 and 2018. In 2010, 2013, and 2018, this figure varies between 0.8% to 2.5%. In their study of internal migration in Mongolia over the 1992-2018 period, Roeckert and Kraehnert (2022) find that winter disasters cause net outmigration from affected areas, with effects being most pronounced in the year after a winter disaster occurs and still detectable up to two years after an event. Our conclusion from those figures is that disaster-induced migration of severely affected pastoralists is likely, despite the fact that Mongolian legislation aims at restricting population movements. Given that few employment opportunities exist in rural areas, it is possible that pastoralist households whose herd size fell below the minimum herd size required to maintain a livelihood in the animal husbandry sector in the long term left rural areas in the months following a winter disaster. These households may not yet have formally registered at their new location and, consequently, are likely not included in the MICS sampling design. Hence, our estimates on the effects of winter disasters on violence against children may miss the most severely affected households and should, hence, be regarded as lower bound estimates.

8. Conclusion

This study analyzes the impact of extreme weather events on the risk of children to become victim of psychological and physical violence in Mongolia. In the last decades, Mongolian pastoralists are facing an increasing number of winter disasters that cause mass livestock mortality and put their livelihood in the rural herding economy at risk, thus exerting economic stress. Our analysis draws on pooled data from three rounds of Multiple Indicator Cluster Surveys, collected in Mongolia in 2010, 2013, and 2018, that record violence against children inflicted on them by their parents living in the same household, using the Parent-Child Conflict Tactics Scales. We exploit plausibly exogenous variation in the intensity of extreme winter conditions in three distinct winters of varying severity.

Our analysis documents that the exposure to winter disasters causes significant and sizeable increases in the incidence of psychological and physical violence against children from pastoralist households four to ten months after the height of each winter. Effects are strongest for children from households with larger herds that specialize in animal husbandry and have fewer alternative income sources. Results are robust to the usage of alternative measures of disaster intensity, changes in the control variables and fixed effects, and the usage of Conley

standard errors. A heterogeneity analysis reveals that exposure to winter disasters increases the risk of victimization for older children. There is no evidence for heterogeneous effects of exposure to disaster by children's sex or location of residence. Possible mechanisms explaining the rise in violence against children in the aftermath of winter disasters are changes in behavioral and attitudinal factors among adult household members. These include increased alcohol consumption among men, attitudinal changes toward male dominance in intimate partner relationships among men, and reduced satisfaction with income and job among both men and women. Moreover, exposure to winter disasters tends to increase the time allocated by children to domestic work, possibly freeing up adults' time to engage more intensely in income-generating activities.

Our study contributes to enlarge the empirical evidence base on the socio-economic consequences of climate change, focusing on a dimension of human well-being that, to date, has received little attention. Our results point into the same direction as the study by Evans et al. (2023) on the US, the only other analysis on the effects of weather extremes on child maltreatment we are aware of that employs a rigorous study design. Evans et al. (2023) find that exposure to extremely hot temperature increases the incidence of child maltreatment. While Evans et al. (2023) propose child neglect as a result of parents' reduced cognitive capacity and reduced attentiveness as possible mechanism, our results from winter disasters in Mongolia point at economic stress as mechanism.

From our results, we derive two policy implications for child protection programs. First, there is a need for services that protect children living in areas highly exposed to extreme weather conditions in order to prevent adverse consequences for their health and well-being later in life. In Mongolia, one promising avenue for acting early are so-called *dzud risk maps* that provide spatially fine-grained projections of the risk of extreme winter conditions (Nandintsetseg et al. 2018b). Published by Mongolian authorities every year in November or December, weeks and months before extreme winter conditions start materializing, those risk projections may be used to assist pastoralists at risk to avoid livestock losses and raise awareness for child protection. Second, there is need for a gender-sensitive approach when addressing parents in child protection programs, targeting men in particular.

Further research is warranted that examines the impact of extreme weather events across geographic locations, types of disasters, and wealth levels. An understanding of the mechanisms that foster violence is particularly useful for the design of targeted child protection programs.

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Figures and tables



Fig. 1: District-level livestock mortality in Mongolia in MICS survey years

Notes: District boundaries are shown. Livestock mortality is calculated as the average across species (sheep, goats, cattle, camels, and horses). Sources: Mongolia Livestock Census and MICS Mongolia rounds of 2010, 2013, and 2018.

Fig. 2: Effect sizes for the full sample and for the sub-sample of children from pastoralist households with more than 100 livestock



Notes: Displayed are point estimates of the disaster intensity measure and 90% confidence intervals derived from OLS estimates obtained from pooled cross-sectional data. The complete regression results are displayed in table 3 (full sample) and table A2 in the Appendix (sub-sample of children from wealthier households). Source: MICS Mongolia rounds of 2010, 2013, and 2018 and Mongolia Livestock Census.

Scale	Sub-scale	Item no.	Survey item					
Psychological		(1)	Shouted, yelled at or screamed at (him/her)					
aggression		(2)	Called (him/her) dumb, lazy or another name like that					
		(3)	Shook (him/her)					
	Corporal punishment	(4)	Spanked, hit or slapped (him/her) on the bottom with bare hand					
	P	(5)	Hit or slapped (him/her) on the hand, arm or leg					
Physical assault	Dhysical	(6)	Hit (him/her) on the bottom or elsewhere on the body with something like a belt, hairbrush, stick or other hard object					
maltreatmen		(7)	Hit or slapped (him/her) on the face, head or ears					
		(8)	Beat (him/her) up, that is hit (him/her) over and over as hard as one could					

 Table 1:
 Version of the Parent-Child Conflict Tactics Scales used in MICS Mongolia

Notes: At the beginning of the module, enumerators read out the following statement: "Adults use certain ways to teach children the right behavior or to address a behavior problem. I will read various methods that are used. Please tell me if you or any other adult in your household has used this method with (name) in the past month." Source: National Statistics Office of Mongolia and UNICEF (2023).

Variable name	Description	Mean	Std. dev.	Min	Max	Ν
Dependent variables						
Any violence (binary)	Child was exposed to at least one CTSPC item measuring psychological aggression or physical assault last month	0.45	0.50	0	1	8,533
Psychological violence (binary)	Child was exposed to at least one CTSPC item measuring psychological aggression last month	0.36	0.48	0	1	8,533
Psychological violence (count)	Number of CTSPC items measuring psychological aggression the child was exposed to last month	0.45	0.65	0	2	8,533
Physical violence (binary)	Child was exposed to at least one CTSPC item measuring physical assault last month	0.26	0.44	0	1	8,533
Physical violence (count)	Number of CTSPC items measuring physical assault the child was exposed to last month	0.39	0.78	0	6	8,533
Minor physical violence (binary)	Child was exposed to at least one CTSPC item measuring corporal punishment last month	0.24	0.43	0	1	8,533
Severe physical violence (binary)	Child was exposed to at least one CTSPC item measuring physical maltreatment last month	0.05	0.23	0	1	8,533
Disaster intensity						
Livestock mortality, district	Annual livestock mortality in the district, in percent	0.08	0.13	0.01	0.69	8,533
Child controls						
Female	Child is female	0.48	0.50	0	1	8,533
Age	Age of child, in years	7.54	3.88	2	14	8,533
Household controls						
No. adult members	Number of adult household members	2.24	0.70	1	8	8,533
No. children aged<5	Number of children below age 5	0.70	0.73	0	4	8,533
No. children aged 5-9	Number of children aged 5-9	0.69	0.71	0	6	8,533
No. children aged 10-18	Number of children aged 10-18	0.81	0.88	0	5	8,533
Education: primary	Highest educational level reached by adult household members is primary or less	0.17	0.37	0	1	8,533
Education: secondary	Highest educational level reached by adult household members is secondary	0.47	0.50	0	1	8,533
Education: tertiary	Highest educational level reached by adult household members is tertiary	0.36	0.48	0	1	8,533
Female head	Household head is female	0.09	0.29	0	1	8,533
Age head	Age of household head, in years	39.84	10.79	16	95	8,533
Province center	Household lives in province center	0.16	0.37	0	1	8,533
District center	Household lives in district center	0.27	0.45	0	1	8,533
Rural	Household lives in rural area	0.56	0.50	0	1	8,533

Table 2: Summary statistics from pooled MICS rounds

Notes: Displayed are averages from pooled cross-sectional data of 2010, 2013, and 2018. The sample is restricted to children aged 2-14 years living in pastoralist households outside the capital. Source: MICS Mongolia rounds of 2010, 2013, and 2018 and Mongolia Livestock Census.

Dependent variables	Child was exposed to violence last month								
	Any violence (binary)	Psycho- logical violence (binary)	Psycho- logical violence (count)	Physical violence (binary)	Physical violence (count)	Minor physical violence (binary)	Severe physical violence (binary)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
Disaster intensity									
Livestock mortality, district	0.13 ^{**}	0.12 ^{**}	0.19 ^{**}	0.15 ^{***}	0.25 ^{**}	0.14^{**}	0.06^{**}		
	(0.04)	(0.04)	(0.03)	(0.01)	(0.02)	(0.01)	(0.03)		
Child controls									
Female	-0.08^{***}	-0.06 ^{***}	-0.08^{***}	-0.08 ^{***}	-0.15***	-0.07***	-0.03***		
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		
Age	0.00	0.02**	0.05***	-0.02***	-0.02*	-0.02***	0.01***		
	(0.74)	(0.01)	(0.00)	(0.01)	(0.07)	(0.00)	(0.01)		
Age sq.	-0.00	-0.00**	-0.00 ^{***}	0.00	-0.00	0.00	-0.00^{***}		
	(0.21)	(0.02)	(0.00)	(0.88)	(0.63)	(0.48)	(0.00)		
Household controls									
No. adult members	-0.00	-0.01	-0.00	0.00	0.00	0.00	-0.00		
	(0.77)	(0.53)	(0.73)	(0.84)	(0.77)	(0.83)	(0.55)		
No. children aged<5	0.04^{***}	0.03 ^{***}	0.05***	0.04^{***}	0.07^{***}	0.04^{***}	0.01*		
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.06)		
No. children aged 5-9	0.03***	0.03***	0.05^{***}	0.02**	0.02	0.01*	0.00		
	(0.00)	(0.00)	(0.00)	(0.02)	(0.18)	(0.07)	(0.31)		
No. children aged 10-18	0.01	0.01	0.02	-0.00	0.00	-0.00	0.00		
	(0.18)	(0.17)	(0.11)	(0.66)	(0.84)	(0.70)	(0.27)		
Education: secondary	-0.01	-0.02	-0.02	-0.02	-0.04	-0.02	-0.01		
	(0.42)	(0.12)	(0.43)	(0.19)	(0.12)	(0.16)	(0.13)		
Education: tertiary	0.00	0.01	0.02	-0.03**	-0.06**	-0.03**	-0.01*		
	(0.99)	(0.54)	(0.41)	(0.03)	(0.03)	(0.02)	(0.06)		
Female head	0.03^{*}	0.03	0.04	0.01	0.04	0.00	0.01		
	(0.08)	(0.11)	(0.12)	(0.55)	(0.21)	(0.75)	(0.41)		
Age head	-0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00		
	(0.58)	(0.45)	(0.42)	(0.45)	(0.60)	(0.57)	(0.68)		
Age head sq.	-0.00	-0.00	-0.00	0.00	-0.00	0.00	0.00		
	(0.92)	(0.14)	(0.14)	(0.65)	(0.98)	(0.85)	(0.75)		
District center	-0.04*	-0.04**	-0.07**	-0.01	-0.02	-0.00	-0.01*		
	(0.10)	(0.03)	(0.01)	(0.73)	(0.50)	(0.80)	(0.06)		
Rural	-0.04**	-0.04**	-0.07**	-0.02	-0.05	-0.02	-0.01		
	(0.04)	(0.02)	(0.01)	(0.30)	(0.15)	(0.29)	(0.16)		
Constant	0.54^{***}	0.28^{***}	0.23**	0.44^{***}	0.69^{***}	0.44^{***}	0.04		
	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.32)		
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Survey round FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Interview month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
R-squared	0.03	0.02	0.03	0.06	0.05	0.06	0.01		
Number of children	8,533	8,533	8,533	8,533	8,533	8,533	8,533		

Table 3: Violence against children – baseline results

Notes: Displayed are OLS estimates obtained from pooled cross-sectional data. Standard errors are clustered at the district level. P-values are in parentheses with * p < 0.10, ** p < 0.05, *** p < 0.01. The sample is restricted to children aged 2-14 years living in pastoralist households outside the capital. In household location, the reference category is province center. In education, the reference category is primary. Source: MICS Mongolia rounds of 2010, 2013, and 2018 and Mongolia Livestock Census.

Dependent variables		Child w	vas exposed to	o violence las	t month	
	Psycho- logical violence (binary)	Physical violence (binary)	Psycho- logical violence (binary)	Physical violence (binary)	Psycho- logical violence (binary)	Physical violence (binary)
	(1)	(2)	(3)	(4)	(5)	(6)
Disaster intensity						
Livestock mortality, district	0.13 [*] (0.09)	0.13* (0.05)	0.01 (0.94)	-0.01 (0.95)	0.13* (0.05)	0.29** (0.03)
Heterogeneity by sex of child						
Female	-0.06*** (0.00)	-0.08^{***} (0.00)				
Female # Livestock mortality, district	-0.01 (0.89)	0.04 (0.54)				
Heterogeneity by age of child						
Age 5-9			0.04 ^{**} (0.03)	-0.08^{***} (0.00)		
Age>9			0.02 (0.22)	-0.16*** (0.00)		
Age 5-9 # Livestock mortality, district			0.07 (0.49)	0.15 (0.18)		
Age>9 # Livestock mortality, district			0.23** (0.05)	0.26 ^{**} (0.02)		
Heterogeneity by household location						
District center					-0.04** (0.03)	-0.01 (0.75)
Rural					-0.04** (0.02)	-0.02 (0.29)
District center # Livestock mortality, district					0.02 (0.81)	-0.18 (0.22)
Rural # Livestock mortality, district					-0.02 (0.80)	-0.18 (0.19)
Constant	0.29 ^{***} (0.00)	0.45^{***} (0.00)	0.33 ^{***} (0.00)	0.43 ^{***} (0.00)	0.29 ^{***} (0.00)	0.45^{***} (0.00)
Child controls	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Survey round FE	Yes	Yes	Yes	Yes	Yes	Yes
Interview month FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.02	0.06	0.02	0.06	0.02	0.06
Number of children	8,533	8,533	8,533	8,533	8,533	8,533

Table 4: Heterogeneity analysis

Notes: Displayed are OLS estimates obtained from pooled cross-sectional data. Standard errors are clustered at the district level. P-values are in parentheses with * p < 0.10, ** p < 0.05, *** p < 0.01. The sample is restricted to children aged 2-14 years living in pastoralist households outside the capital. Livestock mortality is centered. Source: MICS Mongolia rounds of 2010, 2013, and 2018 and Mongolia Livestock Census.

Dependent variables	Behavioral or attitudinal factors										
	Alcohol consumption	Considers wife beating justified	Considers sole male decision- making justified	Satisfaction with life	Satisfaction with job	Satisfaction with income					
	(1)	(2)	(3)	(4)	(5)	(6)					
Disaster intensity											
Livestock mortality, district	0.20** (0.02)	0.19 ^{***} (0.00)	0.21** (0.03)	-0.14 (0.15)	-0.29** (0.04)	-0.66*** (0.00)					
Heterogeneity by sex of adult											
Female	-0.28*** (0.00)	0.03 ^{**} (0.03)	-0.01 (0.68)	-0.08^{***} (0.00)	-0.06** (0.04)	-0.07* (0.05)					
Female # Livestock mortality, district	-0.22*** (0.01)	-0.23*** (0.00)	-0.41*** (0.00)	-0.12 (0.28)	-0.09 (0.61)	0.33 (0.14)					
Constant	0.41^{***} (0.00)	0.30 ^{***} (0.00)	0.12 (0.19)	4.46^{***} (0.00)	3.96 ^{***} (0.00)	3.70 ^{***} (0.00)					
Household controls	Yes	Yes	Yes	Yes	Yes	Yes					
Region FE	Yes	Yes	Yes	Yes	Yes	Yes					
Interview month FE	Yes	Yes	Yes	Yes	Yes	Yes					
R-squared	0.12	0.03	0.01	0.03	0.03	0.02					
Number of adults	5,147	5,147	5,147	5,147	3,355	3,355					

Table 5: Mechanism analysis at adult level

Notes: Displayed are OLS estimates. Standard errors are clustered at the district level. P-values are in parentheses with * p < 0.10, ** p < 0.05, *** p < 0.01. The sample is restricted to adults living in pastoralist households outside the capital. It consists of N=3,466 women and N=1,681 men. Livestock mortality is centered. Source: MICS Mongolia round of 2010 and Mongolia Livestock Census.

Dependent variables	Indicator of child well-being										
	Illness: Cough	Illness: Diarrhea	School attendance	Child labor: Herding, business	Child labor: Water, firewood	Child labor: Domestic chores					
	(1)	(2)	(3)	(4)	(5)	(6)					
Disaster intensity											
Livestock mortality, district	0.11 (0.11)	0.00 (0.96)	-0.03 (0.32)	0.04 (0.37)	0.21 ^{***} (0.00)	0.21 ^{***} (0.01)					
Constant	0.51^{***} (0.00)	0.36 ^{***} (0.00)	1.21*** (0.00)	-0.18** (0.02)	0.12 (0.44)	0.20 (0.19)					
Child controls	Yes	Yes	Yes	Yes	Yes	Yes					
Household controls	Yes	Yes	Yes	Yes	Yes	Yes					
Region FE	Yes	Yes	Yes	Yes	Yes	Yes					
Interview month FE	Yes	Yes	Yes	Yes	Yes	Yes					
R-squared	0.04	0.04	0.09	0.08	0.14	0.15					
Number of children	1,957	1,957	4,239	4,239	4,239	4,239					

Table 6: Mechanism analysis at child level

Notes: Displayed are OLS estimates. Standard errors are clustered at the district level. P-values are in parentheses with * p < 0.10, ** p < 0.05, *** p < 0.01. The sample is restricted to children living in pastoralist households outside the capital. Livestock mortality is centered. Source: MICS Mongolia round of 2010 and Mongolia Livestock Census.

Online Appendix

Table A1:	Summary	statistics,	by	MICS	round
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MICS round	2	010	2	013	2018		
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	
Dependent variables							
Any violence (binary)	0.42	0.49	0.47	0.50	0.46	0.50	
Psychological violence (binary)	0.33	0.47	0.38	0.48	0.38	0.48	
Psychological violence (count)	0.42	0.64	0.48	0.67	0.45	0.62	
Physical violence (binary)	0.25	0.43	0.26	0.44	0.26	0.44	
Physical violence (count)	0.39	0.78	0.40	0.79	0.39	0.77	
Minor physical violence (binary)	0.25	0.43	0.25	0.43	0.23	0.42	
Severe physical violence (binary)	0.04	0.19	0.05	0.21	0.08	0.26	
Disaster intensity							
Livestock mortality, district	0.21	0.17	0.02	0.02	0.03	0.04	
Child controls							
Female	0.47	0.50	0.49	0.50	0.48	0.50	
Age	7.86	3.90	7.60	3.92	7.21	3.81	
Household controls							
No. adult members	2.23	0.72	2.21	0.66	2.27	0.72	
No. children aged<5	0.65	0.73	0.70	0.71	0.74	0.74	
No. children aged 5-9	0.63	0.68	0.67	0.69	0.76	0.74	
No. children aged 10-18	0.91	0.94	0.76	0.85	0.77	0.86	
Education: primary	0.15	0.36	0.17	0.38	0.18	0.38	
Education: secondary	0.52	0.50	0.47	0.50	0.43	0.49	
Education: tertiary	0.33	0.47	0.36	0.48	0.40	0.49	
Female head	0.09	0.28	0.09	0.28	0.09	0.29	
Age head	39.11	10.49	39.16	10.18	41.06	11.43	
Province center	0.15	0.36	0.20	0.40	0.15	0.35	
District center	0.34	0.47	0.18	0.39	0.30	0.46	
Rural	0.51	0.50	0.62	0.49	0.55	0.50	
Number of children	2,	599	2,	804	3,	130	

Notes: The sample is restricted to children aged 2-14 years living in pastoralist households outside the capital. Source: MICS Mongolia rounds of 2010, 2013, and 2018, and Mongolia Livestock Census.

Dependent variables	Child was exposed to violence last month										
	Any violence (binary)	Psycho- logical violence (binary)	Psycho- logical violence (count)	Physical violence (binary)	Physical violence (count)	Minor physical violence (binary)	Severe physical violence (binary)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)				
Disaster intensity											
Livestock mortality, district	0.30 ^{***} (0.00)	0.31*** (0.00)	0.48^{***} (0.00)	0.20*** (0.01)	0.26 ^{**} (0.04)	0.20*** (0.01)	0.03 (0.41)				
Constant	0.39*** (0.00)	0.14 (0.20)	0.02 (0.86)	0.41^{***} (0.00)	0.56^{***} (0.00)	0.38 ^{***} (0.00)	0.03 (0.57)				
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
Survey round FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
Interview month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
R-squared	0.04	0.03	0.03	0.06	0.05	0.07	0.02				
Number of children	4,653	4,653	4,653	4,653	4,653	4,653	4,653				

Table A2: Robustness test - children from pastoralist households with more than 100 livestock

Notes: Displayed are OLS estimates obtained from pooled cross-sectional data. Standard errors are clustered at the district level. P-values are in parentheses with * p < 0.10, ** p < 0.05, *** p < 0.01. The sample is restricted to children aged 2-14 years living in pastoralist households owning more than 100 heads of livestock and living outside the capital. Source: MICS Mongolia rounds of 2010, 2013, and 2018 and Mongolia Livestock Census.

Dependent variables	Child was exposed to violence last month									
	Any violence (binary)	Psycho- logical violence (binary)	Psycho- logical violence (count)	Physical violence (binary)	Physical violence (count)	Minor physical violence (binary)	Severe physical violence (binary)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)			
Disaster intensity										
Livestock mortality, district	-0.05 (0.73)	-0.10 (0.34)	-0.16 (0.27)	0.06 (0.57)	0.11 (0.54)	0.06 (0.57)	-0.02 (0.59)			
Constant	0.65^{***} (0.00)	0.43 ^{***} (0.00)	0.45^{***} (0.00)	0.57 ^{***} (0.00)	0.90^{***} (0.00)	0.57 ^{***} (0.00)	-0.00 (1.00)			
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Survey round FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Interview month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
R-squared	0.03	0.03	0.03	0.05	0.04	0.05	0.02			
Number of children	6,621	6,621	6,621	6,621	6,621	6,621	6,621			

Table A3: Placebo test - children from non-pastoralist households

Notes: Displayed are OLS estimates obtained from pooled cross-sectional data. Standard errors are clustered at the district level. P-values are in parentheses with * p < 0.10, ** p < 0.05, *** p < 0.01. The sample is restricted to children aged 2-14 years from households that do not own livestock and live outside the capital. Source: MICS Mongolia rounds of 2010, 2013, and 2018 and Mongolia Livestock Census.

Dependent variables		Child was exposed to violence last month Any Psycho- Psycho- Physical Physical Minor Severe										
	Any violence (binary)	Psycho- logical violence (binary)	Psycho- logical violence (count)	Physical violence (binary)	Physical violence (count)	Minor physical violence (binary)	Severe physical violence (binary)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)					
Panel A: Pooling all rou	nds											
Cold wave, district	0.0006 (0.25)	0.0002 (0.61)	0.0008 (0.20)	0.0011** (0.04)	0.0021** (0.03)	0.0011** (0.04)	0.0001 (0.72)					
Constant	0.5827*** (0.00)	0.3162*** (0.00)	0.2744 ^{***} (0.01)	0.4720 ^{***} (0.00)	0.7370 ^{***} (0.00)	0.4760 ^{***} (0.00)	0.0511 (0.18)					
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
Survey round FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
Interview month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
R-squared	0.03	0.02	0.02	0.06	0.05	0.06	0.01					
Number of children	8,423	8,423	8,423	8,423	8,423	8,423	8,423					
Panel B: 2010 round onl	у											
Cold wave, district	0.0017^{***} (0.01)	0.0015^{**} (0.01)	0.0022** (0.01)	0.0018 ^{***} (0.00)	0.0039*** (0.00)	0.0017^{***} (0.00)	0.0005^{*} (0.07)					
Constant	0.5205 ^{***} (0.00)	0.1982 (0.15)	0.2178 (0.23)	0.5417 ^{***} (0.00)	0.7860^{***} (0.00)	0.5491 ^{***} (0.00)	0.0559 (0.39)					
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
Interview month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
R-squared	0.03	0.03	0.03	0.05	0.05	0.05	0.02					
Number of children	2,570	2,570	2,570	2,570	2,570	2,570	2,570					

Table A4: Robustness test – proxying disaster intensity with weather data

Notes: Displayed are OLS estimates. Standard errors are clustered at the district level. P-values are in parentheses with * p < 0.10, ** p < 0.05, *** p < 0.01. The sample is restricted to children aged 2-14 years living in pastoralist households outside the capital. In Panel A, cross-sectional data from 2010, 2013, and 2018 are pooled. In panel B, the sample is restricted to 2010. Source: MICS Mongolia rounds of 2010, 2013, and 2018 and ERA5 Reanalysis data.

Dependent variables	Child was exposed to violence last month											
	Psycho- logical violence (binary)	Physical violence (binary)	Psycho- logical violence (binary)	Physical violence (binary)	Psycho- logical violence (binary)	Physical violence (binary)	Psycho- logical violence (binary)	Physical violence (binary)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)				
Disaster intensity												
Livestock mortality, district	0.12** (0.05)	0.14 ^{**} (0.01)	0.11 [*] (0.07)	0.18^{***} (0.00)	0.13 ^{**} (0.03)	0.22 ^{***} (0.00)	0.12* (0.07)	0.11 ^{**} (0.03)				
Constant	0.23 ^{***} (0.00)	0.40^{***} (0.00)	0.30 ^{***} (0.00)	0.37 ^{***} (0.00)	0.27 ^{***} (0.00)	0.38 ^{***} (0.00)	0.23 ^{***} (0.00)	0.47^{***} (0.00)				
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
Region FE	Yes	Yes	Yes	Yes	No	No	No	No				
Survey round FE	Yes	Yes	Yes	Yes	No	No	Yes	Yes				
Interview month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
Respondent controls	Yes	Yes	No	No	No	No	No	No				
Linear time trends at region level	No	No	Yes	Yes	No	No	No	No				
Region-survey round FE	No	No	No	No	Yes	Yes	No	No				
Province FE	No	No	No	No	No	No	Yes	Yes				
R-squared	0.03	0.06	0.02	0.06	0.03	0.06	0.03	0.06				
Number of children	8,533	8,533	8,533	8,533	8,533	8,533	8,533	8,533				

Table A5: Robustness tests – alternative specifications

Notes: Displayed are OLS estimates obtained from pooled cross-sectional data. Standard errors are clustered at the district level. P-values are in parentheses with * p < 0.10, ** p < 0.05, *** p < 0.01. The sample is restricted to children aged 2-14 years living in pastoralist households outside the capital. Source: MICS Mongolia rounds of 2010, 2013, and 2018 and Mongolia Livestock Census.

Dependent variables	Child was exposed to violence last month							
	Any violence (binary)	Psycho- logical violence (binary)	Psycho- logical violence (count)	Physical violence (binary)	Physical violence (count)	Minor physical violence (binary)	Severe physical violence (binary)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
Disaster intensity								
Livestock mortality, district	0.13 [*] (0.10)	0.12* (0.06)	0.19 ^{**} (0.05)	0.15 ^{**} (0.02)	0.25 ^{**} (0.02)	0.14 ^{**} (0.04)	0.06 ^{**} (0.04)	
Constant	0.54 ^{***} (0.00)	0.28 ^{***} (0.00)	0.23** (0.01)	0.44^{***} (0.00)	0.69*** (0.00)	0.44^{***} (0.00)	0.04 (0.35)	
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Survey round FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Interview month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
R-squared	0.03	0.02	0.03	0.06	0.05	0.06	0.01	
Number of children	8,533	8,533	8,533	8,533	8,533	8,533	8,533	

Table A6: Robustness tests – Conley standard errors

Notes: Displayed are OLS estimates obtained from pooled cross-sectional data. Conley standard errors are clustered at the district level. P-values are in parentheses with * p < 0.10, ** p < 0.05, *** p < 0.01. The sample is restricted to children aged 2-14 years living in pastoralist households outside the capital. Source: MICS Mongolia rounds of 2010, 2013, and 2018 and Mongolia Livestock Census.

Table A7: Exploring pre-trends

Dependent variables	Percent of children per survey cluster exposed to violence last month				
	Any violence (binary)	Psychological violence (binary)	Physical violence (binary)		
	(1)	(2)	(3)		
Interacting survey round indicator with disaster intensity in 2010					
2005 # Livestock mortality 2010, survey cluster	-0.05 (0.78)	-0.05 (0.76)	0.02 (0.88)		
2010 # Livestock mortality 2010, survey cluster	0.16 (0.12)	0.20* (0.06)	0.14 (0.27)		
2013 # Livestock mortality 2010, survey cluster	-0.02 (0.84)	-0.05 (0.68)	0.01 (0.89)		
2018 # Livestock mortality 2010, survey cluster	0.01 (0.96)	-0.10 (0.45)	0.11 (0.35)		
Constant	0.81 ^{***} (0.00)	0.80 ^{***} (0.00)	0.39*** (0.00)		
Survey round FE	Yes	Yes	Yes		
R-squared	0.48	0.57	0.16		
Number of survey clusters	235	235	235		

Notes: Displayed are OLS estimates obtained from pooled cross-sectional data. The level of analysis is MICS survey clusters. The sample is restricted to survey clusters outside the capital. The outcome is defined as the percent of children per MICS survey cluster, who are aged 2-14 years, live in pastoralist households, and were exposed to violence last month out of the total survey population of children of this age range living in pastoralist households in the respective cluster. Standard errors are clustered at the survey cluster level. P-values are in parentheses with * p < 0.10, ** p < 0.05, *** p < 0.01. Source: MICS Mongolia rounds of 2005, 2010, 2013, and 2018 and Mongolia Livestock Census.

Variable name	Description	Mean	Std. dev.	Min	Max	Ν
Dependent variables						
Alcohol consumption	Respondent consumed any alcohol last month	0.23	0.42	0	1	5,147
Considers wife beating justified	Respondent consider wife beating justified (0=wife beating considered justified in none of 6 scenarios, 1=wife beating considered justified in at least 1 of 6 scenarios)	0.17	0.37	0	1	5,147
Considers sole male decision-making justified	Respondent's attitude toward male dominance (0=sole male decision making desired in none of 6 scenarios, 1=sole male decision making desired in at least 1 of 6 scenarios)	0.34	0.48	0	1	5,147
Satisfaction with life	General satisfaction with life (1=very unsatisfied, 5=very satisfied)	4.16	0.69	1	5	5,147
Satisfaction with job	Satisfaction with job (1=very unsatisfied, 5=very satisfied)	4.18	0.77	1	5	3,355
Satisfaction with income	Satisfaction with income (1=very unsatisfied, 5=very satisfied)	3.54	0.96	1	5	3,355
Disaster intensity						
Livestock mortality, district	Annual livestock mortality in the district, in percent	0.21	0.17	0	0.69	5,147
Household controls						
No. adult members	Number of adult household members	2.40	0.87	1	7	5,147
No. children aged<5	Number of children below age 5	0.54	0.69	0	3	5,147
No. children aged 5-9	Number of children aged 5-9	0.45	0.65	0	3	5,147
No. children aged 10-18	Number of children aged 10-18	0.82	0.95	0	5	5,147
Education: primary	Highest educational level reached by adult household members is primary or less	0.19	0.39	0	1	5,147
Education: secondary	Highest educational level reached by adult household members is secondary	0.50	0.50	0	1	5,147
Education: tertiary	Highest educational level reached by adult household members is tertiary	0.31	0.46	0	1	5,147
Female head	Household head is female	0.07	0.26	0	1	5,147
Age head	Age of household head, in years	40.15	10.45	18	95	5,147
Province center	Household lives in province center	0.14	0.34	0	1	5,147
District center	Household lives in district center	0.32	0.47	0	1	5,147
Rural	Household lives in province center	0.54	0.50	0	1	5,147
Respondent controls						
Female	Respondent of mechanism survey items is female	0.67	0.47	0	1	5,147

Table A8: Summary statistics for mechanism analysis at adult level

Notes: The sample is restricted to adults living in pastoralist households outside the capital. It consists of N=3,466 women and N=1,681 men. For satisfaction with job and income, the sample size reduces to N=1,976 women and N=1,379 men as this survey item was not asked to individuals without a job or personal income. Source: MICS Mongolia round of 2010 and Mongolia Livestock Census.

Variable name	Description	Mean	Std. dev.	Min	Max	N
Dependent variables						
Illness: Cough	Child was ill with cough in last two weeks (for children aged<5 years)	0.23	0.42	0	1	1,957
Illness: Diarrhea	Child was ill with diarrhea in last two weeks (for children aged<5 years)	0.11	0.32	0	1	1,957
School attendance	Child is currently attending school (for children aged 5-17 years)	0.95	0.21	0	1	4,239
Child labor: Herding/ business	Child was involved in paid or unpaid work in tending the family's livestock or in family business in last 7 days (for children aged 5- 17 years)	0.08	0.27	0	1	4,239
Child labor: Water/ firewood	Child was involved in fetching water or collecting of firewood or fuel for own household use in last 7 days (for children aged 5-17 years)	0.51	0.50	0	1	4,239
Child labor: Domestic chores	Child was involved in household chores in the last 7 days (for children aged 5-17 years)	0.55	0.50	0	1	4,239
Disaster intensity						
Livestock mortality, district	Annual livestock mortality in the district, in percent	0.21	0.17	0	0.69	4,239
Household controls						
No. adult members	Number of adult household members	2.25	0.75	1	7	4,239
No. children aged<5	Number of children below age 5	0.42	0.61	0	3	4,239
No. children aged 5-9	Number of children aged 5-9	0.80	0.76	0	3	4,239
No. children aged 10-18	Number of children aged 10-18	1.46	0.99	0	5	4,239
Education: primary	Highest educational level reached by adult household members is primary or less	0.12	0.33	0	1	4,239
Education: secondary	Highest educational level reached by adult household members is secondary	0.53	0.50	0	1	4,239
Education: tertiary	Highest educational level reached by adult household members is tertiary	0.34	0.47	0	1	4,239
Female head	Household head is female	0.09	0.29	0	1	4,239
Age head	Age of household head, in years	41.13	9.36	9	95	4,239
Province center	Household lives in province center	0.15	0.36	0	1	4,239
District center	Household lives in district center	0.38	0.48	0	1	4,239
Rural	Household lives in province center	0.47	0.50	0	1	4,239
Child controls						
Female	Child is female	0.47	0.50	0	1	4,239
Age	Age of child	11.01	3.47	5	17	4,239

Table A9: Summary statistics for mechanism analysis at child level

Notes: The sample is restricted to children living in pastoralist households outside the capital. The dependent variables were recorded for children of different age ranges. The control variables are calculated for children aged 5-17 years. Source: MICS Mongolia round of 2010 and Mongolia Livestock Census.