



The influence of natural disasters on violence, mental health, food insecurity, and stunting in the Philippines: Findings from a nationally representative cohort

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ABSTRACT

Background: Climate change is leading to an increased number of natural disasters. Children from low- and middle-income countries are disproportionately affected. The impacts of exposure to multiple natural disasters on the development of children are not well understood. The Philippines had 6.5 million people affected by natural disasters in 2018 and is therefore an ideal country in which to study the cumulative effects of natural disasters on human development.

Methods: We used wave 1 (2016–17) of the Longitudinal Cohort Study on the Filipino Child, a nationally representative cohort study of 4952 10-year-old children, to examine the impact of natural disasters. For caregivers, we examined mental health, family violence, and food insecurity. For children, we examined exposure to violence and stunting. We used random effects models to estimate the associations between natural disasters and children's development outcomes and caregivers' outcomes, after adjusting for neighbourhood, demographic, and geographic variables. Disaster exposure was measured using caregiver-reported measures of cumulative exposure and cumulative impact of disasters, average neighbourhood reports and data linked from the International Disaster Database (EM-DAT), an independent measure of community exposure to disaster.

Findings: We found that experiencing natural disasters, as measured by neighbourhood reports, was associated with higher levels of family violence in the previous 12 months, parenting stress, children witnessing physical violence, physical abuse of children, stunting in children, and greater food insecurity. Associations with individual self-reported exposure showed was similar. Associations with natural disasters measured using EM-DAT data showed a similar pattern: exposure to greater numbers of natural disasters was associated with higher levels of family violence, physical abuse of children, stunting in children, and food insecurity. Impacts of disasters was associated with higher levels of family violence, depression and food insecurity.

Interpretation: This is the first national study to document that cumulative measures of natural disasters had small, but wide-ranging, impacts on children and their caregivers. Further research is needed to identify factors that will protect populations who are at risk of high levels of natural disasters to ensure the optimal development of children.

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1. Introduction

Natural disasters have been defined as 'a situation or event that overwhelms local capacity, necessitating a request at the national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering' (Centre for Research on th, 2017). Climate change is leading to an increased number of natural disasters in many countries (Oppenheimer & Anttila-Hughes, 2016). Consequently, one of the United Nations Sustainable Development Goals (SDGs)—SDG 13—focuses on strengthening resilience and adaptation to natural disasters (United Nations. The Susta, 2017). The evidence is that children are

disproportionately affected by natural disasters by affecting child physical health (e.g. injuries, malnutrition, reduced access to medical care), by causing mental health problems (through trauma and loss, abuse and neglect and breakdowns in support networks, neighbourhoods and local economies) and their education (displacement of families, destruction of schools and poverty increasing pressure to work). (Codreanu et al., 2014; Dyregrov et al., 2018; Kousky, 2016; Masten & Narayan, 2012).

To date, research on the impacts of natural disasters on children has focused on the impacts of single disasters on children's physical and mental health, and schooling (Codreanu et al., 2014; Dyregrov et al., 2018; Kousky, 2016; Masten & Narayan, 2012). Many studies report

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small but significant long-lasting impacts. These include a study of the long-term impacts of the Black Saturday bushfires in Victoria, Australia, on numeracy and literacy learning of children in primary school compared to unaffected peers 4 years later (Masten & Narayan, 2012). Another study of an Australian bushfire in 1983 found higher levels of psychological symptoms amongst children two years after the fire (McFarlane, 1987) and some lingering effects after 20 years (McFarlane & Van Hooff, 2009). A 100 year study of the impacts of natural disasters in Latin America reported fewer years of education, worse health and fewer assets as adults for children exposed in utero through to school age (Caruso, 2017). A recent meta-analysis of violence against children following natural disasters concluded that there were mixed and inconsistent findings from a small number of unrepresentative studies, and more rigorous research was needed (Cerna-Turoff et al., 2019).

The implications of experiencing multiple natural disasters on children's development are not well understood. A recent review of the impact of natural disasters on children (Kousky, 2016) noted that most studies have focused on particular geographic areas and were not nationally representative, and few studies considered the cumulative effects of natural disasters. The review argued that more research is needed in this area. One of the few nationally representative studies, in the United States, reported that 14% of 2–17-year-olds had been exposed to a natural disaster in their lifetime and 4% in the past year. Of these children and young people, those aged 10–17 years experienced higher levels of anxiety, depression, and aggression (Becker-Blease et al., 2010).

There are not well-established scientific methods for quantifying cumulative natural disasters. The International Disasters Database (EM-DAT) (Centre for Research into, 2018) provides standardised reporting on disaster exposure. For many countries EM-DAT provides some information about the geographic areas within the country affected by a particular disaster. While this data can be used to generate a cumulative index of disaster exposure for smaller geographic areas, EM-DAT does not capture variation in disaster exposure and impact for individual households so may lack the specificity required to examine impacts on children and their families. For example, extensive damage to houses in low-lying areas from flooding could occur but houses built on higher ground may not be affected in the same area. Self-reported measures of natural disasters could better capture heterogeneity in disaster impacts than official reports (e.g. EM-DAT) and numerous studies have used self-report measures of exposure to disasters (Garfin et al., 2014; Harville et al., 2015; Sherwood et al., 2017; Verger et al., 2003). In this study we include a self-reported index of cumulative disaster exposure and another that measure of the cumulative disaster impacts. One limitation of using self-reports to generate an index of cumulative disaster impacts may be that reporting could be colored by individual circumstances such as poverty or mental health or trauma (the measure is endogenous) and recall bias. A recently developed measure of cumulative disaster exposure avoids this limitation by using reports of neighbours' disaster exposure but excludes the residents own report using established methods for the aggregation of self-reports of neighbourhood characteristics (Edwards et al., 2019, 2021; Mair et al., 2010; Sampson et al., 1997).

The Philippines is an ideal country in which to study the impact of natural disasters on human development because it has the second largest number of people affected by natural disasters after India (6.5 million in 2018) (Centre for Research into, 2018). The Longitudinal Cohort Study on the Filipino Child (LCSFC) is a nationally representative cohort study of children in the Philippines designed to measure SDG indicators. The LCSFC collected unusually rich data on natural disaster exposure, as reported by caregivers. Using caregiver-reported measures of cumulative exposure and cumulative impact of disasters, a newly developed neighbourhood index of cumulative disaster exposure based on these self-reports and a cumulative measure of disaster exposure from the International Disaster Database (EM-DAT) we examine the association between cumulative disasters and:

- household food insecurity and child stunting (relevant to the SDG 2 goal of zero hunger);
- caregivers stress and depression (SDG 3, ensuring healthy lives and promoting wellbeing at all ages); and
- caregivers, and children's exposure to family violence and physical abuse (SDG 16.2 end abuse, exploitation, trafficking and all forms of violence and torture against children) (United Nations. The Susta, 2017).

Based on previous research into the impact of exposure to a single disaster we hypothesise that cumulative exposure will be associated with poorer outcomes in these areas and that the self-report and neighbourhood index of cumulative disaster exposure will be more strongly related to outcomes than the EM-DAT index.

2. Methods

2.1. Study design and participants

The LCSFC is the Philippines' first nationally representative longitudinal study of child development. It is designed to examine how the lives of young Filipinos change in the course of the 15-year implementation of the SDGs. The study recruited 4952 10-year old children at baseline (2016–17) who will be observed for 15 years through to age 25.

The sample was selected to be nationally representative of 10-year old Filipinos living in the country's three main island groups of Luzon, Visayas, and Mindanao at the time of the baseline survey. A two-stage sample selection scheme was used. In the first stage, 345 barangays (neighbourhoods) were selected using probability proportional to size systematic sampling. In each barangay, 15 households were selected that had a 10-year-old (as of last birthday) resident using equal probability systematic sampling. Implicit stratification (Lynn, 2018) was used to ensure that marginalised children were included (specifically indigenous peoples and children with disabilities). Each of the 15 households selected were approached to participate in the study.

2.2. Procedures

For this study we use the baseline survey data that was undertaken from October 2016 to January 2017. Consent was obtained from the mother or main caregiver of the 10-year-old. Assent from the child (termed the index child) was also obtained. A household questionnaire was administered to the mother or main caregiver at the home of the index child. The index child was also asked a series of questions by interviewers and given a self-administered questionnaire that included more sensitive questions (e.g., reports of child physical abuse, witnessing violence).

A community questionnaire collected secondary data about the barangay from multiple key informants. The official in charge of the area, known as the Barangay Captain, provided consent for this information to be collected.

The University of San Carlos Institutional Ethics Review Committee approved the survey design, protocol, and instruments on October 27, 2016. Further details about protocols reporting harm to children are provided in the Appendix. Initially, 5270 children were identified as eligible, and 4952 (94%) participated in wave 1. Our analytical sample were the 4084 children living in the same neighbourhood for the last 10 years.

2.3. Dependent variables

Food insecurity: Caregivers were asked about food insecurity using the 8-item Food Insecurity Experience Scale, which is the official indicator of food insecurity for the SDGs (Cafiero et al., 2018). The scale has good evidence on validity (Cafiero et al., 2018) and standardised scoring (Ballard et al., 2013). In wave 1, 34% of caregivers reported being in

severe food insecurity, 33% in moderate food insecurity, and 18% in mild food insecurity in the previous 12 months.

Stunting: Stunting (being short for the age of the child) is usually a consequence of chronic or recurrent undernutrition and repeated infections (World Health Organization, 2014). It is defined as having a height-for-age that is more than two standard deviations below the World Health Organization Child Growth Standards median (de Onis et al., 2007; ulticentre Growth Re, 2006). In the LCSFC, stunting was identified through direct assessment of height using a Seca 206 body-meter. All instruments were calibrated before fieldwork, and interviewers were trained to calibrate the instruments to ensure ongoing accuracy (Adair et al., 2010).

Caregiver stress: This was measured using a 10-item version of the Perceived Stress Scale (Cohen et al., 1983), adapted for the Philippines context (Cebu Study Team. Underlyi, 1991). The scale asks participants to report their thoughts and feelings (Never = 0; Almost never = 1; Sometimes = 2; Fairly often = 3; Very often = 4). For wave 1, the Cronbach's alpha was 0.78. An example of an item was "In the last month, how often have you felt nervous and stressed?"

Caregiver depression: This was measured using a 12-item version of the Centre for Epidemiological Studies—Depression Scale (Radloff, 1977), adapted for the Philippines context (Hindin & Gultiano, 2006). Participants reported on their symptoms in the past week—for example "I felt depressed" (Rarely/not at all = 1; Sometimes = 2; Often = 3). In wave 1, Cronbach's alpha was 0.73.

Family violence in the past 12 months: Interviewers were instructed to read the following: "No matter how well people get along, there are times when they disagree on their decisions, get annoyed about something the person does, or just have spats or fights. I am going to read a list of things or behaviour that you might have experienced when you had a dispute. I would like you to tell me if this ever happened to you". Caregivers were asked whether their husband or partner, or previous husband or partner, ever:

- physically abused you (pushed, shook, slapped, beat, kicked, threw something at you)
- verbally abused you (insults, said something to humiliate you)
- financially abused you
- emotionally or psychologically abused you (silent treatment)
- sexually abused you (physically forced you to perform sexual acts you did not want to).

If caregivers indicated that any of these five acts were done to them, they were then asked whether this has occurred in the past 12 months. If "yes", they were asked to indicate how often it occurred (Seldom or rarely = 1; Sometimes = 2; Often = 3).

Family violence in the past 12 months: This was calculated by summing the number of family violence acts. Scores ranged from 0 to 15. The internal consistency of the Family Violence Frequency scale was $\alpha = 0.65$.

Witnessing violence at home: Children were asked "Have you witnessed any physical violence at home?" The response format was "Yes" or "No".

Child physical abuse: Children were asked in the questionnaire to report about their experiences of physical abuse in the past 12 months. Children were asked "Since last May:

- have any of your parents physically hurt you?
- have any of your parents physically hurt you in a forceful manner?"

Children could respond "Yes" or "No". Given that these two items were not specifically developed as a scale, we estimated the association with disasters separately.

2.4. Cumulative disaster exposure: household disaster exposure

One measure of exposure to natural disasters is number of disasters experienced by households in each barangay in the previous 3 years, as reported by caregivers surveyed in the LCSFC. The types of disasters included in the measure are tropical cyclones, extreme rainfall, drought, volcanic activity, storm surges, sea level rises, flooding, tsunamis, earthquakes, fire, armed conflicts, epidemics, and marine pollution. For each of these disasters, caregivers indicated whether this hazard occurred in the last 3 years (Yes/No). Responses were summed to form a household disaster exposure index.

2.5. Cumulative disaster exposure: household disaster impact

In addition to asking caregivers about disaster exposure in the last three years the LCSFC also asked caregivers to record the type of damage. Caregivers indicated whether the damage was: loss of life, injuries, house damage, property loss, and loss of livelihood or crops. The development of the household disaster impact variable is documented in detail elsewhere (Edwards et al., 2019, 2021) but in essence, deaths were not included as they were too rare an occurrence and a factor score was generated from the remaining variables using a principal components analysis with a quartimax rotation.

2.6. Cumulative disaster exposure: average neighbourhood report

In this study neighbourhoods are *barangay* or village which is the country's lowest level of administrative unit. Another measure of exposure to natural disasters is the average number of disasters experienced by households in each barangay in the previous 3 years using the caregiver reported household disaster exposure variable. This provides a barangay-level measure of the number of disasters experienced. The barangay level is used because it is the smallest geographic administrative division in the Philippines, and, given their small size, entire barangays tend to be affected by significant natural disasters (refer to section 2.7 for a definition of significant natural disasters).

Given that the number of disasters experienced is used to estimate the impact of exposure to disaster on individual and household outcomes, households' own responses are excluded from the measure; in other words, we generated an average exposure score for each household based on neighbours' but not caregivers' reports of disasters. This neighbourhood report has an ecometric reliability of 0.89, has established convergent and discriminant validity and was associated with economic impacts of disasters on households. Aggregation of individual self-reports of neighbourhood social and physical environments has been used routinely since the 1990s (Sampson et al., 1997). Moreover, aggregated self-reports of drought have been validated and used in Australia (Edwards et al., 2014, 2019; Hunter et al., 2012).

2.7. Cumulative disaster exposure: EM-DAT

EM-DAT provides data on the occurrence and effects of natural and technological disasters including drought, earthquakes, and epidemics (Centre for Research into, 2018). To be entered into EM-DAT, the disaster must have a significant impact on the human population. Information is compiled from information provided by United Nations agencies, the United States Office of Foreign Disaster Assistance, national governments, the International Federation of Red Cross and Red Crescent Societies, other nongovernment organisations, insurance companies, research institutes, and the media. For disasters with a wide geographic scope (e.g., tsunami), the EM-DAT measure is limited because it does not provide information on variation in the severity of the disaster within small geographic areas.

This study links a disaster in EM-DAT to the barangay level. We create a cumulative measure of the number of disasters experienced by each barangay during the child's life (2006–17).

2.8. Other covariates

Neighbourhood crime: The community questionnaire collected information on the number of reported cases of crimes from police reports in 2016 for each barangay in the sample (e.g. For each criminal or police event listed enter number of reported cases for 2016 in the baranagay). We conducted a principal components analysis with a quartimax rotation on the following seven variables: number of thefts or robberies, homicides, complaints about violence against women, complaints about violence against children, drug surrenderees, and drug-related deaths in the neighbourhood as reported by police. The eigenvalues (3.34 and 1.37) suggested a two-factor solution, but only two indicators loaded on the second factor, and the majority of variance was explained by the first factor (48%). Therefore, we constructed a weighted factor score based on the factor loadings for factor 1 based on all seven variables. We used this variable as a control in statistical models.

Neighbourhood poverty: The Philippines Federal Government has a conditional cash transfer program called the Pantawid Pamilyang Pilipino Program (4Ps) for poor families (Fernandez & Olfindo, 2011). The roll-out of the 4Ps is complex, but the initial two sets of communities had a poverty incidence of more than 60% (Fernandez & Olfindo, 2011). The neighbourhood poverty measure was a binary indicator based on 4Ps communities (54.5% of children in the LCSFC).

Population density: Given that communities with a greater population density may also be more likely to be affected by natural disasters (Hallegatte et al., 2020), we also controlled for the number of households in the community.

Island groups: We took account of the main island groups—Luzon, Visayas, and Mindanao.

Demographic and household characteristics: In addition to the community-level controls, we also took account of child indigenous status (Yes = 1; No = 0), number of people in the household, number of rooms in the household, and internet access (Yes = 1; No = 0). As a further control, for economic resources, we took the mean income of households in a good and poor month (“What is the total cash income that is received by your household in a poor/good month, in pesos?”). We also took account of household composition and year interviewed (2017 or 2016).

2.9. Statistical analyses

We estimated a random effects model to account for clustering at the barangay level. We used the xtreg command in STATA 15 for continuous outcomes: frequency of family violence in the past 12 months, parental depression, and parental stress. For binary outcomes, we used the xtlogit command in STATA 15. Standard errors were adjusted to take account of clustering at the neighbourhood level using STATA command cluster. The following covariates were included: indigenous status, household type, number of people in the household, number of rooms, mean household income, island groups, year interviewed, internet access, neighbourhood crime, neighbourhood poverty, and population density.

Disadvantaged families are more likely to live in areas susceptible to disasters and to be exposed to the negative effects of disasters (Hallegatte et al., 2020). Families with more financial resources are also more likely to move away from these vulnerable areas. In order to address these issues, we restricted our analytic sample to the 87.9% of children who were living in the same neighbourhood for the last 10 years (4084 children). Given that financial resources may relate to disaster exposure in addition to household income as a covariate, we examined interactions between household income and exposure to natural disasters on the dependent variables. There was no evidence of neighbourhood selection that modifies the influence of disasters on child and family outcomes in this sample.

For caregivers’ reports of the number of family violence acts and family violence in the past 12 months we restrict the analytical sample to female caregivers to obtain more reliable reports of violence exposure

(n = 3793).

There was limited missing data in the analytical sample with 93–97% of the 4084 cases used. Therefore, conditional on the covariates in our statistical models, missing data are likely to be missing at random.

2.10. Funding source

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3. Results

Table 1 shows the descriptive statistics for the variables in the statistical analyses. On average, children in the sample lived in barangays that have experienced significant numbers of natural disasters. Based on household disaster exposure children were exposed to an average of 2.87 disasters from 2014 to 2017 and this is similar average neighbourhood reports. While many households were exposed to disasters, fewer households experienced direct disaster impacts with a mean of 0.79. Based on EM-DAT, children lived in barangays that experienced 25.21 disasters from 2006 to 2017. Detailed information on the frequency of natural disasters has been documented in a related paper (Edwards et al.).

Many study children were living in households that experienced

Table 1
Descriptive statistics for dependent and independent variables.

Variable	Mean	Standard deviation
Number of family violence acts	1.00	1.85
Perceived stress	17.48	4.18
Depression	7.32	3.74
Household disaster exposure	2.87	1.37
Household disaster impact	0.79	1.18
Average neighbourhood report of cumulative disasters	2.85	0.87
EM-DAT disasters	25.22	5.76
Number of people in household	6.43	2.28
Number of bedrooms	1.61	1.42
Mean household income (₱)	9493.97	8612.26
Total number of households in neighbourhood	274.97	464.90
Neighbourhood crime	65.55	144.01

Variable	Percentage
Family violence in past 12 months (Yes = 1; No = 0)	40.74
Witnessed violence (Yes = 1; No = 0)	33.03
Physically hurt by parent (Yes = 1; No = 0)	29.80
Parent physically hurt forcefully (Yes = 1; No = 0)	19.82
Stunted (Yes = 1; No = 0)	35.19
Severe food insecurity	34.75
Female caregiver	94.22
Indigenous status (Yes = 1; No = 0)	12.98
Household type: Nuclear family	66.67
Horizontally extended nuclear family	2.96
Vertically extended nuclear family	14.67
Horizontally and vertically extended nuclear family	1.03
Multi-nuclear family	14.67
Island group: Luzon	31.17
Visayas	34.45
Mindanao	34.38
Year interviewed: 2016	90.82
2017	8.84
Internet access (Yes = 1; No = 0)	23.81
Neighbourhood high poverty (Yes = 1; No = 0)	54.29

family violence in the past 12 months (41%), and 33% of children reported witnessing violence in the past 12 months. Around one in three study children (30%) reported being physically hurt by a parent, and 20% reported being hurt by parents in a forceful manner. About one in three children (35%) were stunted; this is consistent with the 2013 National Nutrition Survey, which recorded 30% of Filipino 10–13-year-olds as being stunted (World Health Organization, 2014). Food insecurity was also high, with 35% of caregivers reporting severe food insecurity.

Thirteen per cent of children were indigenous. The majority of children (67%) were living in nuclear households; 15% were living in vertically extended nuclear families, which include at least three generations of parents and children residing together under one roof (e.g., grandparents, children, and their children’s children) and multi-nuclear families; and 15% were living in households comprising more than one nuclear family. On average, there were 6.4 people per household but only 1.6 bedrooms. The mean household income per month was 9494 pesos. Only 24% of households had internet access. About one-third of children were living in each of the three major island groupings. Fifty-four per cent of neighbourhoods had more than 60% of households in poverty. The average neighbourhood crime factor score was 66.

Table 2 shows the association between having experienced disasters and outcomes for children and their caregivers, adjusting for demographic, household, and neighbourhood characteristics. The number of household disaster exposures was significantly associated with all outcomes except being hurt by a parent and child stunting. Household disaster impact was associated with far fewer outcomes, notably higher levels of caregiver depression, an increased likelihood of family violence and severe food insecurity. As measured by the average neighbourhood report, disasters were associated with being more likely to have experienced family violence in the past 12 months and to report having experienced a larger number of incidents of family violence. Exposure to a larger number of disasters was also associated with an increased likelihood of children witnessing violence, being hurt by an adult, being hurt by a parent, and being hurt by a parent forcefully.

The number of disasters in the barangay for a household was also associated with higher levels of parenting stress, a greater likelihood of children being stunted, and more food insecurity. The size of the impacts vary between the outcome measures, but in general they are substantial. For example, each additional disaster experienced increases the likelihood of having experienced family violence during the past 12 months

by 1.2 times. The findings in relation to food insecurity show that household disaster exposure, disaster impacts and average neighbourhood reports were all associated with an increased likelihood of severe food insecurity. No statistically significant associations were found between the average neighbourhood report of the number of disasters experienced and caregiver depression.

Although the EM-DAT measure of exposure to disasters was only statistically significantly associated with stunting but it was not correlated with any other outcome measure. The stronger relationship between the household reports, and neighbourhood report measure and outcomes than was found for the EM-DAT measure is expected. First, the EM-DAT measure covers broader geographic regions than the household and average neighbourhood reports, and the impacts of some disasters can be very localised. Second, the household and neighbourhood reports span the previous 3 years, whereas the EM-DAT measure is for 10 years, and it is likely that more recent exposure to disasters has a greater impact than more distant exposures.

4. Discussion

In a representative national sample of 10-year-old children from the Philippines using four cumulative measures of natural disasters, we document the wide-ranging impacts that natural disasters have on caregivers and children, adjusting for a number of demographic, household, and community characteristics. We find that the cumulative impact of natural disasters has wide-ranging implications for exposure to family violence for caregivers, reports of violence in the household by children, and the likelihood of children experiencing physical violence (relevant to SDG 16.2). Caregivers reported higher levels of depression and parenting stress (relevant to SDG 3). Caregivers were also more likely to report greater levels of food insecurity, and children were more likely to be stunted (relevant to SDG 2) when exposed to greater levels of natural disasters.

There were a substantial number of statistically significant findings that have important public health implications (Codreanu et al., 2014). For example if we consider the impacts of disasters as measured by average neighbourhood reports, a 6.6 percentage point difference in levels of stunting between those living in the most disaster-affected areas and those living in the least disaster-affected areas (in terms of quintiles) suggests that there are substantial public health benefits in mitigating disaster exposure—a key focus of the SDGs (Oppenheimer &

Table 2
Impact of disasters on caregiver and child outcomes, summary statistical models – 10 years or more living in the neighbourhood.

	Household disaster exposure			Household disaster impact			Average neighbourhood report			EM-DAT disasters		
	B	95% CI	N	B	95% CI	N	B	95% CI	N	B	95% CI	N
Frequency of family violence in past 12 months	0.11***	[0.07,0.16]	3793	0.06*	[0.002,0.11]	3793	0.17***	[0.08,0.26]	3791	0.01	[-0.01,0.02]	3793
Perceived stress	0.19***	[0.08,0.29]	4027	-0.09	[-0.21,0.03]	4027	0.43***	[0.21,0.63]	4024	-0.02	[-0.06,0.01]	4027
Depression	0.23***	[0.14,0.32]	4058	0.24***	[0.13,0.34]	4058	0.06	[-0.12,0.24]	4055	0.01	[-0.03,0.04]	4058
	Odds ratio	95% CI	N	Odds ratio	95% CI	N	Odds ratio	95% CI	N	Odds ratio	95% CI	N
Family violence in past 12 months	1.15***	[1.09,1.22]	3833	1.08*	[1.01,1.15]	3833	1.23**	[1.09,1.39]	3831	1.01	[0.99,1.03]	3833
Witnessed violence	1.08**	[1.02,1.14]	3977	0.98	[0.92,1.05]	3977	1.15*	[1.02,1.29]	3974	1.00	[0.98,1.02]	3977
Parent hurt	1.05	[0.99,1.11]	3969	1.03	[0.97,1.11]	3969	1.15**	[1.03,1.28]	3966	1.01	[0.99,1.03]	3969
Parent hurt forcefully	1.10**	[1.03,1.17]	3963	1.03	[0.95,1.10]	3963	1.27***	[1.13,1.43]	3960	1.02	[1.00,1.04]	3963
Stunted	1.03	[0.97,1.09]	4047	0.98	[0.92,1.05]	4047	1.23***	[1.11,1.36]	4044	1.02*	[1.01,1.04]	4047
Severe food insecurity	1.27***	[1.20,1.35]	4066	1.12***	[1.05,1.19]	4066	1.36***	[1.21,1.53]	4063	1.01	[0.99,1.03]	4066

*p < 0.05, **p < 0.01, ***p < 0.001.

Note: Adjusted for the following variables: indigenous status, household type, number of people in the household, number of rooms, mean household income (monthly), island group (Luzon, Visayas, Mindanao), year interviewed, internet access, number of households in the area, 4Ps area, crime factor. These summarise Tables A1-A4 in the Appendix.

Anttila-Hughes, 2016). For caregivers, there were also substantial associations, with an 11 percentage point difference in the experience of any family violence in the past 12 months between the least and most affected disaster areas.

Our study makes a number of theoretical and methodological contributions. First, we demonstrate that cumulative measures of disasters constructed from self-report in a similar manner to ecometric neighbourhood indicators have robust associations with child physical abuse and stunting and caregiver reported food insecurity, stress and mental health, and family violence. Our findings are consistent with Bronfenbrenner's model of human development that assumes that development is driven by interactions between the developing child, other people and the surrounding environment (Bronfenbrenner & Evans, 2000). A feature of understanding human development in this model is that multiple risk factors are likely to disrupt children's development (Evans et al., 2013), our findings suggest that cumulative disasters (1) undermine parenting capacity by increasing caregiver stress and depression and increased family violence, (2) increases the prospect of severe food insecurity in the household which may lead to child stunting and child physical abuse. Although this study suggests several candidate pathways of influence of disasters, further research is required to formally identify mediated pathways of influence of cumulative disasters.

This study has several strengths. Most previous research examining natural disasters has been characterised by small and non-representative samples of participants, and a focus on individual disaster impacts (Codreanu et al., 2014). In this study, we take a life course perspective on disaster exposure and find wide-ranging influences on hunger, mental health, and family violence. We use rich and detailed measures of natural disasters over 4- and 10-year periods and as hypothesized, household and neighbourhood average reports of cumulative measures of natural disasters were more consistently related to children and caregiver outcomes than the EM-DAT index (Gibbs et al., 2019). Given that the time frame of household and neighbourhood average report was shorter it may be that these stronger associations reflect the more contemporary information captured in the index than the lifetime exposure captured in the EM-DAT. The EM-DAT recorded events also capture a larger geographic area and therefore may also misclassify exposure to natural disasters. It is notable that neighbourhood reports of natural disasters showed the strongest associations with outcomes, and perhaps reflects the extent to which community experiences drive individual outcomes.

Although we used standardised measures of food insecurity, stunting, perceived stress, and depression (Caruso, 2017; Cerna-Turoff et al., 2019; Becker-Blease et al., 2010; Centre for Research into, 2018; Garfin et al., 2014; Harville et al., 2015; Sherwood et al., 2017; Verger et al., 2003; Sampson et al., 1997)¹⁹, our measures of family violence and child physical abuse were specifically developed for this study. The measures of family violence and child physical abuse had a limited number of items and therefore may have underestimated the extent of the association with natural disasters due to potential for measurement error particularly with respect to under reporting (Cerna-Turoff et al., 2019). Our statistical models adjusted for a variety of household and individual demographic characteristics, as well as area-level measures of neighbourhood poverty and crime. However, our results are correlational and we do not claim that we have causal estimates because of the cross-sectional nature of the data and the possibility of unmeasured confounding. For example, for food insecurity, family violence and child physical abuse there is some temporal overlap in disaster exposure and reporting of outcomes. Further research when longitudinal data become available from the LCSFC will improve the precision of our estimates and methodological research using longitudinal data will improve our understanding of the sensitivity of self-reported measures of disasters.

5. Conclusions

Given that the era of climate change will mean even more exposure

to natural disasters, this study highlights that addressing some areas of the SDGs, such as disaster mitigation, will have positive benefits for other areas, such as hunger, health, abuse and violence. This will contribute to the positive development of children in low- and middle-income countries in the future.

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Contributors

Ben Edwards: Conceptualization, Methodology, Formal Analysis, Writing – Original Draft; **Matthew Gray:** Conceptualization, Methodology, Writing – Review & Editing, **Judith Borja:** Investigation - Supervised Wave 1 Data Collection, Writing – Review & Editing.

Declaration of competing interest

The authors declare that they have no competing interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2021.100825>.

Ethical statement

The University of San Carlos Institutional Ethics Review Committee approved the survey design, protocol, and instruments on October 27, 2016.

Ethics Protocols for child safety: All study researchers and data collection staff were trained on data confidentiality and child protection policy (DCCPP) and were required to sign a DCCPP agreement at the start of each survey wave. Our child protection policy was based on the UNICEF guidelines and approved by the UNFPA and by the ethics review board. Our policy stipulates that study staff immediately report to authorized *barangay* officials any verifiable evidence or justifiable concern that a child was a victim of abuse or exploitation. Our staff need to have actually witnessed evidence or have established sufficient certainty of violence to report and file a case with proper officials because we are committed to follow through with the case. We were careful about this as we don't want to expose our research subjects to unnecessary conflicts within the household after we leave the study area. After each home visit interview, all study respondents were provided a resource list with the names and phone numbers of people in the village or municipality/city to contact or approach in cases of violence against women and children. We "mask" the VAW intention of the list (to avoid suspicion from domestic perpetrators within the household) by including in the list contact info of the police and fire department, local health facilities, social services and the local disaster risk reduction and management council.

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