Are Natural Disasters Disastrous for Learning? Evidence from Seven Asian Countries

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Motivation

"Between 1970 and 2019, climate change and extreme weather events have caused a surge in natural disasters."

— *United Nations (2021)*

"[The Asia-Pacific region] remains the most disaster-prone region... In 2022, over 140 disasters struck...affecting over 64 million people and causing economic damage estimated at US$57 billion." — *United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP) (2023)*

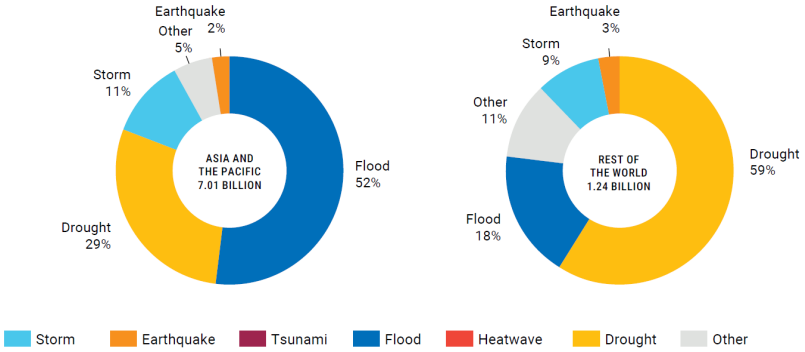

Figure 1: People affected by disasters in the Asia-Pacific region and the rest of the world, 1970-2022

- ***Children* are potentially heavily exposed.**
  - About one billion children across the world are at an 'extremely high risk' of experiencing impacts of climate crisis (UNICEF 2021).
- **Exposures are distributed *unequally* among children.**
  - Climate change tends to interact with 'non-climatic stressors and entrenched structural inequalities to shape vulnerability (Olsson et al. 2014).
  - Climate hazards may also differently affect children by age and gender (Caruso 2017; Maccini and Yang 2009; Shah and Steinberg 2017).

This paper

1. **What are the implications of exposure to natural disasters for children's educational outcomes?**
2. **Are there heterogeneous impacts on school enrollment and math skills for children along gender and age gradients?**

Research design

- We link **survey data on children** with **time- and geo-coded disaster records**.
- We provide one of the first **cross-nation and cross-disaster** analysis of effects of multiple disruptive natural disasters on educational attainment.
- We consider the exposure history of children and distinguish between separate effects of **current and early-life (first 1000 days)** disaster shocks.
  - Natural disasters cause changes in prenatal stress (Andrabi et al. 2021; Charil et al. 2010; Fuller 2014).
  - Central nervous systemgrow rapidly between 8 and 25 weeks post-conception, which is essential for cognitive development (Almond et al. 2009).
- We consider exposures to all disasters and disasters of different intensity.
- Related literature and contribution

Data

Data on educational outcomes and school systems

UNICEF Multiple Indicator Cluster Surveys (MICS)

- General information
  - About 30 years, 120 countries, 365 surveys.
  - Integral part of plans and policies of many governments.
  - Major data source for $>$ 30 Sustainable Development Goals indicators.
- 6th round (MICS6)
  - Child age 5-17: school enrollment, attainment, survey-administered literacy and numeracy assessment tests.
  - Parental and household background.

Data on natural disasters

EM-DAT International Natural Disaster Database (1900-2023)

- Sources: UN agencies, non-governmental organizations, insurance companies, research institutes, and press agencies.
- Entry criteria: (a) 10 or more people killed, (b) 100 or more people affected, (c) declaration of a state of emergency, (d) call for international assistance.
- Time- and geo-coded.
- **Context variables**: disaster type, administrative level, affected location.
- **Impact variables**: number of deaths, injured, missing, total affected, economic damages, insured losses, sectors affected, infrastructure affected.

Geographic and temporal coverage

- **More than 140,000 children in seven Asian countries of ages 5-17**
  - Low- and middle-income countries
  - Pre-pandemic data available
  - South Asia (Bangladesh, Nepal, Pakistan), East Asia and the Pacific (Mongolia, Thailand), and Central Asia (Kyrgyzstan, Turkmenistan)
- **About 500 natural disasters from 1998 to 2019**
- **Various categories** (flood, storm, drought, earthquake,...) where floods are the most common disasters in the sample.
- **"Severe disasters"** are defined as causing $\geq$ 500 casualties or affecting $\geq$ 5,000 people or more.

Summary statistics

MICS6 overview and key statistics for children 5-17

Country	Year	Start	End	Obs	Geo info ‡		Age	Female	Enrollment rate	Mother ever educated
					Geo-id	N	Mean	Share		
South Asia										
Bangladesh	2019	01/19	06/01	40617	District	64	10.95	0.48	0.89	0.74
Nepal	2019	05/04	11/13	7824	Region	7	10.55	0.50	0.93	0.52
Pakistan	2017-19	2017 12/03	2019 10/23	71121	District	97	10.49	0.48	0.86	0.36
East and Southeast Asia										
Mongolia	2018	09/17	12/24	7628	Region	5	10.06	0.49	0.96	0.94
Thailand	2019	05/18	12/03	9608	Changwat	18	9.03	0.48	0.99	0.95
Central Asia										
Kyrgyzstan	2018	09/06	11/19	3897	Oblast	9	10.34	0.47	0.96	0.99
Turkmenistan	2019	05/02	08/02	3776	Region	6	10.08	0.48	1.00	1.00

Note: At the smallest geo-identifier available, we compute the share of enrolled in school reporting school closure due to natural disasters (or teacher absenteeism) in the past year and s.d. across geo-identifiers. Smallest geo-identifiers differs across countries.

Child and parental characteristics

	Mean	SD	Min	Max	N
Age of child	10.49	3.78	4.00	17.00	144471
Female	0.48	0.50	0.00	1.00	144471
Mother age	37.78	8.68	2.00	95.00	132143
Father age	43.06	9.70	0.00	95.00	116791
Mother ever educated	0.58	0.49	0.00	1.00	144338
Mother has secondary sch education	0.31	0.46	0.00	1.00	144338
Father ever educated	0.69	0.46	0.00	1.00	116768
Father has secondary sch education	0.20	0.40	0.00	1.00	116768
Mother is living in same HH	0.92	0.28	0.00	1.00	144222
Father is living in same HH	0.81	0.39	0.00	1.00	144068

Enrollment, attainment, and math score

	Mean	SD	Min	Max	N
Ever enrolled	0.88	0.33	0.00	1.00	144426
Enrollment in last school year	0.74	0.44	0.00	1.00	144394
Enrollment in this school year	0.79	0.41	0.00	1.00	144410
Attainment (highest)	3.29	3.34	0.00	16.00	144358
Attainment at start of last school year	2.69	3.06	0.00	16.00	144360
Attainment at start of this school year	3.25	3.32	0.00	16.00	144358
Math score (total)	14.09	7.37	0.00	21.00	78,704

- Math test is for children 7-14 only.
- Distribution: Enrollment Enrollment transition Attainment Math score

Location- and period-specific disaster shocks of children

	Mean	SD	Min	Max	N
Had recent disaster					
in survey mo	0.08	0.27	0.00	1.00	144471
in this yr prior survey mo	0.55	0.50	0.00	1.00	144471
in yr prior to 12 mo ago	0.63	0.48	0.00	1.00	144471
Had disaster at least once given period-specific disaster history					
in child's first 1000 days	0.58	0.49	0.00	1.00	144471
between 1000 days and 2 yr before survey mo	0.70	0.46	0.00	1.00	144471

Methods

Enrollments and disaster shocks

$$E_{ilt} = \alpha_0 + \psi_0 \cdot E_{il,t-1} + \psi_1 \cdot A_{ilt} + \sum_{j \in \text{TimeSpan}} \alpha_j \cdot D^p_{ilj} + \theta X_i + \mu_l + \mu_{g_i(t)} + \mu_t + \epsilon_{ilt} \quad (1)$$

- $E_{il,t}$ - enrollment status of child i in location l in school year t.
- TimeSpan = $\{MostRecentYr, First1000Days\}$.
- A_{ilt} - year of education completed at start of school year t.
- D^p_{ilj} - natural disaster shock of type p (eg. type A means any type of disaster).
- X - individual characteristics - parental age, mother's education, whether parents are alive, and whether child resides with parents.
- μ_l, $\mu_{g_i(t)}$, μ_t - fixed effects of sub-national location, child age, and survey time.

Math test scores and disaster shocks

$$S_{ilm} = \alpha_0 + \sum_{j \in TimeSpan} \alpha_j \cdot D^p_{ilj} + \theta X'_i + \mu_{c,Ai(m)} + \mu_l + \mu_{g_i(m)} + \mu_m + \epsilon_{ilm} \quad (2)$$

- S_{ilm} - MICS-administered math test score of child i in location l in survey mo m.
- TimeSpan = $\{MostRecentYr, MidLife, First1000Days\}$.
- D^p_{ilj} - natural disaster shock of type p (eg. type A means any type of disaster).
- $\mu_{c,Ai(m)}$ - country- and attainment-specific fixed effects.

Results

Effects of disasters on enrollments

	(1) All disasters	(2) Flood	(3) Severe disasters	(4) Severe flood
Had disaster in recent 12 mo.	-0.004	-0.012**	0.003	0.002
	(0.006)	(0.005)	(0.008)	(0.006)
# of mo. with disaster first 1,000 days	-0.001**	-0.002***	-0.002***	-0.004***
	(0.000)	(0.001)	(0.001)	(0.001)
Female	-0.006***	-0.006***	-0.006***	-0.006***
	(0.002)	(0.002)	(0.002)	(0.002)
Observations	143,645	143,645	143,645	143,645
Within country location FE	Y	Y	Y	Y
Interview year FE	Y	Y	Y	Y
Interview month FE	Y	Y	Y	Y
Child age FE	Y	Y	Y	Y

Disasters and enrollments: Heterogeneity across age groups

	(1) All disasters	(2) Flood	(3) Severe disasters	(4) Severe flood
Had disaster in recent 12 mo.				
× Age 5–8	0.008	-0.019**	0.019*	0.045***
	(0.010)	(0.009)	(0.011)	(0.008)
× Age 9–12	-0.009	-0.014**	-0.004	-0.017***
	(0.006)	(0.007)	(0.008)	(0.006)
× Age 13–17	-0.012	-0.003	-0.008	-0.025***
	(0.009)	(0.009)	(0.010)	(0.008)
# of mo. with disaster in the first 1,000 days				
× Age 5–8	0.001	-0.001	-0.001	-0.005*
	(0.001)	(0.003)	(0.001)	(0.003)
× Age 9–12	-0.002***	-0.003***	-0.002***	-0.003***
	(0.000)	(0.001)	(0.001)	(0.001)
× Age 13–17	-0.001	-0.002***	-0.003***	-0.003**
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	143,645	143,645	143,645	143,645

Disasters and enrollments: Heterogeneity across gender and age groups

	(1) All disasters	(2) Flood	(3) Severe disasters	(4) Severe flood
Had disaster in recent 12 mo.				
× Male				
× Age 5–8	0.013	-0.019**	0.015	0.036***
	(0.009)	(0.009)	(0.011)	(0.009)
× Age 9–12	-0.010	-0.022***	-0.014	-0.031***
	(0.007)	(0.007)	(0.009)	(0.007)
× Age 13–17	-0.017	-0.011	-0.016	-0.036***
	(0.010)	(0.009)	(0.010)	(0.008)
× Female				
× Age 5–8	0.003	-0.019*	0.022*	0.053***
	(0.010)	(0.010)	(0.012)	(0.008)
× Age 9–12	-0.009	-0.005	0.007	-0.001
	(0.006)	(0.007)	(0.009)	(0.006)
× Age 13–17	-0.008	0.005	0.003	-0.011
	(0.009)	(0.009)	(0.010)	(0.008)
# of mo. with disaster in the first 1,000 days				
× Male				
× Age 5–8	0.001	0.002	0.001	-0.001
	(0.001)	(0.003)	(0.002)	(0.003)
× Age 9–12	-0.003***	-0.003***	-0.003***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
× Age 13–17	-0.001	-0.002**	-0.004***	-0.003**
	(0.001)	(0.001)	(0.001)	(0.001)
× Female				
× Age 5–8	0.001	-0.005*	-0.002	-0.009***
	(0.001)	(0.003)	(0.002)	(0.003)
× Age 9–12	-0.000	-0.003***	-0.000	-0.002*
	(0.000)	(0.001)	(0.001)	(0.001)
× Age 13–17	-0.001	-0.002**	-0.003**	-0.003**
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	143,645	143,645	143,645	143,645

Effects of disasters on math scores

	(1) All disasters	(2) Flood	(3) Severe disasters	(4) Severe flood
***Recent** experience: had disaster*				
in recent 12 mo.	-0.070	-0.364	-0.015	-0.380
	(0.171)	(0.275)	(0.209)	(0.314)
in yr prior 12 mo. ago	-0.014	0.016	0.213	-0.058
	(0.165)	(0.254)	(0.204)	(0.188)
***Mid-child life** experience: # of mo. with disaster*				
($>$ 1,000 days) & ($<$ yr.)	-0.024	-0.022	-0.009	0.013
	(0.016)	(0.027)	(0.022)	(0.036)
***Early-life** experience: # of mo. with disaster*				
in the first 1,000 days	-0.031**	-0.065***	-0.008	-0.047
	(0.015)	(0.024)	(0.022)	(0.033)
Female	-0.420***	-0.417***	-0.419***	-0.418***
	(0.061)	(0.061)	(0.061)	(0.061)
Observations	78,305	78,305	78,305	78,305

Disasters and math scores: Heterogeneity across gender

	(1) All disasters	(2) Flood	(3) Severe disasters	(4) Severe flood
# of mo. with disaster in mid-child life				
× Male	-0.036**	-0.018	-0.013	0.022
	(0.016)	(0.030)	(0.024)	(0.038)
× Female	-0.014	-0.027	-0.002	0.003
	(0.017)	(0.028)	(0.022)	(0.036)
# of mo. with disaster in the first 1,000 days				
× Male	-0.028	-0.069***	-0.017	-0.064*
	(0.017)	(0.026)	(0.024)	(0.035)
× Female	-0.034**	-0.061**	0.003	-0.030
	(0.015)	(0.026)	(0.022)	(0.035)
Observations	78,305	78,305	78,305	78,305

Disasters and math scores: Heterogeneity across gender and age groups

	(1) All disasters	(2) Flood	(3) Severe disasters	(4) Severe flood
# of mo. with disaster in mid-child life				
× Male				
× Age 7–9	-0.037	0.013	-0.011	0.073
	(0.024)	(0.052)	(0.042)	(0.064)
× Age 10–12	-0.023	-0.011	-0.014	0.047
	(0.023)	(0.044)	(0.028)	(0.054)
× Age 13–14	-0.026	-0.044	-0.034	0.010
	(0.022)	(0.040)	(0.027)	(0.050)
× Female				
× Age 7–9	-0.004	0.018	0.003	0.067
	(0.026)	(0.052)	(0.040)	(0.066)
× Age 10–12	-0.006	-0.060	-0.021	-0.010
	(0.023)	(0.044)	(0.027)	(0.051)
× Age 13–14	-0.007	-0.017	-0.016	0.032
	(0.022)	(0.037)	(0.026)	(0.046)
# of mo. with disaster in the first 1,000 days				
× Male				
× Age 7–9	-0.036	-0.095*	-0.047	-0.070
	(0.027)	(0.053)	(0.031)	(0.060)
× Age 10–12	0.015	-0.003	0.011	-0.031
	(0.021)	(0.032)	(0.029)	(0.047)
× Age 13–14	-0.018	-0.008	-0.031	-0.025
	(0.031)	(0.045)	(0.038)	(0.052)
× Female				
× Age 7–9	-0.041**	-0.076	-0.015	-0.035
	(0.021)	(0.059)	(0.030)	(0.063)
× Age 10–12	0.012	0.004	0.023	0.028
	(0.019)	(0.033)	(0.025)	(0.046)
× Age 13–14	-0.041*	-0.037	-0.023	-0.054
	(0.024)	(0.040)	(0.035)	(0.050)
Observations	78,303	78,303	78,303	78,303

Conclusions

Key findings, to date

- Average effects of disasters on enrollments and math scores
  - There are significant negative effects of early life disaster exposures.
  - There are weaker or no corresponding effects from recent disaster exposures.
- Age patterning and heterogeneity across gender
  - There is persistent negative relationship between early life natural disaster experience and enrollment through the primary-school-going ages for boys but not for girls.
  - Older boys suffer more on enrollment status due to early disaster exposure, while cognitive performances of girls are harder hit especially in younger and older cohorts.
- Robustness using other disaster exposure measures
  - The results are robust with **continuous and binary measures**.
  - It is important to consider not only one type of disasters.

Challenges and next steps

- MICS data lacks information on migration status of children. Migration status of majority of mothers shows about 90% of them have been living in same location since conception of children. We assume children do not move.
- The effectiveness of each government in recording and reporting disasters depends on the capabilities of individual locations. Entry criteria for EM-DAT can result in exclusion of more localized disasters.

Thank you!

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Appendix. Introduction

Related literature and contributions

- **We consider early life exposures as well as recent disaster shocks.**
  - Children exposed to hurricanes *in utero* have lower scores in third grade (Fuller 2014).
  - Prenatal exposures have negative effects on educational or economic performance later in life (Almond and Mazumder 2005, Almond et al. 2009).
- **We explore heterogeneity globally and locally with a large sample.**
  - Negative effects are correlated with social disadvantages (Fuller 2014, Cutter et al. 2003, Zahran et al. 2008).

Related literature and contributions

- **Most existing studies of natural disasters' effects on children focus on a *specific large-scale disaster.***
  - 2017 Pohang earthquake in South Korea (Cho and Kim 2023)
  - 1976 Tangshan earthquake in China (Tian et al. 2022)
  - 1985 earthquake in Chile (Ciraudo 2020)
  - 1987-89 locust plague in Mali (De Vreyer et al. 2015)
  - 2009 Bushfire in Australia (Gibbs et al. 2019)
- **There are limited studies on broad groups of disasters yet *not study educational outcomes in developing countries.***
  - U.S. (Opper et al. 2023, Simeonova 2009, Currie and Rossin-Slater 2013)

Potential mechanisms

- Direct: disasters $\longrightarrow$ educational outcomes.
  - **Disasters can interrupt learning process.**
    - Worldwide, 875 million school children live in high-seismic-risk zones, with 32 million of these children newly enrolled in primary schools (Wisner et al. 2004).
    - In Pakistan in 2010, 11,906 schools with $>$ one million children were affected by natural disasters - used as shelter (2,674) or damaged (9,232) (Change et al. 2013).
  - **Schools serve as a refuge place when they are more resilient than houses.**
    - Parents may be unable to provide as much care for children at home.

Potential mechanisms

- Indirect: disasters $\longrightarrow$ other stressors $\longrightarrow$ educational outcomes.
  - **Health shock on children**
    - Exposure to disasters affect birth outcomes (Currie 2013, Glynn et al. 2001, Torche 2011, Oyarzo et al. 2012, Tan et al. 2009).
    - Disasters reduce children's physical capacity to attend school.
  - **Income and health shock on family**
    - Natural disasters affect employment, wages, and assest prices (Barro 2009, Belasen and Polachek 2008).
    - Household resource availability for schooling may be lower.
    - Opportunity costs of schooling may increase as children compensate for lost parental income by taking up greater household and wage work responsibilities (Alam 2015; Bandara et al. 2015; Guarcello et al. 2010).

Appendix. Data and descriptives

Context Variables (EM-DAT Example)

- Example showing 3 natural disasters in Bangladesh (continued in next slide).

Disaster Type	Origin	OFDA Response	Dis Mag Value	Dis Mag Scale	Latitude	Longitude	Admin1 Code	Admin2 Code	Geo Locations
Flood	Torrential Rain		3882	Km2	23.226	92.13			
Storm				Kph			577		Dhaka (Adm1)
Flood		Yes		Km2				5761...	Bagerhat Barguna... (Adm2)
Storm			130	Kph					

Impact Variables (EM-DAT Example)

- Example showing 3 natural disasters in Bangladesh (continued from last slide).

Start Year	Start Month	Start Day	End Year	End Month	End Day	Total Deaths	No Injured	No Affected	Total Damages, Adjusted ('000 USD)	Total Damages ('000 USD)
2018	5	20	2018	5	22	21		14000		
2019	3	31	2019	3	31	15				
2019	6		2019	7	28	114		7600000	75000	85854
2019	11	9	2019	11	10	40	71	251506	5785	6622

Disaster measures: Binary and continuous measures

$$DM^{p}_{il,j} = \sum_{\text{mo=start mo. of j}}^{\text{end mo. of j}} DI^{p}_{il,mo} \tag{3}$$

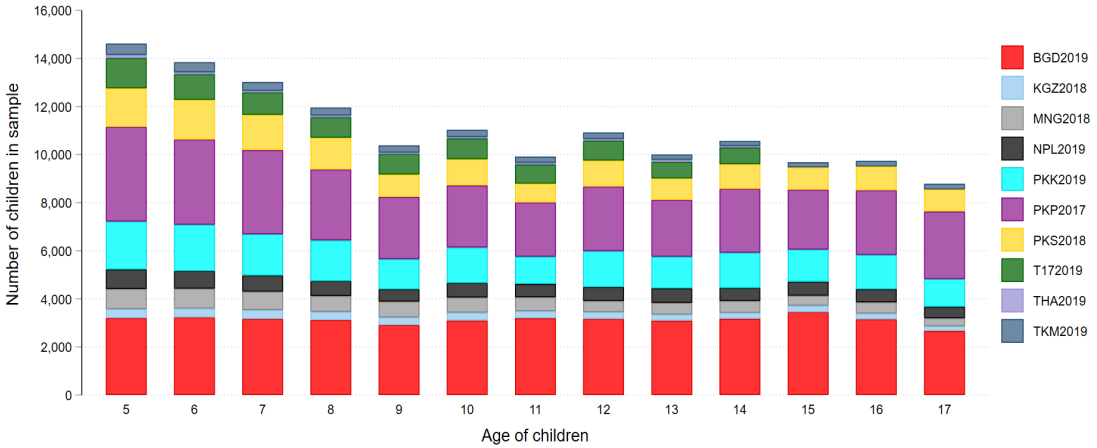
$$DB^{p}_{il,j} = 1\{DM^{p}_{il,j} \geq 1\}$$

- $DI^{p}_{il,mo}$: Binary indicator of disaster for each child in each month, 1 if location l in month mo has experienced type p disaster intensity.
- $DM^{p}_{il,j}$: # of months in disaster for child i in location l during period j.
- $DB^{p}_{il,j}$: binary indicator for existence in time span j of type p disaster intensity.

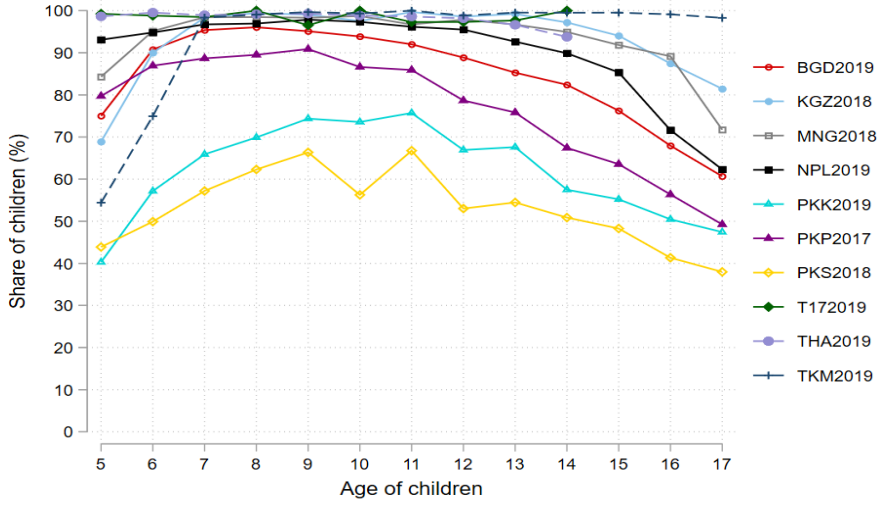
Disaster measures: Types of disaster intensity

- Type A: any type of disaster
- Type B: only floods
- Type C: severe disasters which is defined as causing more than 50 people dead or injured or 5,000 people affected
- Type D: combines B and C, considering only severe flood
- In the main results, we use type A disaster intensity for all time spans.
- Having various types of disaster intensity provides us possibility for robustness check on disaster experience construction.

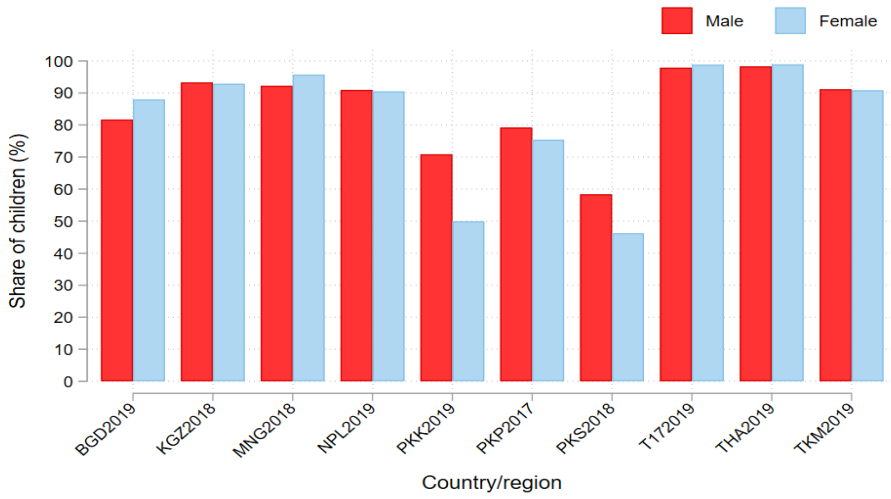
Sample sizes across countries and ages



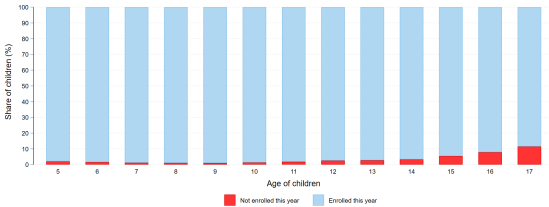
Enrollment rates in survey year by ages and countries

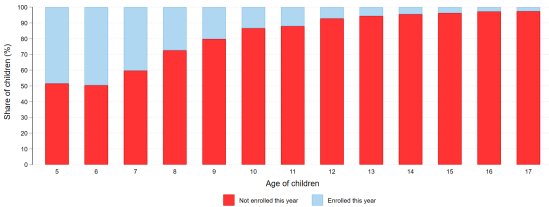


Enrollment rates in survey year by gender and countries



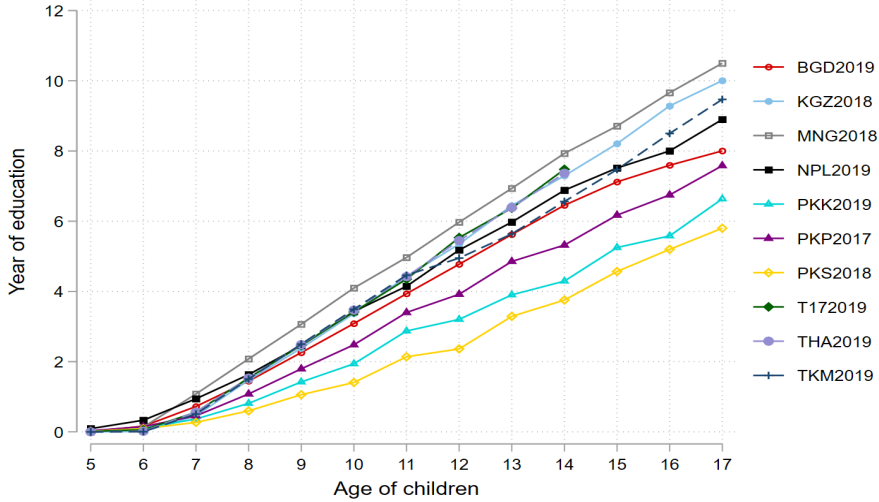
Enrollment transition probabilities by ages



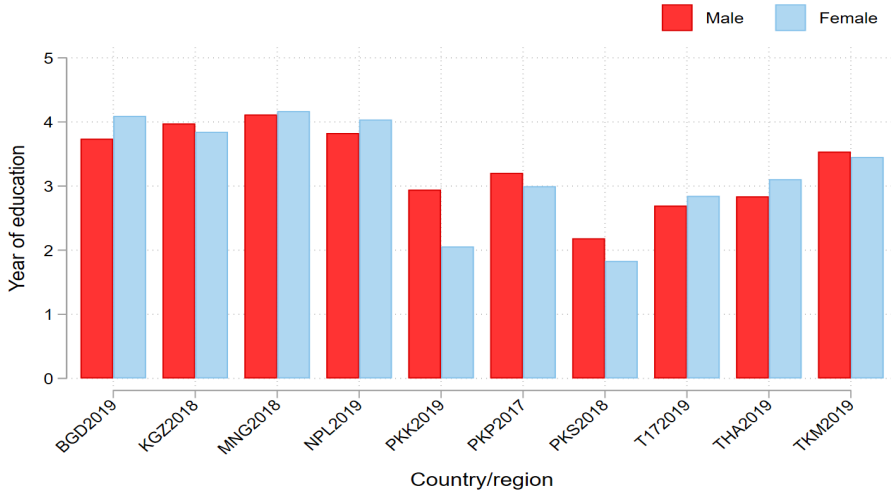


- Share of children who were enrolled in the year prior to the survey and continued to enroll in the survey year is greater than 95% up to age 14, but falls to 88% by age 17.
- Share of children who come back to enrollment after not enrolled in the last year before the survey decreases with age and falls below 10% after age 11.

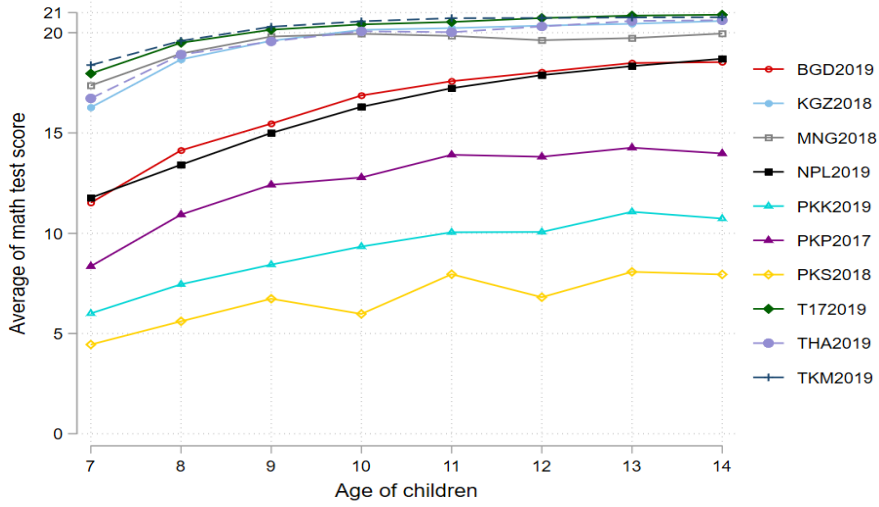
Average highest grade completed by ages and countries



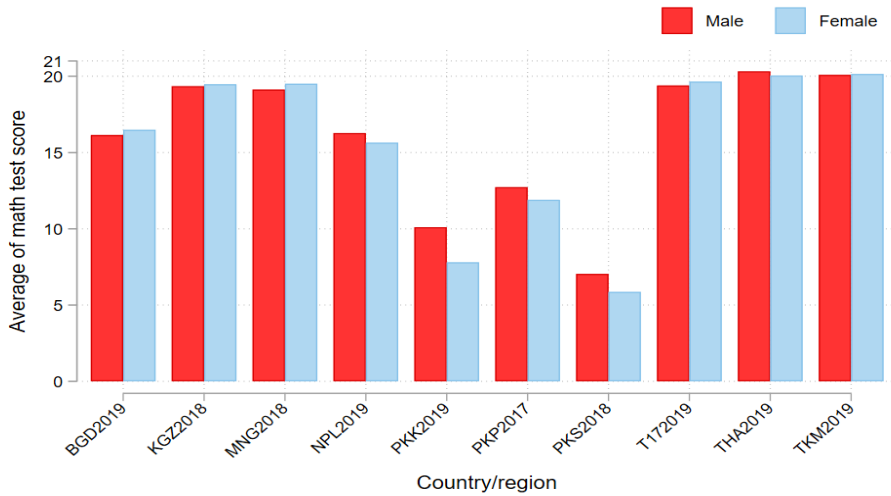
Average highest grade completed by gender and countries



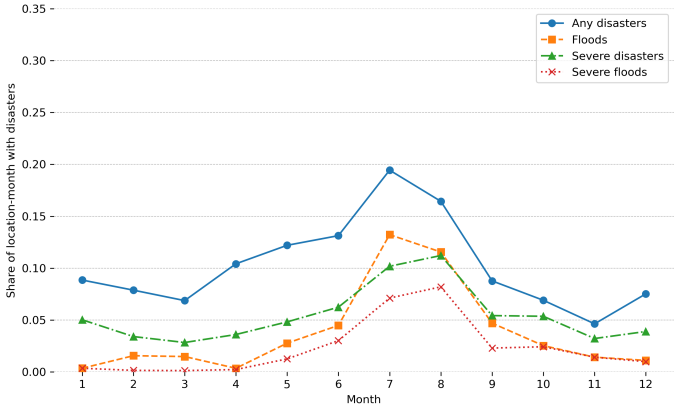
Average of math test score by ages and countries



Average of math test score by gender and countries



Average shares of location-month disasters in calendar months over 20 years



- Types: A) any disasters, B) floods, C) severe disasters D) severe floods.
- For all types, during summer locations are hit by disasters most.
- Focusing on only one category omits a large proportion of overall shocks.

Key variables by age groups and periods

Mean	Early life	Mid-child life	Recent year
Length of period (mo.)	By def. 33	84	By def. 12
# of mo. with disaster in early life and mid-child life			
Share of children having experienced disasters in recent year			
Overall	3	7.8	57%
Age 5-8	2		55%
Age 9-12	3		56%
Age 13-17	4		59%
Age 7-9	2	5.4	56%
Age 10-12	3	8	56%
Age 13-14	4	10.5	56%
Math test score	**Overall**	**Boys**	**Girls**
Age 7-9	12.3	12.4	12.1
Age 10-12	15.2	15.4	15
Age 13-14	15.9	16	15.6

Appendix. Estimation strategy

Enrollments and disaster shocks

Households make binary school enrollment decisions given trade-offs between going to school and alternatives of child staying at home or working (Attanasio, Meghir, and Santiago 2012; Todd and Wolpin 2006; Casco 2022).

- Not enrolled in $t \Rightarrow$ no additional grade completion progress.
- Enrolled in $t \Rightarrow$ prob. of passing grade and increasing attainment.
- Utility from enrollment comes from expected value minus cost: $u(\text{enroll})_t = E(\text{increased attainment})_{t+1} - C(\text{enroll})_t$.
- Decision makers jointly consider key state var.: grade completed, prior enrollment decision, age of child.

Math test scores and disaster shocks

Linear model is assumed to capture the facet of education: it is a cumulative process.
A_{ig} involves whole history of inputs providing basic knowledge (Todd and Wolpin 2003, Hanushek and Rivkin 2012).

$$A_{ig} = f(Sch_i, Fam_i, \pi_i)$$
$$= \sum_{g=0}^{G} \psi Sch_{ig} + \sum_{g=0}^{G} \gamma Fam_{ig} + \sum_{g=0}^{G} \pi_{ig} + \epsilon_{ig}$$

- A_{ig} - achievement of student i in grade g.
- Sch, Fam - vector of school and peer, family and neighborhood inputs.
  π - individual ability.

$$S_{im} = f(D_{im}, X_{im})$$
$$\implies = \sum_{m=-9}^{M} \lambda D_{im} + \sum_{g=-9}^{M} \theta X_{im} + \epsilon_{im} \quad (4)$$

- S_{im} - score in month m.
- X - all factors other than disasters.
- D - individual- and time-specific disaster shocks. This would normally be part of ϵ.

Math test scores and disaster shocks

$$S_{im} = f(D_{im}, X_{im}) = \alpha_1 D_{i1} + \alpha_2 \sum_{m \in \text{mid-child life}} D_{im} + \alpha_3 D_{i3} + \sum_{g=-9}^{M} \theta X_{im} + \epsilon_{im} \quad (5)$$

	D_{i1} Early life	D_{i2} 3-4	D_{i3} 5-6	D_{i4} 7-8	D_{i5} 9-10	D_{i6} 11-12	D_{i7} 13-14
$S_{i7}, 13-14$	λ_{71}	λ_{72}	λ_{73}	λ_{74}	λ_{75}	λ_{76}	λ_{77}
$S_{i6}, 11-12$	λ_{61}	λ_{62}	λ_{63}	λ_{64}	λ_{65}	λ_{66}	
$S_{i5}, 9-10$	λ_{51}	λ_{52}	λ_{53}	λ_{54}	λ_{55}		
$S_{i4}, 7-8$	λ_{41}	λ_{42}	λ_{43}	λ_{44}			

- α_1 - effects of shocks in early life.
- α_2 - homogeneous effects of shocks in mid-child life.
- α_3 - effects of shocks in recent shocks.
- S - outcome across age 7-14.
- D - disaster shocks in each periods.

Appendix. Other results

Disasters and enrollments with different disaster measures

	(1)	(2)	(3)	(4)
	Had disaster in			# of mo. with disaster in
	survey mo.	recent 3 mo.	recent 12 mo.	recent 12 mo.
Recent disaster experience	0.006	0.003	-0.004	0.003
	(0.005)	(0.005)	(0.006)	(0.003)
# of mo. with disaster in the first 1000 days	-0.001**	-0.001**	-0.001**	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)
Enrollment in year $t-1$	0.388***	0.388***	0.388***	0.388***
	(0.012)	(0.012)	(0.012)	(0.012)
Attainment at start of t	0.012***	0.012***	0.012***	0.012***
	(0.002)	(0.002)	(0.002)	(0.002)
Female	-0.006***	-0.006***	-0.006***	-0.006***
	(0.002)	(0.002)	(0.002)	(0.002)
Observations	143645	143645	143645	143645
Within country location FE	Y	Y	Y	Y
Interview year FE	Y	Y	Y	Y
Interview month FE	Y	Y	Y	Y
Child age FE	Y	Y	Y	Y
Enrollment $t-1$ × age group FE	Y	Y	Y	Y
Attainment t × age group FE	Y	Y	Y	Y
Enrollment $t-1$ × country FE	Y	Y	Y	Y
Attainment t × country FE	Y	Y	Y	Y

Disasters and math scores with different disaster measures

	(1)	(2)	(3)
Had disaster in most recent 12 mo.	-0.052	0.055	
	(0.171)	(0.188)	
Had disaster in yr prior 12 mo. ago	0.004		
	(0.164)		
Had disaster in mid-child life	-0.245		
	(0.167)		
Had disaster in the first 1000 days	-0.284***		
	(0.109)		
# of mo. with disaster in recent 12 mo.			-0.061
			(0.119)
# of mo. with disaster in yr prior 12 mo. ago		0.184	0.164
		(0.146)	(0.135)
# of mo. with disaster in mid-child life		-0.022	-0.022
		(0.017)	(0.017)
# of mo. with disaster in the first 1000 days		-0.029**	-0.030**
		(0.015)	(0.015)
Observations	78305	78305	78305
Within country location FE	Y	Y	Y
Interview year FE	Y	Y	Y
Interview month FE	Y	Y	Y
Child age FE	Y	Y	Y
Country × attainment t FE	Y	Y	Y