Flooding and child development: Evidence from Vietnam

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ABSTRACT

This study examines the extent to which recent exposure to flooding influences the development outcomes (education and health) of Vietnamese children. Given children's higher vulnerability to the threat of extreme weather events compared to the general population, it is important to study the impacts of flooding on child development. To do so, we draw from a panel dataset of children (the Young Lives Project) from five provinces of Vietnam (Phu Yen, Ben Tre, Lao Cai, Hung Yen, and Da Nang) where children were followed over 15 years. The flooding measure from the data is a self-reported measure as household indicates whether they have been recently affected by flooding. Regarding the empirical method, we employ the child-fixed effects model. We find that recent exposure to flood shocks makes children 3.3 percentage points less likely to enroll in school and score 0.21 and 0.24 standard deviations lower in math and reading achievement tests, respectively. They are also 0.11 standard deviations thinner in height, 3.8 percentage points more likely to be underweight, and 0.27 points lower in subjective well-being. Our mechanism analyses show that the adverse impacts of flooding on child development could be ascribed to the declines in food expenditure and household wealth as well as the increase in the amount of time spent on productive activities such as housework. Specifically, flooding could decrease food expenditure and household wealth, which, as a result, leads to insufficient food intake, thus worsening child health and nutrition status. Flooding might also induce households to substitute adult labor in unpaid housework with child labor, leading children to divert their time away from studying to doing household chores, and thus their schooling outcomes suffer.

1. Introduction

Among many aspects of climate change, climate volatility, such as changing precipitation patterns, has largely affected multiple dimensions of the global economy such as agricultural production and incomes (Brückner & Ciccone, 2011; Vogel et al., 2019). According to World Bank (2022), Vietnam is one of the most vulnerable countries in the world to climate change. Vietnamese children tend to be more susceptible to the effects of climate change than the general

population and climate change could threaten their health and educational outcomes (UNICEF, 2021). In a statement, Ms. Lesley Miller, UNICEF Viet Nam Deputy Representative, considers a climate crisis a child crisis and calls for immediate actions to protect our future generation. In a UNICEF report, it is also pointed out that among natural disasters, Vietnamese children are highly exposed to flooding (UNICEF, 2021). In fact, as 70% of the population lives in coastal areas and low-lying deltas, Vietnamese children are especially vulnerable to flooding hazards (Bangalore et al., 2019; Tarp, 2017; World Bank, 2022).

This study examines the extent to which recent exposure to flooding affects child development measured by their educational and health outcomes in the context of Vietnam. We also look at the effect on a child's subjective well-being. The paper makes three contributions to the literature. First, we estimate the relatively less salient cost of an extreme climatic event on early human development rather than concentrate on the impacts on more visible aspects such as income, production, and consumption. Regarding the timing of the shock, we estimate the impacts on children of flood shocks that happened recently rather than those occurring during the prenatal period like prior studies. Second, we explore both the educational and health outcomes of children instead of focusing on one dimension. Regarding educational outcomes, we look at both the extensive margin (school enrollment) and the intensive margin (test scores) to see how flooding affects the quantity and quality of learning. Third, in addition to presenting the impacts of flooding on child development, we further conduct the mechanism analyses to explore how the effects of flooding transmit to a child's schooling, health, and subjective well-being outcomes. Understanding the transmission pathways is important to devise policy tools to tackle the consequences of climate risks.

To investigate the impacts of flooding on child development, we employ the data from the Young Lives Project, which is a longitudinal project on childhood poverty across four developing countries, including Vietnam. A variety of child development measures such as health, education, and well-being information of the child is collected. As participating households also indicate whether they have been badly affected by floods recently, we can identify if the child is exposed to flooding each year. Because the project follows up the child in subsequent five rounds over 15 years, the panel nature of the data allows us to implement the child fixed effects model to deal with the endogeneity problem and produce reliable estimates for the impacts of flooding on child development. In the model, we compare the development measures of a child across time, where in some years, the child might be exposed to flood shocks while in some other years, he/she might not be. This within-child comparison (child fixed effects model) can be better than the cross-sectional comparison of children (i.e., between-child comparison) as some randomly chosen children may be fundamentally different in characteristics jointly correlated with shock exposure and development outcomes, but such characteristics cannot be observed by the researcher.

We uncover the following findings. First, flooding is associated with worse educational outcomes. Specifically, recent exposure to flood shocks makes children 3.3 percentage points less likely to enroll in school and score 0.21 and 0.24 standard deviations lower in math and reading achievement tests. Second, flooding further worsens child health and subjective well-being. Particularly, if the child's household is affected by a flood, the child is 0.11 standard deviations thinner for his/her height and is 3.8 percentage points more likely to be underweight. Recent exposure to floods is also associated with a 0.27-point reduction in a child's subjective well-being. Third, exploring the potential pathways to the impacts of flooding on child development, we find suggestive evidence that the adverse impacts of floods on children's health

and educational outcomes could be attributed to the declines in food expenditure and household wealth as well as the increase in the amount of time spent on productive activities such as housework (so that parents might have more time doing market work).

Our findings offer meaningful policy implications. The adverse impacts of weather shocks such as flooding emphasize the importance of policy tools that incentivize households to keep their children at school and prevent them from diverting their time toward activities like household chores. Financial assistance programs such as cash transfers might ease the financial burden on households following floods and thus could improve both the health and educational outcomes of children.

The paper proceeds as follows. Section 2 reviews the related literature. Section 3 describes the data. Section 4 outlines the empirical model. Section 5 discusses the results, and Section 6 concludes.

2. Literature review

Our study of the impacts of flooding on children's educational and health outcomes is related to the literature examining the relationship between climate volatility and child development. Regarding the relationship between climatic shocks and child's educational outcomes, prior studies have shown how vulnerable school enrollment is to weather shocks (Baez et al., 2017; Björkman-Nyqvist, 2013; De Janvry et al., 2006; Duryea & Arends-Kuenning, 2003; Jacoby & Skoufias, 1997; Kruger, 2007; Schady, 2004; Shah & Steinberg, 2017). In the current literature, there are two opposing hypotheses concerning the channels driving the impacts of rainfall shocks on children (Zimmerman, 2020). One hypothesis states that adverse weather shocks can lead to the reduction of household resources because a worse harvest means lower income. Therefore, children are likely to be forced to drop out of school or to divert their time away from school work to productive activities so their academic performance will suffer. Studies supporting this hypothesis and uncovering the negative impacts of weather shocks on educational outcomes include Baez et al. (2017), Björkman-Nyqvist (2013), De Janvry et al. (2006), Jacoby and Skoufias (1997).

Another hypothesis, known as the opportunity channel hypothesis, predicts that educational outcomes may actually improve after an adverse weather shock because the opportunity cost of contributing to household income is lower during an adverse weather shock when agriculture and agriculturally related jobs are scarce due to a bad harvest, compared to normal times when more jobs in agriculture and related industries will be available. Studies supporting the opportunity channel hypothesis and documenting the positive effect of weather shocks on educational outcomes include Duryea and Arends-Kuenning (2003), Schady (2004), Kruger (2007), Shah and Steinberg (2017).

In terms of the relationship between climatic shocks and child health, our study is built upon the conceptual framework of the United Nations Children's Fund (UNICEF) where child undernutrition is caused by many interconnected factors (United Nations Children's Fund [UNICEF], 2014). Specifically, the immediate channels behind the influence of weather shocks on child health include nutrition intake and disease prevalence. Since adverse weather shocks depress agricultural production, food availability, and household incomes (Levine & Yang, 2006), children's nutritional intake might deteriorate in both the quantity dimension (they might not have enough to eat) and quality dimension (they might experience the lack of diet diversity). Therefore, nutritional deficiency induced by weather shocks will lead to poorer health outcomes. Another channel is that rainfall shocks can make certain diseases, such as diarrhea and malaria,

more prevalent (Levy et al., 2016; Umbers et al., 2011). This might expose children in affected areas to more health risks and the affliction of such diseases can deteriorate their health. For instance, diarrheal disease may reduce the absorption and retention of essential nutrients from food, negatively affecting a child's weight.

Empirically, prior studies have uncovered the negative impacts of climate shocks on child health in various contexts, such as Mexico (Skoufias & Vinha, 2012), Nigeria (Jacoby et al., 2014), Uganda (Omiat & Shively, 2020), India (Dimitrova & Muttarak, 2020) and in 55 developing countries (Le & Nguyen, 2021). While some papers focus on the impacts of rainfall shocks during pregnancy (Dimitrova & Bora, 2020; Le & Nguyen, 2021; Randell et al., 2020), others examine rainfall shocks occurring more recently (Dimitrova & Muttarak, 2020; Jacoby et al., 2014; Omiat & Shively, 2020; Skoufias & Vinha, 2012).

Closely related to our study are studies on the impacts of climate change on Vietnamese children. Thai and Falaris (2014) find that adverse rainfall shocks during pregnancy negatively affect children's school entry delay and academic progression. Le and Nguyen (2022) uncover the adverse impacts of in-utero exposure to rainfall shocks on early childhood health among Vietnamese children.

The existing literature on the impacts of climate volatility on child development still has certain gaps that need to be explored further. First, there should be more studies to shed additional light on how rainfall shocks affect educational outcomes, to resolve the current conflicting findings in the literature. We fill this gap by focusing on Vietnam, a middle-income country that is vulnerable to climate change, to explore the climate-child development linkage. The analysis in a different context may bring more insight into this relationship of interest. Second, while there is much international work exploring the impacts of recent or contemporaneous rainfall shocks on child health, there is scant research in the context of Vietnam that concentrates on rainfall shocks that happened recently, and they tend to focus on rainfall shocks that occur during the prenatal period (before the child was born). We complement the literature by analyzing how the rainfall shocks that happen recently rather than during pregnancy affect Vietnamese children's health. Third, while many efforts have been directed to the examination of the existence and impact magnitude of the climate-child development linkage, insufficient attempts have been made to investigate the pathways underlying the impacts of rainfall on child development. Our study fills this gap by conducting a mechanism analysis to present the transmission mechanisms through which flooding (excessive rainfall) influences children's educational and health outcomes.

3. Data

The data for this study are drawn from the Young Lives Project (YLP) which is a longitudinal project on childhood poverty across four developing countries: Vietnam, India, Peru, and Ethiopia. The project is funded by the UK Department for International Development. The project has been collecting data on poverty from 12,000 children over 15 years, and five rounds of data have been compiled from 2002 to 2016. To study childhood poverty, the YLP follows two cohorts of children born in 1994 - 1995 and 2001 - 2002. The panel nature of the data allows researchers to observe the same child over the years and thus observe how his/her development progresses.

In Vietnam, the project is carried out by the Research and Training Centre for Community Development, the General Statistics Office, and Save the Children UK. The project tracks 3,000 children in five provinces: Phu Yen, Ben Tre, Lao Cai, Hung Yen, and the City of Da Nang.

In the first round of data collection, 2,000 children born in 2001 - 2002 and 1,000 children born in 1994 - 1995 and their households were selected from 20 sentinel sites across these five provinces. These children and households are followed up in subsequent rounds. There are household questionnaires and child questionnaires which ask children and their households to provide information about the child's general characteristics (such as age, sex, ethnicity) and basic characteristics of the child's family (such as household size, household head's sex, head's education, etc.).

An important feature of these questionnaires is that a variety of child development measures including health, education, and well-being information of the child is collected. In terms of health, we have access to a child's incidences of illness as well as anthropometric measures, including height-for-age, weight-for-height, and nutrition status (whether the child is underweight or not). Regarding education, we are able to see the child's school enrollment status (whether he/she is at school). In addition, children are administered reading and mathematics tests, so we also have some measures of children's academic ability. To facilitate interpretation, we standardize test scores across all children in each round to have zero mean and unit standard deviation. As for a child's well-being, it is measured by a self-assessment of how the child sees his/her personal well-being at the time of the interview. The response is coded in a nine-step ladder where 09 represents the 'best possible life' and 01 'the worst possible life'.

Table 1

Summary Statistics

	Mean	**SD**	**Observations**
	(1)	**(2)**	**(3)**
Panel A: Outcome Variables			
Enrol in School	0.810	0.392	10,714
Math Test Score	0.404	0.906	3,344
Reading Test Score	0.003	1.008	3,344
Weight-for-height z-score	-1.147	1.184	3,844
Underweight	0.219	0.413	3,842
Subjective Wellbeing	5.578	1.754	9,122
Panel B: Explanatory Variables			
Flood Shocks	0.076	0.265	10,714
Female Child	0.491	0.500	10,714
Minority Child	0.139	0.346	10,714
Child's Age	10.499	5.983	10,714
Head Education	6.836	3.873	10,714
Female Head	0.149	0.357	10,714
Head's Age	42.086	11.837	10,714
Household Size	4.565	1.549	10,714

Source. Authors' calculation

The questionnaire has one question on the incidence of flood the household experienced recently. Specifically, households indicate whether they have been badly affected by floods in the last twelve months. Our main explanatory variable, Flood Shocks, takes the value of one if the household is recently affected by floods, and zero otherwise. We want to focus on floods rather than different shocks because flood is regarded as a major type of natural disaster in Vietnam (Tarp, 2017). In fact, as 70% of the population lives in coastal areas and low-lying deltas, Vietnam is especially vulnerable to flooding risk (Bangalore et al., 2019).

The descriptive statistics of the variables used in this study are presented in Table 1. Looking at various child development measures (Panel A), the school enrollment rate is 81% in our sample. The average weight-for-height z-score is -1.147 standard deviations and the proportion of underweight children is 22%. As evident from Panel B, 7% of households recently experienced flood shocks.

4. Empirical methodology

To estimate the impacts of the flood on child development, we employ the child fixed effects model expressed in the following equation,

$$DEV_{iht} = \beta_0 + \beta_1 FloodShocks_{ht} + X'_{iht}\Gamma + \theta_i + \mu_t + \varepsilon_{iht} \quad (1)$$

Where *i, h*, and *t* denote child, household, and survey year. DEV_{iht} refers to various measures of child development, including educational measures (his/her school enrolment status, test scores in math and reading), health measures (weight-for-height z-score, whether the child is underweight), and the child's subjective well-being. The main explanatory variable is $FloodShocks_{ht}$ which is a dummy taking the value of one if the child's household is recently affected by a flood in the past 12 months, and zero otherwise. X'_{iht} is the covariate of child characteristics (age, gender, ethnicity), household characteristics (household size, household head gender, education, age, household composition disaggregated by age and sexes, residential regions). We also control for survey year fixed effects (μ_t) and child fixed effects (θ_i). The term ε_{iht} is the error term.

Our coefficient of interest is β_1 which can capture the impact of flood shock exposure on child development. While the year-fixed effects account for the time-varying aggregate events affecting all children, the child-fixed effects account for time-invariant unobserved child characteristics that could be jointly associated with exposure to flood shock and child development measures. For instance, a child from a disadvantaged family background might have worse development outcomes (less likely to be in school, lower test score, more likely to be thinner for their height, etc.), and the parents might have insufficient education and low productivity, thus have fewer resources to cope with adverse shocks or tend to reside in poor and flood-prone areas. If that is the case, then the effect on child development may be attributed to family background rather than flood shock.

To deal with this endogeneity issue, we compare the development measures of a child across time where some years the child might be exposed to flood shocks while some other years he/she might not be. This *within-child comparison* (*child fixed effects* model) can be better than the cross-sectional comparison of children (i.e., *between child comparison*) as some randomly chosen children may be fundamentally different in characteristics jointly correlated with shock exposure and development outcomes, but such characteristics cannot be observed by the researcher. We carefully acknowledge the limitation of our child fixed effects model as although it accounts for the *time-constant* unobserved *child specific* characteristics, it cannot deal with the

time-variant unobserved child characteristics (confounders that vary over time). Therefore, assuming that in the absence of time-varying confounders, our child-fixed effects could produce an unbiased estimate of the effects of flood exposure on child development outcomes.

5. Results

5.1. Impacts of flood on child's education

The estimated impacts of the flood on children's educational outcomes are presented in Table 2. It is evident that recent flood exposure makes children 3.3 percentage points less likely to enroll in school (Column 1), which corresponds to a 4.1% decrease relative to the sample mean. Our findings are in line with prior studies, which also uncover the negative impacts of rainfall shocks on school enrollment in various contexts such as India, Mexico, and Guatemala (Baez et al., 2017; Björkman-Nyqvist, 2013; De Janvry et al., 2006; Jacoby & Skoufias, 1997). In terms of magnitude, our estimate is close to the effect of rainfall shocks on school enrollment in Guatemala and India (Baez et al., 2017; Zimmerman, 2020). To put our estimate into perspective, the estimated reduction in school attendance induced by recent exposure to flood is equivalent to the impact of the financial crisis in Peru (Schady, 2004), but it is smaller than the impact of the economic downfall in Costa Rica (Funkhouser, 1999) and is just one third the impact of armed conflict in Ethiopia (Assefa et al., 2022).

Besides, recent flood exposure further lowers math and reading achievement test scores by approximately 0.21 and 0.24 standard deviations, respectively (Columns 2 and 3). This finding is consistent with the results of Nübler et al. (2021) and Dasgupta and Karandikar (2021), who also detected a negative association between rainfall shocks and children's cognitive test scores in Kenya and India, respectively. In terms of magnitude, our estimates are larger than those of Dasgupta and Karandikar (2021) but are somewhat smaller than those of Nübler et al. (2021). Overall, we can see the adverse impact of floods on child development along the lines of school enrolment status and academic achievement.

Table 2

Impacts of Flood on Child's Education

	Enroll in School	**Math Test Score**	**Reading Test Score**
	(1)	**(2)**	**(3)**
Flood Shocks	-0.033**	-0.208**	-0.240**
	(0.015)	(0.094)	(0.107)
Observations	10,714	3,344	3,344

Note. *** p < 0.01, ** p < 0.05, * p < 0.1. Each column represents a separate regression and the column name indicates the dependent variable. Each regression controls for child characteristics (age, gender, ethnicity), household characteristics (household size, household head gender, education, age, household composition disaggregated by age and sexes, residential regions), year and child fixed effects. Standard errors are clustered at the child level

Source. Authors' calculation

5.2. Impacts of flood on child health and well-being

The estimated impacts of flooding on child health and subjective well-being are displayed in Table 3. According to Column 1, if the child's household is affected by a flood, the

child is 0.11 standard deviations thinner in his/her height. Our finding is consistent with those of prior studies, which also uncover the negative impacts of climate shocks on child health (Dimitrova & Muttarak, 2020; Jacoby et al., 2014; Omiat & Shively, 2020; Skoufias & Vinha, 2012; Tiwari et al., 2017). Our estimate is close to the impacts of raising rainfall in the current season by 30% relative to the long-run local average in Nigeria (Jacoby et al., 2014). Our estimated effect is also similar to the impacts of a 10% increase in rainfall (above the historical average) in the prior year in Uganda (Omiat & Shively, 2020).

We carefully note that we examine the effect on the weight-for-height z-score instead of the height-for-age z-score because weight-for-height is an indicator of short-term child nutritional status. As a short-run nutrition status, a child's weight-for-height might be more sensitive to contemporaneous and recent shocks, such as the occurrence of extreme events. Weight-for-height is more sensitive to contemporaneous and recent shocks than a long-term measure such as height-for-age. Here we examine the effect of flood shocks recently experienced by the household, so weight-for-height z-score is the appropriate outcome to look at. A negative and statistically significant estimate suggests that a recent flood shock indeed lowers a child's short-run nutrition outcome, i.e., his/her weight weight-for-height z-score.

We also examine a child's underweight status, which is determined by both long-run and short-run conditions. According to Column 2, recent exposure to floods raises the incidence of underweight by 3.8 percentage points. Taking the proportion of underweight children as the benchmark, this estimate represents the 17.4% increase in the incidence of underweight. Besides, Column 3 shows that recent exposure to floods reduces a child's subjective well-being by roughly 0.27 points, corresponding to a 5% decrease relative to the sample average.

Table 3

Impacts of Flood on Child Health and Well-being

	Weight-for-height z-score	**Underweight**	**Subjective Well-being**
	(1)	**(2)**	**(3)**
Flood Shocks	-0.109***	0.038*	-0.272***
	(0.031)	(0.020)	(0.079)
Observations	3,844	3,842	9,122

Note. *** p < 0.01, ** p < 0.05, * p < 0.1. Each column represents a separate regression and the column name indicates the dependent variable. Each regression controls for child characteristics (age, gender, ethnicity), household characteristics (household size, household head gender, education, age, household composition disaggregated by age and sexes, residential regions), year and child fixed effects. Standard errors are clustered at the child level

Source. Authors' calculation

5.3. Possible mechanisms

In this section, we proceed to explore the potential pathways to the impacts of floods on child development outcomes. The literature suggests that adverse weather shocks could depress agricultural production, therefore lowering food supply, and household income (Boansi et al., 2021; Chuang, 2019). While the reduction in food supply is quite noticeable among agricultural households, non-agricultural households might also be affected as decreasing agricultural outputs could raise food prices, or decrease food availability.

Regarding child health and nutrition, it is possible that the reduction in food supply implies lower nutrition intake, thus impeding the child's health and growth. At the same time, the declining income also means that households now have fewer resources to provide health inputs (e.g., vitamins, vaccines, medical services, etc.) for children, which consequently leads to worse health (Brückner & Ciccone, 2011; Vogel et al., 2019). Another explanation for the poorer health outcome is that extreme weather events such as flooding could make certain diseases more prevalent, exposing children to more health risks, thus deteriorating child health (Umbers et al., 2011).

To test for the role of food supply and income, we re-estimate equation (1) but replace the development outcomes with measures proxying for food supply and household income. Depending on the availability of the data, we choose the household's monthly food expenditure measure (in log form) and the household's wealth index. As evident from Columns 1 and 2 of Table 4, recent exposure to flood reduces spending on food by 3.1% and reduces household wealth by 0.01 points. It is possible that recent exposure to floods might negatively affect household wealth, inducing them to reduce food expenditure. Another possibility is that floods reduce the availability of food, therefore households might not have much to eat. Either way, recently insufficient food intake ultimately worsens short-run child health as shown in the reduction in weight-for-height z-score and increased incidence of underweight. In other words, our estimated results confirm the role of declining food supply and household income as the pathways to the impacts of recent exposure to flood.

To test for the prevalence of diseases as a potential mechanism, we use the information on the child's recent incidence of illness and construct the variable Recent Illness, which takes the value of one if the child is reported to be ill in the past 12 months and otherwise. As shown in Column 3, although the estimate is positive, it fails to be statistically significant at conventional levels. It seems we do not have enough evidence that disease prevalence could be the pathway to the effect of flooding on child health in our context.

As for children's educational outcomes, it is possible that children's worsened health might make them suffer academically (Glewwe, 2005; Glewwe & Miguel, 2008). Another explanation can be related to the decrease in income induced by floods. Now that households find themselves short of financial resources, they may allocate resources away from the "less urgent category" such as education, and thus reduce educational investment in their children. In other words, children might be forced to divert their time away from studying to doing some paid or nonpaid work. This way, children might drop out of school, or they might just reduce their studying time and spend their time doing other work instead. The former case may decrease the quantity of education while the latter could deteriorate the quality of a child's education. From a household's standpoint, having children do some paid jobs, households might receive some extra income since every labor in the family is utilized. Therefore, we examine the effects of recent flood exposure on the number of hours children spend being engaged in paid jobs. As can be seen from Column 4, being exposed to flood does not lead to an increase in the amount of time spent doing paid work.

However, as we turn to the amount of time spent doing housework, we detect a positive and statistically significant impact of floods (Column 5). Particularly, recent exposure to floods raises the number of hours the child spends doing household chores per day by approximately 0.18 hours. This is approximately a 20% increase (relative to the sample mean) in the number of hours per day spent doing household. Flood afflicted households may be substituting adult labor

in unpaid housework with child labor so that adults can have more time doing paid activities. As children divert their time away from studying to do household chores, their academic achievement suffers.

Table 4

Possible Mechanisms

	Food Expenditure	Household Wealth	Recent Illness	Hours Doing Paid Job	Hours Doing Chores
	(1)	(2)	(3)	(4)	(5)
Flood Shocks	-0.031*	-0.007*	0.020	-0.082	0.183***
	(0.017)	(0.004)	(0.015)	(0.083)	(0.034)
Observations	7,626	7,486	8,256	10,962	10,955

Note. *** p < 0.01, ** p < 0.05, * p < 0.1. Each column represents a separate regression and the column name indicates the dependent variable. Each regression controls for child characteristics (age, gender, ethnicity), household characteristics (household size, household head gender, education, age, household composition disaggregated by age and sexes, residential regions), year and child fixed effects. Standard errors are clustered at the child level

Source. Authors' calculation

In terms of a child's subjective well-being, the reduction in nutrition intake (food expenditure, Column 1), lower living standards (household wealth, Column 2) and the worsening health outcomes (Table 3) could contribute to the decline in the child's personal well-being.

Taken together, our analyses provide suggestive evidence that the adverse impacts of floods on children's health and educational outcomes could be attributed to the declines in food expenditure and household wealth as well as the increase in the amount of time spent on non-academic activities such as housework.

6. Conclusion

In this paper, we explore the extent to which exposure to flooding affects children's educational and health outcomes in the context of Vietnam. Employing the panel data from the Young Lives Project, we tackle the endogeneity inherent in any empirical work by making the within-child comparison in development outcomes where the child might be exposed to flood shocks in some years but not the others. The child fixed effects model accounts for the time-constant unobserved child-specific characteristics that are jointly associated with both development outcomes and flood exposure, therefore producing reliable estimates of the impacts of flooding on the educational and health outcomes of children.

Our study reaches the following findings. First, flooding is associated with worse educational outcomes. Specifically, recent exposure to flood shocks makes children 3.3 percentage points less likely to enroll in school, which corresponds to a 4.1% decrease relative to the sample mean. Math and reading achievement test scores also decrease by approximately 0.21 and 0.24 standard deviations following recent flood shocks. Second, flooding reduces further worsens child health and subjective well-being. Particularly, if the child's household is affected

by a flood, the child is 0.11 standard deviations thinner for his/her height and is 3.8 percentage points more likely to be underweight. Recent exposure to floods is also associated with a 0.27-point reduction in a child's subjective well-being (corresponding to a 5% decrease relative to the sample average).

Our findings are consistent with those in prior literature regarding the relationship between weather shocks and child development. In particular, our estimated effects of flooding on children's educational outcomes are in line with studies that also uncover the negative impacts of rainfall shocks on school enrollment in various contexts such as India, Mexico, and Guatemala (Baez et al., 2017; Björkman-Nyqvist, 2013; De Janvry et al., 2006; Jacoby & Skoufias, 1997). Our estimates are also comparable to those of Nübler et al. (2021), and Dasgupta and Karandikar (2021) who also detect the negative association between rainfall shocks and children's cognitive test scores in Kenya and India, respectively.

Our estimated effects of flooding on child health are consonant with those of prior studies which also document the negative impacts of climate shocks on child health (Dimitrova & Muttarak, 2020; Jacoby et al., 2014; Omiat & Shively, 2020; Skoufias & Vinha, 2012; Tiwari et al., 2017). Our estimate is close to the impacts of raising rainfall in the current season by 30% relative to the long-run local average in Nigeria (Jacoby et al., 2014). Our estimated effect is also similar to the impacts of a 10% increase in rainfall (above the historical average) in the prior year in Uganda (Omiat & Shively, 2020).

We also explore the transmission mechanisms behind the impacts of flooding. Our analyses show that recently experiencing floods decreases food expenditure and household wealth, which, as a result leads to insufficient food intake, thus worsening child health and nutrition status. We also find that recent exposure to floods raises the number of hours the child spends doing household chores. It is possible that flood-afflicted households are substituting adult labor in unpaid housework with child labor so that adults can have more time doing paid activities. As children divert their time away from studying to do household chores, their schooling outcomes suffer. Overall, our mechanism analyses provide suggestive evidence that the adverse impacts of floods on children's health and educational outcomes could be attributed to the declines in food expenditure and household wealth as well as the increase in the amount of time spent on non-academic activities such as housework.

Our study has several limitations. First, our flood exposure is based on self-reported data, therefore, it might have measurement error. Second, the flood shock in this study only reflects whether the child was exposed to flooding without accounting for the intensity and duration of floods, which could affect the magnitude of the impacts. Third, this paper does not explore the heterogeneous impacts of flood exposure across different regions and socioeconomic groups. Future research could address these limitations by employing more accurate measures of flood exposure and examining the heterogeneity of impacts.

Our findings offer meaningful policy implications. First, the adverse association between flooding and child development justifies government interventions to assist children in flood-prone areas. To the extent that poor health and schooling outcomes in early life could leave long-term ramifications on future life such as lower educational attainment and lifetime earnings, as well as increased susceptibility to illnesses (Briend & Berkley, 2016; Doyle et al., 2009; Glewwe & Miguel, 2008), the detrimental consequences of flooding to human capital might be wide-reaching. This highlights the role of mitigative measures and assistance programs from the government to alleviate the cost of climate volatility on long-term human capital accumulation.

Second, as the repercussions of flooding on child development transmitted through declines in food expenditure and household wealth, it is possible that the government should initiate food assistance programs to make sure that children receive enough nutritional intake.

Another efficacious measure could be the implementation of cash transfers, which might help flood-affected households weather the financial difficulty induced by the disaster. Because children's time diversion away from studying to doing domestic chores could also be the pathway to the impacts of flooding, such financial assistance from the government may prevent resources from being allocated away from children's education, as households are not financially stressed out, children might not be forced to spend time being engaged in non-academic activities and instead allow to focus on their school work.

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