Flood Exposure and Child Health in Bangladesh

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In the summer of 1998, Bangladesh was inundated by significant flooding that covered two-thirds of the country and affected more than 30 million people. Although annual flooding is normal and expected in Bangladesh, the 1998 floods caused extraordinary devastation and were considered a "century" flood. Homestead flooding, crop loss and infrastructure damage all compromised food security in rural areas. In this paper I use longitudinal data from the post-flood period in rural Bangladesh to examine how children's health and nutritional status responded to the severe flooding. I ask whether 1998 flood exposure caused growth faltering among children, or if 1998 flood exposure and growth faltering are both manifestations of more chronic household vulnerability. Future work will extend this analysis to other welfare measures including household food security and disease prevalence, and to the use of specific coping strategies.

Understanding the impact of this type of disaster on individual and household welfare is vital for future planning and relief efforts. In the wake of the 1998 floods in Bangladesh, considerable relief and recovery efforts were launched by the Government of Bangladesh, by the international aid community, and by local and international NGOs. Development and planning practitioners in Bangladesh continue to make significant resource allocation decisions based on research findings on disaster preparedness, impact, and recovery (Beck, 2005). This study contributes to these efforts by exploiting longitudinal data and age differences in growth rates to pinpoint the causal effects of the flood on nutritional status.

DATA

This study uses data from the Coping Strategies in Bangladesh survey, fielded by the International Food Policy Research Institute in partnership with the Bangladesh Ministry of Food (Del Ninno, 2001). The goal of the survey was to assess household and community responses to the severe flooding in Bangladesh in summer 1998. The sample includes 757 households in 126 villages from seven flood-affected thanas. The survey was fielded in three waves: Round 1 in November 1998, round 2 in March-April 1999, and round 3 in November 1999. The household questionnaire includes modules on flood exposure, household expenditures and assets, receipt of transfers, and allocation of food to individuals in the day prior to the survey. Morbidity for all household members in the prior two weeks was reported, and anthropometric data for all women and children under 10 years old were recorded in the field.

GROWTH FALTERING AND NUTRITION SHOCKS

Infants and young children grow rapidly from birth through age three or four. Nutrition during this stage largely determines the proportion of genetic growth potential that will be achieved by age three (Martorell, 1995, 1999; Martorell & Ho, 1984). Stature achieved by age three is in turn associated with important human capital outcomes, including physical and mental development, school performance, and labor productivity. (Alderman, Hoddinott, & Kinsey, 2002; Behrman, 1996; Grantham-McGregor, Fernald, & Sethurman, 1999; Grantham-McGregor, Walker, Chang, & Powell, 1997). During this rapid growth stage, children are vulnerable to nutrition shocks (Martorell & Habicht, 1986). "Weanlings" who are being transitioned from breastmilk to complementary foods and who are still wholly dependent on caregivers for feeding are particularly at risk (UNICEF, 1990). In addition, immature immune systems leave children vulnerable to infections that can both lead to and exacerbate inadequate dietary intake (Chen, 1983; Scrimshaw, Taylor, & Gordon, 1968). The determinants of child malnutrition suggest possible sources of nutrition shocks. Proximate determinants include both inadequate dietary intake and repeated episodes of infectious disease. More distal factors include household resources, care behaviors, and the health environment (UNICEF, 1990).

Unfortunately, both chronic and acute spells of inadequate dietary intake and infectious diseases are common occurrences for many children in the developing world, resulting in substantial growth faltering. Across Asia, children are born near the growth reference standard for height-for-age. However, height-for-age z-scores (reflecting the deviation from the growth standard for well-nourished children) quickly fall from birth to 24 months, and then plateau or continue to fall more slowly. (Shrimpton et al., 2001). The situation is particularly dire in Bangladesh, where more than half of all of rural children ages two to six five are stunted (Bangladesh Nutritional Surveillance Project, 2002). Stunting is defined as a slowing of skeletal growth and stature resulting in a height-for-age that is less than two standard deviations below the median of the reference population (or a z-score of less than -2). Stunting typically results from chronic undernutrition, but acute nutrition shocks can also permanently affect growth trajectories. Figure 1 shows stunting rates for rural children in Bangladesh from two nutrition surveillance surveys. While rates have improved recently for older toddlers, the peak prevalence rate around the weaning period remains high.

THE 1998 FLOODS IN BANGLADESH

Rural populations in Bangladesh are accustomed to annual flooding, and in fact rely on it for rice cultivation. In 1998, however, the monsoons flooded more than two-thirds of the country and destroyed more than 10 percent of the targeted rice production for the 1998-1999 agricultural season (Del Ninno, Dorosh, Smith, & Roy, 2001). Flooding was deeper and lasted significantly longer than in "normal" flood years. The implications of the 1998 floods for child health were substantial and widespread. Almost one million homes were affected, displacing more than one million people for days or weeks. In the survey sample of affected areas, 47 percent of households lost housing assets and more than 20 percent of households lost productive assets. (Del Ninno et al., 2001). Labor demand declined, and households reported reduced food consumption and increased rice prices. Incidence of diarrheal and respiratory diseases increased significantly (Del Ninno et al., 2001), due in part to lack of clean drinking water and sanitation.

In an analysis of impacts of the flood, Del Ninno and colleagues identified higher rates of stunting and wasting among flood exposed preschool children in and higher rates of chronic energy deficiency among flood exposed women in November 1998, two months after the flood waters receded (Del Ninno et al., 2001). In longitudinal analysis, there was no evidence of catch-up growth among flood exposed children relative to unexposed children from November 1998 to December 1999 (Del Ninno & Lundberg, 2005). However, their analytic approach has several shortcomings which I seek to address in this study.

ANALYSIS

My goal is to identify a causal link between 1998 flood exposure and growth faltering among children. My measure of growth faltering is a decline in height-for-age z-score that exceeds the typical HAZ downward trajectory for rural children in Bangladesh. My analysis must account for the fact that household flood exposure is likely to be correlated with unobserved household characteristics that are also associated with poor nutritional status. For example, if poorer households are more likely to live on marginal lands that are vulnerable to flooding, and also more likely to have stunted children, the estimates of the effects of flood exposure on nutritional status will be biased if household wealth is not observed or is measured with considerable error.

To assess the impact of the floods on growth trajectories, therefore, I exploit the timing difference in vulnerability to nutrition shocks with a difference-in-difference approach. The analysis proceeds in three stages. First, I confirm Del Ninno et. al's finding that flood exposed children are smaller than unexposed children at each age and in both November 1998 and November 1999 (survey rounds 1 and 3). Next, I compare the change in height-for-age z-scores (HAZ) from November 1998 to November 1999 in exposed children to the change in HAZ for unexposed children for each birth year cohort from 1989 to 1998. For older birth cohorts (children who were four years or older during the flood, or born prior to 1995), I expect a minimal difference, because children at this age are less vulnerable to a nutrition shocks. For younger birth cohorts, however, who experienced the 1998 flood period during a nutritionally vulnerable time, I expect the difference in HAZ change scores from 1998 to 1999 to be larger and significant.

In the third stage of the analysis, I attempt to parse this difference in growth trajectories further. I first compare HAZ scores for exposed vs. unexposed children in the youngest birth cohort, those who are age 6-12 months in November 1998 and were therefore alive during the flood period in summer 1998. While I expect to see a difference in z-scores in these two groups, I am not able to attribute the difference wholly to flood exposure due to the endogeneity of flood exposure with respect to child growth. However, I can then compare the HAZ scores for the 1999 birth cohort (or those children age 6-12 months in November 1999), based on the household's 1998 flood exposure. Because these children were not exposed to the 1998 flood, none of the difference in their HAZ scores can be attributed to the direct impact of the flood. Therefore, I subtract this difference from the difference in HAZ scores for the 1998 cohort (as measured in 1998), to obtain the "pure" effect of the flood on the 1998 cohort (Frankenberg, Suriastini, & Thomas, 2004).

PRELIMINARY RESULTS

Descriptive statistics shown in Table 1 confirm that flood exposure is associated with poorer nutritional status for children. I group children into three age cohorts by birth year. For the oldest and youngest cohorts in both survey rounds, HAZ is lower for flood-exposed children than for unexposed children. While exposed and unexposed children in the oldest cohorts show slight improvements in z-scores from 1998 to 1999, the youngest cohort falters quite substantially: HAZ scores for unexposed children drop by .293 standard deviations, and exposed children drop by .628 standard deviations on average. Evidence of the flood's impact can be seen in the lower (less male) sex ratios in exposed households relative to exposed households, likely reflecting a high male infant mortality rate immediately following the flood. Per capita expenditures (measured in November 1998) and landholding rates are higher in unexposed households.

In Table 2 I show preliminary results from a model predicting the change in child height-for-age from November 1998 to November 1999 as a function of age, household flood exposure, and the interaction between age and flood exposure. To account for unobserved village attributes related to flood exposure and child nutritional status, the model includes village fixed effects. The model also controls for sex of the child, household expenditures in November 1998, and landholding status in 1998. There are several notable results. First, the youngest age group (ages 0-1 in 1998) experiences a decline of .464 standard deviations in HAZ relative to children ages 4 and older. This is in line with the normal HAZ trajectories for rural Bangladesh children. Similarly, children ages 2-3 also experience significant growth faltering relative to older children. However, children in the youngest age group who were also exposed to the flood experienced a marginally significant additional decline in HAZ of .279 standard deviations relative to the oldest children. The flood exposed children in the middle cohort (ages 2-3 in 1998) do not experience a similar decline. Note that net of age effects, the age-exposure interactions, and the village fixed effects, household flood exposure has no additional predictive power for the change in height-for-age z-score.

FUTURE WORK

Several extensions and refinements of this analysis are planned. First, I will develop more specific measures of flood exposure in order to determine whether homestead flooding, agricultural plot flooding, or community flood exposure is most relevant for child health. These measures will incorporate GIS data on land contours and ground cover in the sample area. Second, I will extend the analysis to other welfare measures, describing maternal nutritional status, disease prevalence, and food security for exposed and unexposed households over the course of the post-flood year. Third, I will develop a model that attempts to predict both child nutritional status and 1998 flood exposure as functions of longer-term household vulnerability measures and coping strategies.

WORKS CITED

Alderman, H., Hoddinott, J., & Kinsey, B. (2002). *Long term consequences of early child malnutrition*.Unpublished manuscript.

Bangladesh Nutritional Surveillance Project. (2002). *Nutritional and Health Surveillance in Rural Bangladesh* (Annual Report 2001, Bulletin No. 2). Dhaka: Helen Keller International, Bangladesh.

Beck, T. (2005). *Learning Lessons from Disaster Recovery: The Case of Bangladesh* (Disaster Risk Management Working Paper Series No. 11). Washington, DC: The World Bank.

Behrman, J. R. (1996). Impact of health and nutrition on education. *World Bank Research Observer, 11*(1), 23-27.

Chen, L. C. (1983). Interactions of Diarrhea and Malnutrition: Mechanisms and Interventions. In L. C. Chen & N. S. Scrimshaw (Eds.), *Diarrhea and Malnutrition: Interactions, Mechanisms and Interventions* (pp. 3-19). New York: Plenum Press.

Del Ninno, C. (2001). *Coping Strategies in Bangladesh (November 1998-December 1999): Survey Documentation* (FMRSP Data Dcoumentation Report No. 1). Washington, DC: Food Management and Research Support Project (FMRSP) Bangladesh and International Food Policy Research Institute (IFPRI).

Del Ninno, C., Dorosh, P. A., Smith, L. C., & Roy, D. K. (2001). *The 1998 Floods in Bangladesh: Disaster Impacts, Household Coping Strategies and Responses* (No. 122). Washington, DC: International Food Policy Research Institute.

Del Ninno, C., & Lundberg, M. (2005). Treading water: The long-term impact of the 1998 flood on nutrition in Bangladesh. *Economics and Human Biology, 3*, 67-96.

Frankenberg, E., Suriastini, W., & Thomas, D. (2004). Can Expanding Access to Basic Health Care Improve Children's Health Status? Lessons from Indonesia's "Midwife in the Village" Program. *Population Studies, 59*(1), 5-19.

Grantham-McGregor, S., Fernald, L., & Sethurman, K. (1999). Effects of health and nutrition on cognitive and behavioral development in children in the first three years of life: Part I. *Food and Nutrition Bulletin, 20*, 53-75.

Grantham-McGregor, S., Walker, C., Chang, S., & Powell, C. (1997). Effects of early childhood supplementation with and without stimulation on later development in stunted Jamaican children. *American Journal of Clinical Nutrition, 66*, 247-253.

Martorell, R. (1995). Promoting Healthy Growth: Rationale and Benefits. In P. Pinstrup-Andersen, D. Pelletier & H. Alderman (Eds.), *Child Growth and Nutrition in Developing Countries: Priorities for Action* (pp. 15-31). Ithaca: Cornell University Press.

Martorell, R. (1999). The nature of child malnutrition and its long-term implications. *Food and Nutrition Bulletin, 20*(3), 288-292.

Martorell, R., & Habicht, J. P. (1986). Growth in early childhood in developing countries. In F. Falkner & J. M. Tanner (Eds.), *Human Growth: A Comprehensive Treatise* (Vol. 3, pp. 241-262). New York: Plenum Press.

Martorell, R., & Ho, T. J. (1984). Malnutrition, Morbidity and Mortality. In W. H. Mosley & L. C. Chen (Eds.), *Child Survival: Strategies for Research. Population and Development Review* (Vol. Supplement 10, pp. 49-68).

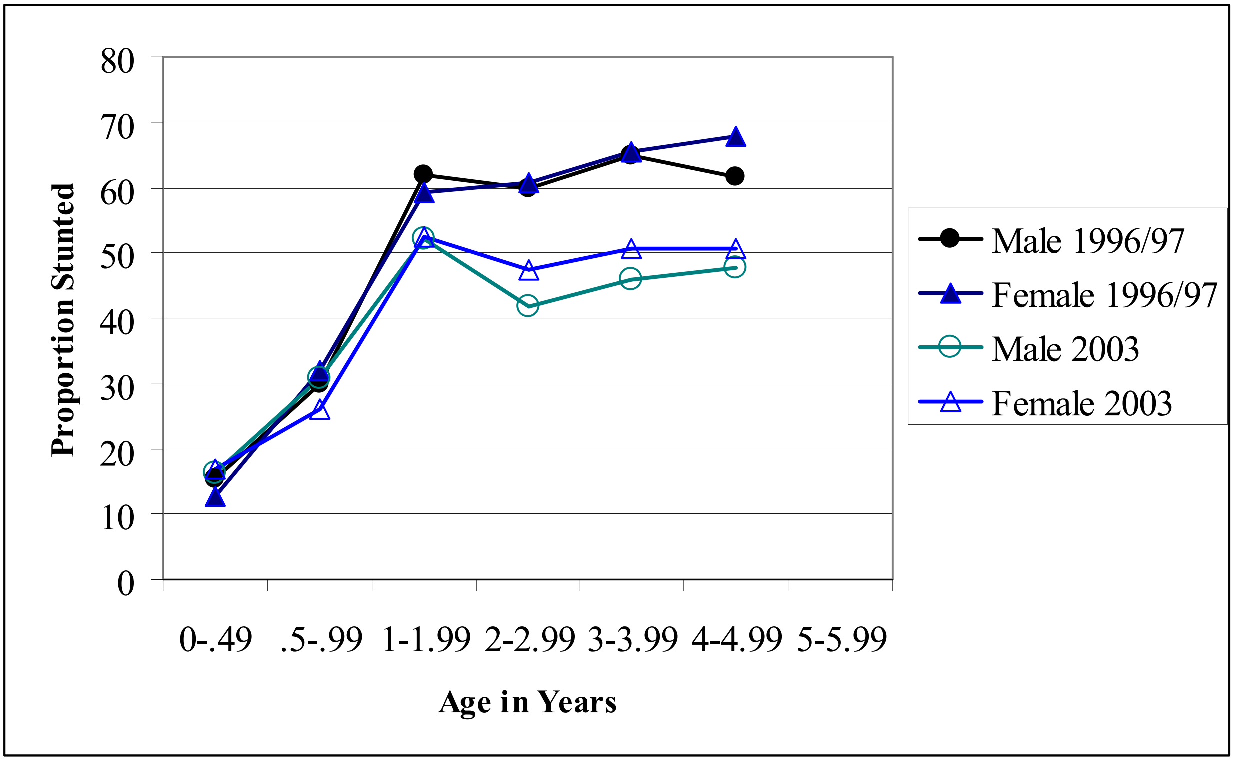
Scrimshaw, N. S., Taylor, C. E., & Gordon, J. E. (1968). *Interactions of Nutrition and Infection*. Geneva: World Health Organization.

Shrimpton, R., Victora, C. G., de Onis, M., Costa Lima, R., Blossner, M., & Clugston, G. (2001). Worldwide Timing of Growth Faltering: Implications for Nutritional Interventions. *Pediatrics, 107*(5), 1-7.

UNICEF. (1990). *Strategy for Improved Nutrition of Children and Women in Developing Countries*. New York: UNICEF.

World Health Organization. (2005). *WHO Global Database on Child Growth and Malnutrition: Bangladesh*. Retrieved June 2005, from http://www.who.int/nutgrowthdb/p-child_pdf/ban_ref.pdf

Figure 1: Stunting Rates for Rural Children in Bangladesh by Age and Sex, 1996-2003.



(Source: World Health Organization, 2005)

Table 1: Descriptive Statistics by Birth Cohort and Household Flood Exposure, Children Ages 0-9 in Rural Flood-Affected Thanas of Bangladesh, 1998-1999 (N=732).

	All Children	Born 1997-1998		Born 1995-1996		Born 1989-1994	
		Not Exposed	Exposed	Not Exposed	Exposed	Not Exposed	Exposed
Height-for-age z-score, 1998	-2.16 (1.35)	-1.72 (1.38)	-1.92 (1.36)	-2.31 (1.09)	-2.26 (1.33)	-1.75 (1.20)	-2.35 (1.38)
Height-for-age z-score, 1999	-2.19 (1.26)	-2.01 (1.17)	-2.54 (1.23)	-2.50 (1.09)	-2.26 (1.23)	-1.66 (1.15)	-2.23 (1.29)
Change in HAZ	-.029 (.682)	-.293 (.928)	-.628 (1.13)	-.197 (.760)	-.002 (.627)	.095 (.437)	.119 (.440)
Age (completed years)	4.53 (2.56)	.478 (.803)	.542 (.501)	2.42 (.502)	2.58 (.496)	6.24 (1.52)	6.17 (1.43)
Male = 1	.511 (.500)	.565 (.507)	.428 (.497)	.495 (.507)	.500 (.502)	.514 (.500)	.526 (.501)
Household exposed = 1	.757 (.429)	--	--	--	--	--	--
Ln(per capita expenditures)	6.72 (.495)	6.81 (.443)	6.76 (.559)	6.80 (.533)	6.73 (.521)	6.76 (.503)	6.68 (.463)
Landholding household = 1	.617 (.486)	.565 (.507)	.552 (.500)	.667 (.478)	.560 (.521)	.697 (.461)	.626 (.485)
N	**732**	**23**	**96**	**33**	**116**	**122**	**342**

Table 2: Correlates of Change in Child Height-for-Age Z-Score from November 1998 to November 1999 in Rural Flood-Affected Thanas of Bangladesh (N=732).

Change in HAZ 1998 to 1999	**Coefficient [t-statistic]**
Age in 1998 (Ref: 4-9 years)	
0-1 year	-0.464
	[3.12]***
2-3 years	-0.303
	[2.31]**
Household Exposed to Flood = 1	-0.09
	[0.78]
Interactions (Ref: Exposed * Age 4-9)	
Household Exposed * 0-1 year old	-0.279
	[1.67]*
Household Exposed * 2-3 years old	0.164
	[1.10]
Constant	0.111
	[0.27]
Observations	732
Number of villages	114
R-squared	0.16

Absolute value of t statistics in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

Model includes gender of child, household ln(per capita expenditures) in 1998, and landholding status in 1998

Model includes village fixed effects