

Implications of Climate Change for Children in Developing Countries

Rema Hanna and Paulina Oliva

Summary

Climate change may be particularly dangerous for children in developing countries. Even today, many developing countries experience a disproportionate share of extreme weather, and they are predicted to suffer disproportionately from the effects of climate change in the future. Moreover, developing countries often have limited social safety nets, widespread poverty, fragile health care systems, and weak governmental institutions, making it harder for them to adapt or respond to climate change. And the fact that many developing countries have high birth rates and high ratios of children to adults (known as high dependency ratios) means that proportionately more children are at risk there than in the developed world.

In this article, Rema Hanna and Paulina Oliva delve into climate change's likely implications for children in developing countries. Such children already face severe challenges, which climate change will likely exacerbate. In particular, most people in developing countries still depend primarily on agriculture as a source of income, and so anything that reduces crop yields—such as excessive heat or rain—is likely to directly threaten the livelihoods of developing-country families and their ability to feed their children. Poor nutrition and economic disruption are likely to lower children's scholastic achievement or even keep them out of school altogether. Children in developing countries also face more-severe threats from both air and water pollution; from infectious and parasitic diseases carried by insects or contaminated water; and from possible displacement, migration, and violence triggered by climate change.

How can we temper the threat to children in developing countries? Hanna and Oliva write that we should design and fund policies to shield children in developing nations from the harm caused by climate change. Such policies might include developing new technologies, inventing more-weather-resistant crops, improving access to clean water, increasing foreign aid during disasters, and offering more assistance to help poor countries expand their safety net programs.

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Climate change may be the “biggest global health threat of the 21st century.”¹ As with many future events that are hard to predict, people disagree about the ultimate nature and extent of climate change. But many observers expect that Earth will warm to at least 2°C (3.6°F) over the preindustrial average; that rainfall patterns will change; that extreme weather events will become more frequent; that sea levels will rise, with increased flooding in coastal areas; and so forth. The other articles in this issue show that such changes may have serious repercussions for children and families worldwide.

Children are potentially much more vulnerable than adults to environmental factors (for example, heat, pollution, or famine) because they are both physically weaker and less able to dissipate heat. Moreover, we now have strong evidence that environmental influences during pregnancy and early childhood have persistent effects through adulthood. Simply put, healthier children grow into healthier, wealthier, more-educated adults.²

Although children worldwide may be at risk from climate change, its effects may be particularly severe for kids who live in poor nations. Temperature increases have a large effect on gross domestic product (GDP) in poor countries but little observable effect in rich ones.³ The reason is partly that poor countries, on average, have warmer climates than richer ones do, and temperature changes may affect health and agriculture more severely in areas that are hotter to begin with. And because of their locations, developing countries are likely to face a disproportional share of extreme changes in weather.

Moreover, developing countries have weaker institutional structures. Weaker infrastructure and less-adequate health systems may make it harder to mitigate the effects of temperature. In the United States, electrification and greater access to health care have greatly reduced mortality from heat.⁴ In developing countries, where energy infrastructure lags behind, we may not see a similar pattern. Developing countries also have weaker labor and credit markets, which may make it hard for families to adapt to losses caused by climate change. For example, a household that faces an agricultural loss caused by an increase in adverse weather may not have enough funds to sustain the family and also invest in agricultural inputs, such as seeds and fertilizer, for the following year. To manage their finances, families in a developed country might be able to get loans, both to have enough money for things like food, health care, and education and to ensure that they can plant again the following year. But in developing countries with limited access to banks and formal financing, such loans may be unavailable. Thus families might not only lose income from the crop loss today but also suffer sustained losses of income over time because they can't invest in future production. Government safety net programs may offer emergency help, but again, such programs are more limited in the poorest countries.

We devote this article, then, to exploring how climate change might affect the especially vulnerable children who live in poorer nations.

Effects on Children

Understanding how climate change will affect people is, in general, a challenging task. The task is further hampered by the

fact that it's hard to disentangle climate effects from other characteristics that coexist with climate. For example, poor regions are likely to experience climate change effects sooner than wealthier regions are. Recent research in economics tries to predict the effects of high-frequency changes in weather, and we exploit that research here because it takes a large step forward in beginning to disentangle weather impacts from other characteristics. But that method could cause us to miss long-run and cumulative impacts that could be important—a particular problem in our case if we believe that the cumulative impacts of shocks to children in early life could produce lasting adult outcomes.

We face several additional challenges in trying to understand how climate change will affect children in developing countries. First, not all developing countries will face the same threats. Impacts may vary greatly from one region to another, and rural areas and cities may be affected very differently. For example, urban children and their families could suffer from rising food prices, while rural families could see their houses and livelihoods destroyed by flooding. Thus we will try to discuss a range of outcomes and places.

Second, the data that we're working with may not have been collected specifically for children in a household, or it may not include a comprehensive set of outcomes that we would care about in assessing impacts on children. For instance, studies on weather-related fatalities rarely include age.⁵ As a result, in some cases, we will infer possible outcomes by combining what we know about effects on families with how we might expect children to be affected when their families face such situations.

Third, it's often hard to isolate the channel through which an impact occurs, because concurrent effects may interact with and compound one another. For example, health effects from malnutrition and dehydration could become much worse if flooding also knocks out essential health services. Or reductions in future work opportunities caused by a slowdown in economic growth might decrease the benefits of attending school, while, at the same time, rising rates of illness might increase the cost of school attendance. Therefore, although we separate potential mechanisms to make it easier to explain how they work, we also try to offer insights into those types of interactions.

Impacts on Health

Climate change may further endanger the already vulnerable health status of children in the developing world, because they will more often experience extreme heat, infectious diseases, and floods. Children in the highlands, who were previously unaffected by vector-borne illnesses (that is, illnesses such as malaria that are transmitted by insects and other pests) may become newly exposed to them. In addition, new health threats may appear, such as new illnesses that emerge from disturbed ecosystems or conditions previously uncommon among low-income youth, such as skin cancer.

Child health in the developing world is already substantially worse than in richer countries. For example, let's look at infant mortality, a leading indicator of child health and access to health care. In 2013, the infant mortality rate was 10 times higher in low-income countries than it was in wealthy ones: 53 vs. 5.3 deaths per 1,000 births, respectively. In poor countries, the main causes of child death often include infections

and parasitic diseases, which are rarer in rich countries today. Because climate change is likely to exacerbate conditions that bring forth infections and parasites, the health of children in poor nations is likely to suffer substantially more than that of children in richer ones.

To understand the pathways through which climate change can affect health, we next describe each potential channel separately, and we provide insights into the importance of each channel based on available evidence.

Direct Effect of More Hot Days

As Joshua Graff-Zivin and Jeffrey Shrader write elsewhere in this issue, the more-frequent hot days and heat waves that accompany climate change may directly affect children's health through increases in rashes, heat exhaustion, temporary loss of consciousness (syncope), and heat stroke. Those impacts are likely to be more pronounced in the developing world because low-income countries will see a disproportional rise in warm days (defined as days above 30°C, or 86°F). Effects will vary by region, however: the percentage of warm days is projected to increase the most in the tropics, particularly in equatorial Africa, the Amazon, and the Malay Archipelago. India and areas of northern Africa will experience strong seasonal increases in warm days, and heat waves are projected to increase in the northwestern Sahara and most of South America.⁶

The effect on mortality of an additional warm day is seven times greater in rural areas of developing countries than it is in the United States. However, the United States experienced similarly high heat mortality before the use of air conditioning

became widespread in the twentieth century. Thus the differences that we see between the United States and developing countries today can be attributed at least in part to technologies that are unavailable to the majority of people in the developing world. It's particularly worrisome that increases in mean annual temperature will occur at least two decades sooner in Africa than in other regions of the world: economic growth in Africa is unlikely to reach a level that can support widespread use of air conditioning and other adaptations by that point.

Water Shortages

Many scientists predict that climate change will lead to an increase in water shortages, although, again, the effects may vary substantially by region. Predictions for Africa, for example, foresee only a modest impact on water availability, although countries in the Zambezi River basin will see additional water shortages. In Asia, water shortages are hard to forecast because of low confidence in precipitation predictions, along with the uncertain effects that increasingly variable precipitation will have on water supply.⁷

Water scarcity may mean that people have less and lower-quality drinking water and that they have to spend more time and money to collect water from sources farther from their homes. Lack of access to sufficient sources of good-quality water—the type you would get from piped water systems, for example—has been linked to more-frequent and longer-lasting cases of diarrhea.⁸ Droughts could also displace people from their homes, as we discuss later. In Asia, droughts could also cause forest fires and dust storms, which have

Figure 1. Top Causes of Death among Children under Five (2012)

WHO Africa Region	WHO Southeast Asia Region	United States
Acute lower respiratory infections (15.9%)	Prematurity (25.2%)	Congenital anomalies (19.4%)
Malaria (14.7%)	Acute lower respiratory infections (14.1%)	Prematurity (15.0%)
Prematurity (12.3%)	Birth asphyxia and birth trauma (11.4%)	Accidents/unintentional injuries (9.0%)
Birth asphyxia and birth trauma (10.9%)	Diarrheal diseases (9.8%)	Sudden infant death syndrome (6.0%)
Diarrheal diseases (10.3%)	Other communicable perinatal, and nutritional conditions (8.5%)	Maternal pregnancy complications (5.4%)

Note: WHO is the World Health Organization.

Sources: World Health Organization, “Global Health Observatory Data Repository,” <http://apps.who.int/gho/data/node.main.CM300REG6>; National Center for Injury Prevention and Control, “10 Leading Causes of Death by Age Group, United States—2012,” http://www.cdc.gov/injury/wisqars/pdf/leading_causes_of_death_by_age_group_2012-a.pdf; National Center for Health Statistics, “Deaths, Percent of Total Deaths, and Death Rates for the 15 Leading Causes of Death in 5-Year Age Groups, by Race and Sex: United States, 2012,” http://www.cdc.gov/nchs/data/dvs/LCWK1_2012.pdf.

devastating effects on family income and health.

Infections and Vector-Borne Diseases

Climate change is likely to increase the incidence of infectious and vector-borne diseases. Because health care, sanitation, and coordinated pest control can greatly reduce human vulnerability to such diseases, they have largely been eradicated in the developed world. But they are still among the primary killers of children in developing countries (figure 1).

Climate change will likely increase the optimal conditions for infectious and parasitic diseases through more heavy rainfall, more flooding, and rising water temperature; for example, the association between heavy rainfall, high water temperatures, and cholera outbreaks has been well documented.⁹ Such environmental changes are likely to affect the developing world disproportionately: Central Africa, Southeast Asia, and Central America, along with Peru, Ecuador, Colombia, and northeast Brazil, will likely experience an

increase in heavy precipitation, making all of them more susceptible to cholera outbreaks.¹⁰ Bangladesh’s high susceptibility to widespread outbreaks of cholera makes the large population of children there particularly vulnerable (about 1 in 10 experienced cholera in 2012, according to UNICEF).¹¹

In addition to their short-run health effects, parasitic diseases may have long-term consequences for health and schooling, which may affect future income. Field experiments have shown that a 25 percent reduction in moderate to heavy infections of intestinal worms (such as hookworm, roundworm, whipworm, and the worms that cause schistosomiasis) reduced school absenteeism by one-fourth and had long-run impacts on adult outcomes.¹²

How climate change will affect vector-borne diseases is hard to predict. On one hand, in some regions where malaria currently flourishes, the optimal incubation temperature for the malaria parasite is likely to be exceeded. On the other hand, some areas that are now malaria free may become

susceptible; many of the insects that transmit malaria to humans thrive in warm night and winter temperatures.¹³ Although the overall pattern for vector-borne diseases is hard to predict, scientists foresee that malaria, dengue, and other vector-borne illnesses will expand to previously unaffected areas that will become suitable habitats for malaria-transmitting insects.¹⁴ People whose immune systems have never been exposed to such parasites will likely be more vulnerable than people in historically exposed populations.

Flooding and Natural Disasters

Flooding and other natural disasters may substantially harm children's health, and children in the developing world may be more susceptible than the average population for two key reasons. First, the Intergovernmental Panel on Climate Change projects that climate change will make extreme precipitation near the centers of tropical cyclones more likely—and regions that experience tropical cyclones are disproportionately poor. Second, death rates from environmental disasters, including floods and windstorms, may be many times higher in low-income countries than in high-income countries. The current number of deaths per year from environmental disasters in countries with a per capita GDP near \$2,000 (such as Bangladesh or Senegal) is 944, compared with 180 in countries with a per capita GDP above \$14,000.¹⁵ Research has also shown that income growth can initially increase the death toll from environmental disasters.¹⁶ Thus poor countries whose per capita incomes will rise to around \$5,000 in the next few decades will reach their peak vulnerability to environmental disasters at a time when such disasters become more common.

One of the reasons low-income countries are more vulnerable to environmental disasters is that they lack complete credit and insurance markets. Few people have private insurance for housing or crop loss, and households that lack such insurance would not have the money to rebuild or resettle after a disaster. Another option could be to borrow funds to get back on their feet after a disaster, but poorly functioning credit markets make that hard—or just very expensive—to do. International aid can help, but because of either lack of funding or the challenges inherent in providing aid in countries with limited institutional capacity and infrastructure to begin with, the donor community can't always respond proportionally to the human and physical toll.¹⁷

Air Pollution

Climate change may lead to higher concentrations of several air pollutants, including ozone and particulate matter. Elsewhere in this issue, Allison Larr and Matthew Neidell discuss climate change's direct effects on ozone and thus on children's health. Here we focus on the potential health effects of particulate matter, which may increase as wildfires and dust storms become more common in the developing world. First, as we've said, greater variability in precipitation patterns may increase drought in some regions in Asia and in eastern and southern Africa, making wildfires more common and more difficult to control.¹⁸ Air pollution from forest fires can increase infant mortality and reduce general health, and the effects are much worse when the exposure occurs in the womb.¹⁹ Studies of how wildfires affect adult health have found significant changes in prime-aged adults' ability to perform everyday activities, such as

carrying heavy objects. Given that children are generally more sensitive to air pollution than adults are, we suspect that those health and productivity effects may extend to children as well.

Droughts can also create more air pollution through dust storms. Recent studies have shown that droughts in Africa and other arid regions can increase the amount of dust over large areas.²⁰ Dust storms and wildfires produce inhalable, coarse particles and a smaller share of fine particles, both of which are associated with increased mortality from heart disease and respiratory disease, especially among infants and the elderly.²¹

Other Potential Health Pathways

Climate change may affect health in developing countries through other pathways, such as previously unknown diseases and conditions that today are more common in the developed world. For example, rapid shifts in temperature and precipitation patterns can destabilize animal populations and lead to the emergence of new diseases, which is what happened with hantavirus—which causes dangerous pulmonary disease in humans—in the US Southwest after an El Niño event in the early 1990s.²² However, predictions about emerging diseases are uncertain, and sound empirical evidence is scarce.²³ Nevertheless, the developing world, whose health systems are seldom able to fully manage even well-known and curable diseases in children, may find it particularly hard to cope with new infectious diseases. The 2014 Ebola outbreak in West Africa is a recent example of how the spread of pathogens can quickly overwhelm health systems.

Climate change may increase the incidence of diseases that are not currently big

health problems in the developing world, such as melanoma, a type of skin cancer. Experimental studies on mice suggest that high temperatures exacerbate ultraviolet rays' impact on skin cancer.²⁴ Applying to humans the effects observed in mice (though doing so overlooks many biological and behavioral differences), one of these studies calculates that skin cancer could become 21 percent more common if global temperatures rise by 2°C, and 46 percent more common with a temperature increase of 4°C. Because melanoma is underreported in developing countries, its incidence is hard to assess. However, the International Agency for Research on Cancer suggests that melanoma is becoming more common in Africa and Southeast Asia.²⁵

Income Loss, Food Insecurity, and Malnutrition

Several other articles in this issue review the link between climate change and agriculture. We'll take those articles as a starting point to discuss how agricultural losses—caused by warmer temperatures and increases in weather variability—could affect children's development.

According to the World Bank, 75 percent of the world's poor live in rural areas and depend on farming for a living either directly or indirectly. Lower yields of subsistence crops, reduced incomes from cash crops, and higher food prices would likely reduce the incomes of many of the world's rural poor. To make up for those income losses, families might borrow money or rely on government safety net programs. But developing countries, which tend to have imperfect credit markets and fewer formal social safety net programs, may be particularly sensitive to climate shocks: families often rely on

informal insurance markets within their villages, and a climate shock that affects an entire region may cause those informal markets to collapse. In that case, families couldn't borrow money to make up for their income losses, making it harder to put food on the table.²⁶ Moreover, if climate shocks raise food prices or reduce urban wages (as we discuss later), children in nonagricultural families, too, may have less to eat.

Reduced income and lower purchasing power for food can affect children's and, ultimately, adults' health.²⁷ Credible empirical evidence supports the fetal origins hypothesis, whereby chronic degenerative diseases, as well as other health problems, can be traced back to mothers' nutrition during pregnancy. Similarly, malnutrition in the early stages of life can contribute to stunting, which is an indicator of adult health; it can also increase vulnerability to other health shocks. For example, recent research shows that Indian children tend to be tall, even taller than African children. But because parents invest less in the nutrition and health of subsequent children, Indian children born second tend to be much shorter than firstborns; children born third are even shorter, and so forth.²⁸ Similarly, we can understand how income affects children's nutritional status by looking at experimental studies that test whether giving parents cash affects their children's health. Such studies find mixed effects on cumulative child health as measured by height: cash transfers led to gains in children's growth in Mexico, Nicaragua, Ecuador, and Colombia but not in Brazil or Honduras. We need more research to understand why cash made a difference in some areas and not in others.²⁹

When productivity losses make poor families even poorer, diminished nutrition

isn't the only threat to children's health. Greater poverty may also make it harder for households to deal with relatively common health shocks: for example, having a child with a cleft palate can lead to enormous challenges for a poor family, even though cleft palate is a relatively common problem that is easily corrected in rich countries.³⁰

Even short-term productivity losses can cause substantial health problems through moderate or chronic malnutrition. But extreme weather such as typhoons, hurricanes, and droughts can be disastrous, wiping out entire crops and, possibly, infrastructure such as housing, health centers, and schools. Following in the footsteps of Nobel Prize-winning economist Amartya Sen, who developed most of today's economic theories of the effects of famine, many researchers have documented how natural disasters and famine affect people in developing countries.³¹

Natural disasters have long-lasting effects on survivor's health.

Environmental disasters kill people directly, of course: one study of hurricanes estimated that from 1970 to 2002, they killed 2.47 million people and injured another 2.7 million.³² Deaths can occur even after a disaster, as health services grow weaker, sanitation and other infrastructure suffers damage, and disease becomes endemic.³³

Natural disasters also have long-lasting effects on survivors' health. Earlier, we discussed how reduced nutrition, both in the womb and early in life, can damage health even into adulthood. Massive food

shortages during famine have even worse effects. For example, if the 1959–61 famine had never occurred, children born in 1959 in China would have been as much as three centimeters (about 1.2 inches) taller.³⁴

Finally, a decline in health caused by reduced access to food that leads to malnutrition could exacerbate the other impacts of climate change. Children who are already in poor health may have a harder time fighting off infections even as climate change makes waterborne diseases more common. Sick children may also miss more days of school, and inadequate education can reduce long-run employability and wages.

In short, climate change will likely impair child nutrition and health, offsetting the gains that children in developing countries have made in recent decades.

Education and Human Capital

We've already touched on education, but the topic is important enough to merit its own discussion. Climate change may affect education through at least four mechanisms: shocks that affect income and wages, poor nutrition as a result of income losses, effects of natural disasters, and direct effects of climate changes (for example, pollution or heat).

First, reduced income might lower school enrollment and attendance because families might not be able to afford school fees or because children have to work to help provide for the family. Evaluations of programs that gave additional income to families in developing countries or directly helped them with school fees show that income changes have large positive effects on school attendance.³⁵ On the other hand, recent research shows that excessive rain

can improve school attendance by reducing wages, thus making jobs scarce for women and children.³⁶ Thus climate shocks, which affect both the labor market and wages at the same time, may have different effects than does loss of income alone. How climate change affects education may depend on the interplay between income losses to families and changes to children's wages.

Second, health declines caused by income loss—both in the womb and in early childhood—may affect children's school attendance. Taking birth weight as an indicator of mothers' nutrition and health, US children whose birth weight is low (defined as less than 2,500 grams, or about 5.5 pounds) are much less likely later in life to pass high-school-equivalency exams and to be employed.³⁷ Mothers' caloric intake is important, but so is their overall nutritional status during pregnancy: In Tanzania, for example, when iodine deficiency disorders were reduced by an intensive iodine supplementation program for mothers, children achieved 0.36 to 0.56 additional years of schooling.³⁸ Similarly, weather in early childhood has had long-run effects on schooling, particularly for girls.³⁹ For example, Indonesian girls whose childhoods are enriched by more rain—and thus higher yields of crops—are not only healthier and taller; they also attain more schooling. In contrast, there is no effect for boys, perhaps because when families face a loss, they adjust by reducing their investments in girls rather than boys.⁴⁰ Climate change, then, could affect girls and boys differently, thereby reducing the gains made in recent years toward closing the gender gap in education.

Third, extreme weather could cause famine and/or large-scale displacement, with massive impacts on human capital accumulation.

For example, men who were exposed to the 1959–61 famine in China during their mothers' pregnancies were 9 percent more likely to be illiterate; exposed women were 6 percent more likely to be illiterate. Those increases in illiteracy eventually translated to higher rates of unemployment for both men and women, as well as to changes in marital patterns.⁴¹ Similarly, people exposed to the 1941–42 famine in Greece were less literate and attained fewer years of education.⁴²

Schooling may also be affected when extreme weather damages infrastructure. For example, during the Yemeni airlift in 1949—when drought and prejudice in Yemen led to a campaign to fly 50,000 Jewish people to Israel—children (especially girls) who were placed in better physical environments (for example, with better sanitation, running water, and electricity) did better in school.⁴³ Another real worry is that an increase in extreme events could mean that more children's parents die. Among other harmful effects on children, a parent's death may also impede schooling: for example, children whose mothers die tend to attain fewer years of schooling and have less money for their education.⁴⁴

Finally, environmental changes could directly affect whether children go to school at all and whether they learn while there. Heat has been associated with lower economic productivity in adults and could presumably also affect children's ability to learn.⁴⁵ Moreover, increased levels of pollution are associated with both lower school attendance and lower test scores.⁴⁶

Displacement and Migration

Climate change may affect where people live. At the extreme, entire families and communities could be displaced by extreme

weather and massive crop losses. Displaced families are often put into makeshift camps with conditions that can be similar to those of refugee camps. That sort of displacement could exacerbate climate change's effects on food supply, access to health care, sanitation, and education.

On the other hand, permanent migration might reduce the adverse effects of a natural disaster: for example, massive migration may have mitigated the environmental catastrophe from land degradation during the American Dust Bowl of the 1930s.⁴⁷ However, the evidence from developing countries is less hopeful: Indonesia, for example, has seen little permanent migration to urban areas after natural disasters.⁴⁸ Similarly, in Bangladesh, there is little evidence of migration in response to massive flooding, suggesting that the lack of immediate funds coupled with an inability to borrow money to finance resettlement could make it hard for people to move away from disaster areas to places with greater employment opportunities.⁴⁹ Moreover, even if people do try to move, cities may not be able to absorb large numbers of migrants.

Research on a wide variety of developing countries confirms that households are more likely to migrate in response to temporary temperature and rainfall changes that are large enough to affect crops than they are in response to large-scale natural disasters.⁵⁰ Though migration may help mitigate income losses from climate shocks, it's unclear whether overall family income would fall or rise. On one hand, we know that there are barriers to migration and that overcoming those barriers could lead to better employment opportunities. Recent evidence also suggests that rainfall-induced migration leads to better work outcomes and

mitigates long-run health effects.⁵¹ However, others have argued that the urban sector of the economy could also suffer if a high share of industry is linked to processing agricultural goods, if a high proportion of jobs are in industries that rely on weather (for example, tourism), or if heat does indeed lower productivity.⁵² In this case, migration might not be a cure for income loss.

Households are more likely to migrate in response to temporary temperature and rainfall changes than they are in response to large-scale natural disasters.

In terms of children specifically, the effects would depend on whether children move to cities with their parents or are left behind with other family members. If entire families migrate, the effects will depend on their financial situation. Further, if sudden increases in urban populations aren't matched by increases in social services, children's health and education may suffer. For example, sharp increases in urbanization in South Africa led to overly congested schools.⁵³ How would school overcrowding affect learning? Some evidence suggests that large class sizes impede learning, but other evidence from the developing world suggests that changes in class size don't matter much, perhaps because classes are too large already.⁵⁴

For children who are left behind in rural areas, the evidence is mixed. Several studies have found that migration leads to better schooling outcomes for children who are left

behind.⁵⁵ On the other hand, another study, which compared families that won a lottery for a visa with families that did not, found no large, systematic effect on the health and education of children left behind. (However, the study's sample was relatively small, making it harder to measure impacts.)⁵⁶ Other research finds more nuance: for example, among people left behind in Mexico when family members migrate to the United States, infant mortality fell and birth weight increased, but investments in more continual, preventive health care for children fell.⁵⁷ Further research may be able to reconcile these conflicting studies and help us better understand the channels through which migration affects children.

Psychological Impacts

We know a good bit about how income shocks and climate disasters affect children's physical health, but less about the effects on their mental wellbeing. And we can't discuss the effects of climate change on children without discussing mental health. Mental health is important not only in its own right, but it can also affect other forms of human capital accumulation (for example, schooling) that we care about. Again, the impacts may vary depending on the nature and extent of the climate shock that a household faces, as well as the child's age.

Increased poverty from climate change could directly harm a child's mental wellbeing, with particularly detrimental effects if natural disasters also increase. For example, numerous studies have shown that children exposed to more natural disasters are more likely to suffer posttraumatic stress.⁵⁸ Moreover, among adults in developing countries, economic distress is strongly correlated with psychological distress and

reduced decision-making ability.⁵⁹ Having psychologically compromised parents could harm a child's psychological development even further.

Recent research suggests that these effects can be long lasting. In Ghana, for instance, low cocoa prices in the year of a child's birth and in early childhood are correlated with higher incidence of severe mental distress once the children become adults; the channels driving that result may include reduced maternal health, worse decision making by stressed-out parents, and reduced physical health among children.⁶⁰ At the extreme end of the spectrum, a number of studies have shown that exposure to famine and war during pregnancy is associated with higher levels of antisocial behaviors and schizophrenia in adulthood.⁶¹

Violence and Children

Climate change may exacerbate domestic violence, raise crime rates, and increase the probability of conflict and war.

Household violence may increase because greater heat can spur aggression. Economic stress from climate shocks could also lead to increased violence; for example, rainfall shocks contribute to domestic violence and deaths during disputes over dowries in India, and job loss among US men is correlated with child abuse.⁶² Extreme weather and natural disasters may also exacerbate household violence: in the United States, for example, hurricanes have been linked to a rise in inflicted traumatic brain injury in young children.⁶³ In addition, maternal stress from violence during pregnancy may lead to lower birth weight.⁶⁴

Crime may be another product of climate change. Both low rainfall and high

temperatures have been associated with increases in property crimes.⁶⁵ The ultimate effect on children will depend on the extent to which they are affected by crimes committed against the family (for example, loss of property or murder of a parent).

Bad economic times are also linked to an increase in child transactional sex—that is, the exchange of sex for money, goods, or services. Lack of data makes it extremely difficult to study this topic, but recent research has shown that among adult women, income losses increase the incidence of transactional sex and of risky sexual behaviors that men are willing to pay more for, whereas rising income reduces risky sexual activity in general among adolescent girls.⁶⁶ Moreover, rainfall shocks have been shown to increase the prevalence of HIV, which suggests an increase in higher-risk sexual behaviors.⁶⁷

Finally, climate change may lead to greater civil conflict. Richard Akresh discusses climate change and conflict in detail elsewhere in this issue. Here we will note only that war could greatly exacerbate all of the effects on children that we've discussed so far by further reducing food security, increasing the incidence of family loss, driving mass displacement, interrupting school, and so on.

Mitigating Policies

In short, climate change can harm the growth and development of children in low-income countries through channels that are different from those present in the developed world. (See the article by Graff-Zivin and Shrader in this issue for more on how climate change can affect children in developed countries.) Of course, the extent of the problem will depend greatly on families' ability to engage in mitigating behaviors—that is, to undertake

steps that would reduce their exposure to climate change—and on whether countries implement policies that help lessen the burdens families will face. But we don't know whether developing countries will be able to adapt in those ways. According to the World Bank, if developing countries aren't able to adapt to climate change, "certain climate scenarios may still cause regional disasters even if global production is not affected."⁶⁸

The extent of the problem will depend greatly on families' ability to engage in mitigating behaviors and on whether countries implement policies that help lessen the burdens families will face.

Part of the challenge comes from the fact that developing countries have underdeveloped formal markets, weaker institutions, inadequate physical infrastructure, and lower incomes than do developed countries. For example, air conditioning can reduce exposure to very hot days that harm infant health. But globally, 1.2 billion households lack electricity. Even those

that have electricity may face spotty service—particularly on hot days—and greater household spending on electricity may come at the cost of food and health-care spending on kids. Similarly, migration to urban areas may help compensate for rural job loss, but it's unclear whether the urban sector can absorb the influx. And migration itself may have adverse effects on children.

Other than the most obvious way to slow down and reduce the severity of climate change worldwide—reducing our carbon output—it is well worth our collective efforts to think about how to design and fund policies that can shield children from climate change's effects—particularly children in developing nations, who may be the most vulnerable. Such policies might include developing new technologies to expand electrification, inventing more-weather-resistant crops, improving access to clean water, increasing foreign aid during disasters, and offering more assistance to help poor countries expand their safety net programs. Investing in ways to help families adjust to the new situations and challenges arising from climate change may have long-run benefits. Not only will those investments affect children today, they may have long-lasting effects on human capital accumulation and, ultimately, on economic growth.

ENDNOTES

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