

Impacts of Natural Disasters on Children

Carolyn Kousky

Summary

We can expect climate change to alter the frequency, magnitude, timing, and location of many natural hazards. For example, heat waves are likely to become more frequent, and heavy downpours and flooding more common and more intense. Hurricanes will likely grow more dangerous, rising sea levels will mean more coastal flooding, and more-frequent and more-intense droughts will produce more wildfires. Children, particularly the poor and those in developing countries, are at risk.

Carolyn Kousky considers three ways that natural disasters may harm children disproportionately, often with long-lasting effects. First, disasters can damage children's physical health. Children may be injured or killed, but they may also suffer from such things as malnutrition caused by disruptions in food supply or diarrheal illness caused by contaminated water. Moreover, disasters can cut off access to medical care, even for non-disaster-related illnesses. Second, disasters can cause mental health problems. Not only are disasters themselves stressful and frightening, but children can suffer psychological harm from the damage to their homes and possessions; from migration; from the grief of losing loved ones; from seeing parents or caregivers undergo stress; from neglect and abuse; and from breakdowns in social networks, neighborhoods, and local economies. Third, disasters can interrupt children's education by displacing families, destroying schools, and pushing children into the labor force to help their families make ends meet in straitened times.

How can we mitigate the dangers to children even as disasters become more powerful and more frequent? For one thing, we can prepare for disasters before they strike, for example, by strengthening school buildings and houses. Kousky also describes actions that have been proven to help children after a disaster, such as quickly reuniting them with parents and caregivers. Finally, a range of policies not designed for disasters can nonetheless help mitigate the harm disasters cause children and their families. In fact, Kousky writes, using existing safety net programs may be easier, faster, and more effective than creating entirely new programs after a disaster occurs.

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Carolyn Kousky is a fellow at Resources for the Future.

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Scientists predict that as the climate warms, certain weather-related extreme events may increase in frequency or magnitude. In some regions, for example, heat waves may become more common or hurricanes more intense. Scholarship on natural disasters goes back to the 1960s, and recent concern about how climate change will affect disasters has led more researchers to study the topic. Only a small subset of studies, however, have focused on how natural disasters affect children. Yet, on average, roughly half the people affected by disasters are children, and Save the Children estimates that during the next decade, up to 175 million children will be affected by weather-related disasters connected to climate change.¹ Compared with adults, children may be more vulnerable to disasters or have different needs afterward, warranting special attention.

In this review, I seek to answer several questions.

- Do disasters have a disproportional effect on children?
- If so, what are those effects?
- How long do the effects last?
- What can be done to mitigate the harm disasters do?

Research that examines those questions comes largely, although not exclusively, from the fields of economics, public health, and psychiatry.

A few things to note at the outset: I focus on empirical findings, not theory. I limit the scope to weather-related disasters because they are the disasters most likely to be altered by climate change. Although studies of

earthquakes or chemical spills, for example, might hold lessons about the impacts of weather-related disasters, I don't include them here. I also focus on sudden-onset disasters, such as severe storms, and not long-duration events, such as droughts, or annual climatological conditions, such as monsoon seasons. Finally, some places experience chronic disaster conditions, such as annual flooding; the effects of such repeated disasters could be quite different, thanks to the adaptation that has occurred in response, and they, too, are not included here. That said, to identify lessons for improving response in areas likely to see more disasters as the climate warms, researchers could usefully examine the adaptations people have undertaken in areas that experience frequent disasters.

Research on the subject of disasters and children is limited almost exclusively to three impacts, which form my framework for organizing this article: (1) physical health, (2) mental health, and (3) educational attainment and achievement. The studies I review identify, for the most part, correlations—that is, associations between a disaster and a health or educational outcome but not the underlying causes of those associations. Identifying the mechanisms that drive relationships should be a research priority, because it would help guide disaster response policy. Many plausible hypotheses have been put forward with some degree of supporting evidence, and I discuss those. It's also worth noting that many studies examine small samples of children, focusing on a particular disaster and geographic and cultural context, meaning that their findings might not apply elsewhere.

Looking across the research, it's clear that natural disasters can harm children's health,

both physical and mental, as well as their education. The effects are often small, but they can be much greater for the severest disasters. Though many impacts seem to subside in the short to medium run, larger effects that occur at critical points in a child's development can persist for a lifetime or even be passed to the next generation. This is particularly true for severe damage to health that occurs in the womb or early childhood. Negative effects are generally greater for the poor and in developing countries. And in many developing countries, children and adolescents constitute a much larger share of the population than they do in developed countries. We need more research on the impact on children not of disasters themselves but of living in areas where disaster risk is high.

Sadly, but also optimistically, many impacts are preventable in the sense that we know ways to lessen the harm disasters do to children. The barriers to more widespread adoption of such practices include different priorities, lack of funding, and lack of political will. Tellingly, general improvements in income and development, along with nondisaster safety-net programs, may be among the best ways to protect children in times of disaster. In addition, there is consensus about what to do after a disaster to protect children, such as quickly reuniting families, providing shelter, and maintaining supplies of clean water. Governments, international agencies, and nonprofit groups continue to work on ensuring that those practices are followed around the world.

How Disasters Affect Children

Scientists increasingly agree that climate change will alter the pattern of many extreme weather events. Heat waves are likely to become more frequent, and heavy

downpours more common and more intense. Hurricanes will likely grow stronger, and more-frequent and more-intense droughts will produce more wildfires. Extreme weather events are the disasters most likely to change in response to elevated levels of greenhouse gases, and they are responsible for the majority of disaster losses. The annual average global cost of weather-related disasters ranges from \$90 billion to \$130 billion.² Those figures likely underestimate the full costs of disasters, however. Many types of disaster damage are underreported or not measured. For instance, many nonmarket impacts, such as loss of family heirlooms or environmental degradation, are rarely measured, and some, such as losses from interrupted business, are not fully captured by estimates.

Changes in extremes won't be uniform around the globe.³ Spatial variation is important for estimating disasters' effects because damage from a disaster is a function not only of the event itself but also of where and how societies build—and the resources available to recover and respond. Those things vary dramatically both across and within countries. On a GDP basis, developing countries sustain greater damage from natural disasters. Developing countries also experience much of the death toll from disasters, although across the globe, fatalities have generally decreased over time, due partly to early warning systems and improved construction techniques.

Impact Pathways

Children may be more vulnerable after a disaster. They rely on caregivers, who may be unprepared or overwhelmed. Very young children may not be able to communicate necessary information if they become separated from their caregivers. Some children require special care, special

nutrition, and special supplies. Children's physiology makes them more vulnerable than adults to certain health impacts. For example, children breathe more air per pound of body weight than adults do, and their bodies contain less fluid, making them more susceptible to dehydration. They can also be at a point in their development where health problems today can have long-term consequences. They may have greater trouble processing emotional trauma. For all those reasons, a natural disaster may affect a child quite differently from the way it affects an adult. Indeed, it may affect children quite differently depending on their ages.

Disasters can affect children through many interrelated pathways. First, they cause direct physical harm. A disaster can damage schools and health-care facilities, thus interrupting education and reducing the availability of medical care. Disasters can destroy a household's assets. Children or family members can be injured or killed, or they can contract illnesses from postdisaster conditions. Families may lose income either because employed members of the household lose their jobs due to injury or macroeconomic conditions or because working members of the household are killed. In many developing-country contexts, loss of income—combined with loss of assets and higher expenditures for disaster repairs—could cause a household to send children into the labor force. Families may also have less money to spend on medical care, food, or school supplies—all with negative effects on children. Finally, a disaster can cause children stress and trauma, which can be exacerbated by witnessing their parents' stress. For children, such a situation can lead to mental health problems that can in turn affect physical health and schooling. Stress can also affect the fetuses of pregnant women.

Children who become separated from their parents or primary caregivers during

or after a disaster represent another cause for concern, especially on the part of nongovernmental organizations. Such children may be abused, exploited, and neglected. Few researchers have examined those impacts, but I return to them later when I discuss best practices for children after a disaster.

A disaster's effects are mediated by the individual characteristics of children, families, communities, countries, and the disaster itself. Different children in different circumstances will not respond the same way to a particular type of disaster. Impacts on children also vary across countries due to socioeconomic conditions, local institutions, and political realities that influence disaster response and recovery. All these things can make it extremely difficult to identify clear causal linkages, even if we see correlations between a disaster and changes in particular measures of child wellbeing, such as time spent in school or health outcomes.

Though little research has examined whether living in an area at higher risk of a disaster has any effect on children, some studies have explored how living with risk can affect household income and consumption choices. For example, households in risky areas may be more likely to grow crops low in risk but also low in returns, such as a variety that tolerates drought but produces lower yields. On the other hand, households might choose to live in riskier areas that provide other benefits for children, such as proximity to jobs or education, though I don't know of any research on those types of trade-offs and how they might affect children.

Much economic research on disasters focuses on how they reduce the funds a household has available to spend. Such research is

related to a subfield of economics called *income and consumption smoothing*, which studies how households can maintain a constant level of income and/or spending in the face of unexpected events. In most developed countries, households achieve smoothing through insurance and access to credit. Insurance and credit markets may not fully function in many developing countries or for certain populations. Other mechanisms could take their place, however, such as liquidating assets, drawing down savings, or reciprocal lending or gift giving. After a disaster, the extent to which households can make use of those mechanisms varies.

If households can't borrow or save, then they must finance all of their expenditures at a given point in time with income from that period. If a disaster reduces their income or requires greater expenditures, then unless they have other sources of funds to cover the difference, households will face trade-offs that could involve reducing consumption of goods that are important for children or using children to help increase income.⁴ If, after a disaster, households reduce their investments in children's health and education—particularly at critical periods in children's development—the effects can persist into adulthood and even to the next generation.⁵ The sections that follow review research that tests that proposition in relation to natural disasters, but the proposition has also been examined in other contexts, providing further evidence that strategies to smooth income can involve children.

Common Methodological Issues

As I've said, most scholarship about children and disasters focuses on physical health, mental health, and education. It's worth briefly reviewing some of the challenges in studying those relationships. Because

of limited data, most studies are able to estimate only short-run impacts, although a few draw on data sets that follow the same people over many years to examine long-run effects. Studies are also generally able to identify only correlations and cannot uncover the underlying mechanisms at work. Estimated impacts usually include not only the effects of the disaster but also any actions taken in response. For instance, in regard to how a flood affects health, the estimated effect could include both the immediate reduction in the availability of clean drinking water and whether households begin boiling or filtering water before using it. Finally, it's clear that the impact of disasters varies along many dimensions; researchers have identified some of that variation, but it's likely there's more that researchers cannot observe.

The population samples used in some of the studies also have problems. Many studies use only small samples over a short time—which can make it hard to identify effects—and their findings should not necessarily be extrapolated to broader populations. Studies may use data collected for other purposes, meaning that the sample is not representative of the affected group. In addition, most studies look at individual localized disasters, raising questions about whether the findings can be extended to other places and other types of disasters. Only a handful of studies have information about their sample from before the disaster. Many mental health studies, for example, can't account for how predisaster mental health affects impacts after a disaster, although the few that are able to do so show that it matters.

Most studies compare people who experience a disaster with a control group that didn't experience it, because the control group is distant in either space or time. Researchers

must ensure that control groups could plausibly be assumed to behave in a disaster the same way that the populations actually affected did. One reason that assumption could be invalid is that households might sort themselves according to the risk of disasters. That is, groups that live in low-risk areas may not be similar to groups that live in high-risk areas, and thus children affected by disasters might have had different educational or health outcomes compared with children living in safer areas even if a disaster hadn't occurred. Researchers use various statistical methods to try to eliminate the influence of sorting, but they may not be able to fully do so. Some studies are able to demonstrate that people who experience a disaster and those who don't are similar when it comes to variables the researcher can measure, which lends some assurance that the findings are valid, but variables that the researcher did not observe might make the two groups different.

Most studies I review are based on survey data. Some people who are present in the first rounds of the survey drop out in later rounds, often because they moved after the disaster. Results could be biased if the people who leave the study by moving have characteristics that are correlated with the variable the researchers are examining. To provide some assurance that any bias from attrition is small, most studies try to minimize the number of people leaving the sample, identify why any attrition occurred, and compare the characteristics of those who leave with those who stay in the sample.

Finally, a study may not have information on variables that influence the outcome being examined—such as years of schooling—but that also influence whether a child is exposed to a disaster. That situation prevents

researchers from being able to identify which effects can be attributed directly to the disaster. Scholars use several approaches to reduce the problem, with varying degrees of success. For example, some health studies compare outcomes among siblings because siblings presumably live in the same household environment and are subject to the same parental decisions, thereby preventing those variables from biasing the estimation. But there may still be differences between siblings that the researcher doesn't know about; for example, one sibling may love school and another may hate it, influencing the family's choice of whether to send a child into the labor force after a disaster.

Effects on Physical Health

Following major disasters, children often suffer from a range of health problems. Natural disasters can affect children's health through several channels. First, a disaster can reduce intake of calories and of essential vitamins and nutrients because a family loses food crops or income to spend on food. Second, a disaster can destroy health infrastructure. This can mean that illnesses or injuries caused by the disaster are difficult to treat and become worse, but it also means that non-disaster-related health problems may go untreated. For example, after Hurricane Katrina struck the US Gulf Coast in 2005, a survey of those living in housing subsidized by the Federal Emergency Management Agency (FEMA) found that access to medical care was fragmented or nonexistent.⁶ For instance, many children of surveyed families were unable to get asthma medications, and half of the children who had a personal doctor before the storm didn't have one afterward. In another example from Katrina, both during the storm and for days afterward, University Hospital in

New Orleans had to triage care for more than 20 infants in its neonatal intensive care unit without adequate power, supplies, or communication with the outside world.⁷ Supplies had to be rationed and decisions made about prioritizing care—all while staff worked without sufficient sanitation, food, or power and while the babies were separated from their parents.

Finally, unhygienic conditions and lack of safe drinking water can cause infectious diseases to spread. During and after floods in Bangladesh, for example, cases of diarrhea, cholera, and other intestinal diseases increased due to lack of safe drinking water.⁸ Diarrheal illness can lead to dehydration and malnourishment. Because of their small size, babies and very young children are especially susceptible, and dehydration can become life threatening. Moreover, those pathways can interact; in other words, poor nutrition can exacerbate illness.

Children's health may be more vulnerable in a disaster for a number of biophysical reasons. Their respiratory rates are higher, their immune systems are less mature, and many of their systems are still undergoing rapid growth and development. It has been documented that fetuses in the womb and very young children are particularly susceptible to severer or longer-term impacts from negative health shocks.

This section first reviews studies that focus on what happens when a disaster occurs while a fetus is in the womb; it then turns to disasters' effects on children.

Exposure in the Womb

Studies of exposure during pregnancy generally find that a disaster can worsen a range of birth outcomes, although they don't always agree about which outcomes are most

affected and to what degree. We also know that the time of exposure during pregnancy influences the effects, although researchers disagree about which stage of pregnancy is most sensitive. No studies have pinned down the mechanisms behind those associations, though maternal stress may play a strong role. In developing countries in particular, decreased nutrition and poor sanitation are also likely factors. Finally, if they're severe enough, shocks experienced in the womb may have long-term consequences.

Several researchers have focused on disasters in the United States. A study of 300 pregnant women affected by Hurricane Katrina found that those whose experience of the storm was severe or more intense were more than three times as likely to have low-birth-weight babies and more than twice as likely to have preterm births.⁹ Most women in the study were early in their pregnancies or became pregnant shortly after the hurricane; we might see different results among women who experienced the storm in late pregnancy.

A careful study of births in Texas from 1996 to 2008 found somewhat different effects among women who experienced hurricanes.¹⁰ The study compared pregnant women who lived within 30 kilometers (18.6 miles) of a hurricane's path during their first or third trimester with pregnant women who lived within 100 kilometers (62.1 miles). The researchers found that living closer to a hurricane increased the probability of labor or delivery complications by 30 percent, and the probability of abnormal conditions—such as the baby's requiring a ventilator for more than 30 minutes—by 60 percent. By looking at variations across siblings, the authors made sure that the differences they saw didn't stem from differences in the types of families living closer or farther from storms.

During the study period, only a very small number of people in Texas experienced direct health effects from hurricanes; the impact on pregnant women, according to the researchers, likely resulted primarily from stress. (They were able to rule out certain other explanations, such as worse medical care or increases in smoking.) Unlike the authors of the Katrina study, they found no impact on birth weight or gestation period.

Turning to another kind of disaster, a study that examined data on more than 37 million US births from 1972 to 1988 found that exposure to heat waves during pregnancy, especially during the second and third trimesters, led to lower birth weight.¹¹ Linking that finding to predictions of temperature change by the end of this century, the authors estimate that the probability of having a low-birth-weight baby (one that weighs less than 2,500 grams, or 5.5 pounds) will increase by 5.9 percent for whites and 5 percent for blacks; of course, those estimates don't account for adaptation that might take place in response to climate change. Heat stress may also be related to preterm birth.¹²

Studies of births in developed countries tend to suggest that stress can affect birth outcomes; in developing countries, stress may be compounded by deteriorating health conditions following a disaster. One study examining the 1997–98 El Niño, which caused excess rainfall in Peru, found that children born during or immediately following El Niño in homes that were likely to have been flooded (based on soil saturation data) were more likely to experience inadequate growth, though birth and death rates were unchanged.¹³ The authors couldn't test mechanisms behind the association between flooding and children's growth, but

flooded areas experienced food shortages, lack of adequate health care, lack of clean water, increases in malaria and diarrheal diseases, and loss of crops and livestock, which led to reduced incomes. The Peruvian government adopted policies in advance of El Niño to try to minimize harm, and the authors note that health outcomes and/or mortality might have been worse without them.

Though I don't review them here, studies that look at the impact of fetal exposure to other types of disasters during pregnancy, such as wars or earthquakes, find that such events are also associated with negative birth outcomes. A word of caution: Many studies of disasters use birth weight as an indicator of health, usually because such data is widely available. But birth weight may not be the most comprehensive or sensitive measure of children's health, and its use may hide other impacts.¹⁴

Childhood Exposure

Most studies of how disasters affect health during childhood focus on malnourishment in developing countries. They generally examine one or more of three indicators of children's health: stunting (failure to grow adequately in height, an indication of malnourishment), measured by height-for-age z-scores; being underweight, measured by weight-for-age scores; and wasting, measured by weight-for-height scores. Stunting, being underweight, and wasting could be caused by shifts in consumption or decreases in food supply, among other things.

Before I review studies that focus on malnourishment, I should note two other important findings related to children's health after a disaster. First, in very extreme disasters, children may be more likely than

adults to be injured or killed. For example, children in Indonesia were less likely than adults to survive the 2004 Indian Ocean tsunami. It may be that greater physical strength increases the chances of survival; children were less likely to die when more prime-age men lived in the household or when households were headed by a prime-age male fisherman.¹⁵

Second, children could be at higher risk for a range of diseases, some of them involving malnourishment and some not. For example, after the 2004 tsunami, a Red Cross emergency relief hospital in Banda Aceh, Indonesia, found that children were more likely than adults to suffer from acute diseases, particularly upper respiratory and gastrointestinal infections.¹⁶ Poor sanitation or disruption of medical care could be behind those increases in disease.

Researchers have observed poorer nutrition among children in many countries after many types of disasters. For example, in Bangladesh, among a sample of more than 4,400 children from birth to five years old, those older than two who had been exposed to an extreme flood in 1998 had lower height-for-age z-scores (the measure of stunting) than did children who hadn't been affected; moreover, the children in the sample didn't grow faster after the flood to make up the loss.¹⁷ In Ivory Coast, among a sample of 1,600 households, extreme rainfall in 1986 increased by 3 to 4 percent the proportion of children from birth to 10 years old who were malnourished.¹⁸ In Nicaragua—among a sample of 2,764 households, of which 396 were affected by 1998's category 5 Hurricane Mitch—children from birth to four years old who had experienced the storm were four times as likely to be undernourished.¹⁹ Finally, in rural India, a survey-based study

found that children of households affected by floods were more likely to be stunted and underweight.²⁰ The greatest impact was on children younger than one year old, suggesting that the first year of life is a sensitive period for disaster exposure. The mechanism for the effects isn't clear, though it could have been lack of safe drinking water.

Long-Term Consequences

A good deal of evidence from outside the field of disaster studies documents long-term harm to health from malnourishment in the womb and in early childhood. Malnourishment during those sensitive periods has been linked to higher risk of illness and death among infants; and, among adults, to shorter stature, less strength, less work capacity, high blood pressure, and high cholesterol.²¹ Many studies have also linked health shocks early in life to education and labor market outcomes. For example, early-life health shocks are associated with fewer years of schooling, reduced economic activity, delayed motor development, lower IQ, more behavioral problems, and lower test scores.²² Evidence is also accumulating to show that the effects of early-life health shocks can persist for generations. Women who were undernourished as children have lower-birth-weight children themselves.²³ Not only did women in Tanzania exposed to a severe flood before they were 18 years of age suffer long-lasting negative effects, but their children had lower height-for-age z-scores. (This wasn't the case among children of men exposed to the flood.)²⁴ Not all impacts may be so persistent, however. For example, stunting in very young children can likely be reversed to at least some degree if a child's environment greatly improves—for example, if the child's level of nutrition increases dramatically.²⁵

Effects on Mental Health

Natural disasters can cause myriad emotionally harmful circumstances for children. Not only is the event itself stressful and frightening, but after it passes, stress can be incurred from the damage to children's homes and possessions, from migration, and from breakdowns in social networks, neighborhoods, and local economies. When loved ones are missing or injured, the grief can be profound, and children may have a harder time processing and coping with such losses. Children may become upset when their caregivers' ability to protect them declines or when they see caregivers experience fear and stress. Many studies have found that when parents have high levels of postdisaster symptoms, their children have high levels as well.

The studies I cover here generally focus on one or both of two things: the prevalence of mental health impacts (researchers have lately been very interested in the symptoms of posttraumatic stress disorder, or PTSD) and whether any observable phenomena predict the likelihood of experiencing mental health symptoms. A few comments are warranted on each topic.

A variety of measures could be used to examine the prevalence of negative mental health impacts. Studies often use arbitrary cutoff values to define a mental "disorder," which can lead to widely different conclusions about the rates of incidence of such things as PTSD and depression, particularly in studies of children. Despite the prevalence of studies examining PTSD symptoms, some concerns have been raised about this measure. PTSD symptoms may not be meaningful unless we can compare them with predisaster symptoms, because some symptoms, such as trouble sleeping,

could have many causes other than exposure to disaster.²⁶ PTSD diagnoses also might not say much about children's daily functioning, might not capture certain anxieties or important features of coping, or might not take account of the cultural context in which children live.²⁷

Many researchers go beyond estimating prevalence to try to identify factors that increase the likelihood a child will exhibit symptoms. As we know from everyday life, children (like adults) can be more or less susceptible to mental health problems such as anxiety or depression; similarly, some people react more strongly to a disaster than others do. A disaster's impact on children varies based on their prior exposure to traumatic events, socioeconomic factors, age, gender, personality traits, cognitive skills, and relationships with their parents and families.²⁸ As a useful framing device, one study grouped factors that predict symptoms into four categories: aspects of exposure (perceived threat of death, losses, etc.), children's characteristics (such as gender and age), social support (for example, the roles of parents and teachers), and children's coping responses (for example, anger, wishful thinking, and talking to someone).²⁹

Short-Term Effects

In the United States, many researchers examined children's and adolescents' mental health after Hurricane Katrina. Among those who had experienced the storm, researchers found high rates of PTSD symptoms as well as other negative mental health impacts and behaviors, such as aggression in adolescents.³⁰ In the survey I mentioned earlier of families living in FEMA-subsidized housing after Katrina, half of parents reported that at least one of their children was having emotional or behavioral difficulties that hadn't been

present before the hurricane.³¹ Those studies generally have small samples and thus may not be representative either of those who experienced Katrina or of broader populations, such as all of those at risk of experiencing a hurricane. Still, studies tend to agree that people who experienced Katrina had higher rates of mental health problems.

Several studies have tried to learn what determined whether people experienced symptoms. Most of the answers weren't surprising. For example, children and adolescents who experienced worse impacts were more likely to have symptoms.³² In one study of 52 children for whom prestorm data was available, those who tended toward anxiety before the storm were more likely to experience symptoms of posttraumatic stress and general anxiety disorder afterward.³³ Younger children also appeared to have more symptoms.³⁴

The rates of symptoms fell as time passed. One study of 387 children 9 to 18 years of age found decreases in posttraumatic-stress and depression symptoms both two and three years after the storm. That said, almost 28 percent of the children still had symptoms three years after Katrina.³⁵ The US Government Accountability Office reported that after Katrina, the number of mental health professionals in the area declined substantially and that the lack of providers was the greatest barrier to getting mental health services for children.³⁶

Katrina's negative effects on mental health increased with the intensity of the disaster experience; similar effects have been found after other disasters. One early study looked at more than 800 children who experienced a devastating bushfire in Australia that destroyed hundreds of thousands of hectares

of land and property and took 14 lives.³⁷ Twenty-six months later, one-third of the children were still preoccupied with the disaster, for example by dreaming about it, talking about it often, or incorporating it into their play. Among children who experienced the disaster, those who became separated from their parents afterward, those whose mothers continued to be preoccupied with the event, and those whose family functioning changed were all more likely to exhibit posttraumatic symptoms. Similarly, two studies that examined children and adolescents after Hurricane Andrew hit Florida in 1992 found mental health symptoms among some portion of those surveyed three to six months after the hurricane.³⁸ Surveys of almost 5,700 children three months after 1989's Hurricane Hugo hit the United States found that symptoms of PTSD were related to how severe the children perceived the hurricane to be, how much damage their homes had sustained, whether one of their parents had lost a job, and whether they continued to be displaced.³⁹ That study found higher rates of PTSD among younger children and girls. Children with a tendency toward anxiety were also more likely to report PTSD symptoms.

Similar findings emerge in studies from developing countries. A survey of 158 adolescents six months after Hurricane Mitch hit Nicaragua found many had symptoms of posttraumatic stress and depression and that symptom levels were higher among those who lived in the most-damaged cities and those who experienced the death of a family member.⁴⁰ Three to four weeks after the 2004 tsunami, a study of 264 children aged 8 to 14 years in affected areas of Sri Lanka found that 14 to 39 percent had PTSD symptoms.⁴¹ Factors that predicted the likelihood children

would experience posttraumatic symptoms included subjective and objective measures of the severity of exposure to the tsunami, having family members who died in the tsunami, and the number of traumatic events the children had experienced before the tsunami.

Long-Term Effects and Resilience

Mental health symptoms usually decline as a disaster recedes into the past. But when disasters produce severe threats to life or dramatic disruptions, the impacts can persist for years. However, some factors, such as available and supportive parents, have been found to buffer the impacts. Researchers recently have tried to find the protective factors that can promote resilience. Resilience is “an individual’s capacity to recover from, adapt, and remain strong in the face of adversity”; we see resilience when an individual demonstrates good outcomes despite high risks, remains competent under threat, and/or recovers from trauma.⁴² A review of studies on disasters’ psychological impacts found that although disasters can indeed have serious negative impacts on a minority of the population, most people demonstrate resilience, and no more than 30 percent of youth typically experience chronic impacts.⁴³

Numerous contextual and individual factors influence whether a disaster is likely to cause long-lasting mental health problems. The review found no dominant predictive factor; all factors studied exhibited small or moderate effects. Thus there is no consensus on what interventions might help most after a disaster, a point I return to in the concluding section. That said, certain basic policies can undoubtedly improve mental health outcomes for children—for instance,

reuniting children with their families as soon as possible and promptly resuming schooling.

Effects on Schooling

Natural disasters can harm schooling in three primary ways. First, the disaster can destroy schools themselves, interrupting children’s education. Second, if children are hurt or sick or malnourished, they may not attend school as frequently and/or may perform more poorly in school. Third, in developing countries in particular, a disaster that reduces household wealth or income may lead parents to shift children out of school and into the labor market to help enhance family income. If those impacts on schooling persist—and whether they do is still an open question among researchers—they could reduce earnings later in life.

This section reviews two types of studies on these topics: (1) studies from developed countries that tend to focus on how changing schools, spending time out of school, or the trauma of the disaster itself can affect educational performance and (2) studies from developing countries that focus on whether households move children into the labor market at the expense of schooling.

Studies from Developed Countries

Severe disasters can damage or destroy schools. When schools cannot reopen after a disaster, not only is a child’s education disrupted, but the child may have to remain in potentially unsafe conditions. If there is no alternative child care, the child’s parents may be prevented from returning to work, thereby creating economic stress.⁴⁴ Disruption to schooling occurred on a very wide scale after Hurricane Katrina. In Louisiana, 196,000 public school students changed schools, many of them missing a month or more of

schooling along with losing their homes and moving to new ones.⁴⁵

The findings from Louisiana are particularly interesting because the school districts that were hit hardest by the storm were also some of the worst performing in the state. Displaced students thus often ended up in better schools. Two studies found that switching to better schools mitigated the hurricane's negative effects. One reported that the test scores of students forced to switch schools declined in the first year but—after controlling for other factors that could have affected the outcome—showed gains that went above prehurricane levels by the third and fourth year.⁴⁶ The study included only students who stayed in the Louisiana public school system; roughly 40 percent of students left the system entirely, and their experiences might have been different. Another study found similar results when it looked at the achievement test scores of students affected by Katrina who reenrolled after the storm in Louisiana's public schools.⁴⁷ Overall, impacts on school achievement were negative but small; they were most significant among students who changed schools and didn't return to their original schools for the entire 2005–06 year or who took longer to reenroll in school after the hurricane. Negative effects were mitigated when displaced students enrolled in higher-performing schools. Less-severe US disasters have also produced small negative effects on education.

Studies from Developing Countries

Very few studies from developing countries look at the impact of destruction of school facilities. However, many government and nongovernmental organization programs alike target that avenue of impact. Children spend a substantial amount of time in school

buildings, which often are not constructed to withstand disasters. For instance, the nonprofit group Build Change reports that the 2007 cyclone in Bangladesh destroyed nearly 500 schools and damaged more than 2,000 others. Super Typhoon Dorian (known locally as Typhoon Reming) damaged 90 to 100 percent of the schools in three Philippine cities and 50 to 60 percent in two others. Build Change works with other organizations, including the World Bank, to build safer schools not only to protect children while they're in school but also to help prevent disruptions in schooling after a disaster.

Most research focuses on the trade-off between sending a child into the labor force for income in the short term versus the long-term benefits of investing in the child's human capital. Some researchers simply document an association between a disaster and reduced schooling, whereas others go further and also show an increase in labor force participation by children. The degree of that effect varies by context and by children's attributes such as age and gender. Studies that don't focus on disasters specifically also show that when households lose income or face unemployment, children are more likely to enter the labor force and go to school less often.⁴⁸ One important question that hasn't been fully answered due to lack of sufficient data is whether children who are pulled out of school and put to work are less likely to reenroll even if household income returns to preshock levels.

Even though a reduction in income or an increase in expenditures after a disaster could lead parents to pull their children from school and put them to work, it's also possible that we might see an increase in schooling should a disaster cause macroeconomic disruption that results in lower wages or

fewer jobs. Although such an outcome is plausible, it was not observed in any of the studies I reviewed for this article.

Studies from developing countries generally examine rural households, and they typically find some substitution away from schooling after a disaster. For example, one study found that in rural India, child labor functions as self-insurance for poor households.⁴⁹ Another study—of households in Tanzania—found that among children aged 7 to 15 years, income shocks due to crop loss led to increased child labor, largely within the household, and decreased school attendance.⁵⁰ Specifically, children in households that experienced a crop loss were 20 percentage points less likely to be enrolled in school (with a mean enrollment rate of 70 percent). In Ivory Coast, school enrollment among children aged 7 to 15 years decreased by about 20 percentage points (more than a third of the original rate) in areas that had experienced rainfall shocks.⁵¹ In Nicaraguan communities affected by Hurricane Mitch, labor force participation by children aged 6 to 15 years increased 58 percent.⁵² The proportion of children who were both enrolled in school and working more than doubled, rising from 7.5 to 15.6 percent.

More evidence comes from Mexico, where researchers examined the impact of climate shocks (and other income shocks I don't discuss here) on the schooling of 8- to 17-year-olds from 1998 to 2000.⁵³ They found that disasters other than droughts reduced school enrollment by 3.2 percentage points during the following six months. The authors also found that primary school children, indigenous children, children of agricultural workers, and girls were all more affected. The authors also found that students who were pulled out of school were less likely

to reenroll in the near term. That effect was stronger for secondary-school children. Participation in the labor force increases among children following a disaster, and more so among older children, providing evidence that the decrease in school attendance is based on a need for income.

We also see educational impacts after Hurricane Mitch in rural households in Honduras.⁵⁴ Among 387 adolescents for whom data was available from four years before the storm to three years after, those who lived in households that experienced greater income loss after the hurricane had lower educational attainment scores—but only in households that had little or no access to credit. Thus it's possible that improving credit or liquidity through transfers or loans could help families maintain investments in their children's education.

Mitigating the Effects of Disasters

Climate scientists project that many regions will see increases in the intensity and/or frequency of certain weather-related extreme events. Some areas that haven't been susceptible to natural disasters in the past may become vulnerable as the climate warms. Thus, unless we take steps to mitigate such disasters, the harm they cause children around the globe is likely to increase. We don't have much research on the efficacy of various policies—including which ones perform better than others in protecting children—but we know that many interventions have a positive impact. That said, lack of funds and a failure to prioritize them often stall the implementation of such policies. Policies could also be enhanced if we better understood the channels through which natural disasters' effects on children operate. Though a full review of various interventions is beyond the scope of this

article, I can offer a brief overview of major findings and themes.

First, to increase the odds that negative impacts on children will be minimized, many measures can be taken before a disaster ever strikes. They include building schools, health facilities, and houses that can better withstand disasters. International agencies and nonprofit groups are helping people in developing countries build safer buildings, and local initiatives have emerged around the world. In Kansas, for example, the Wichita Public Schools have created school safe rooms to protect children from tornadoes. In general, schools and health facilities should adopt disaster response plans, ensure that all of their staff members are aware of the plans, and practice them routinely. Unfortunately, much progress remains to be made in these areas. Save the Children found that as of 2013, 28 states and Washington, DC, were falling short of having the best kinds of policies in place to protect children in day care centers and schools from disasters.⁵⁵ Children should themselves be educated about disaster risks—with curricula tailored for various ages—and empowered to take action to reduce those risks. Children should also be more directly involved in participatory research that aims to understand their needs and responses.⁵⁶

A range of policies not designed for disasters can nonetheless help mitigate the harm disasters cause children and their families. Such policies include wide access to credit, subsidies for school enrollment, and social insurance policies, which can help maintain consumption of goods critical for children after a disaster. For example, in developing countries, conditional cash transfer programs, which give money to families who keep their children in school, can help ensure that

more children stay in school and out of the labor force after a disaster.⁵⁷ In the United States, unemployment insurance and public medical spending increase after a disaster; even though those programs aren't designed specifically for disasters, they help mitigate a disaster's negative effects.⁵⁸ Using existing safety net programs for disaster response may also be easier, faster, and more effective than creating entirely new programs after a disaster occurs.

In the aftermath of a disaster, numerous actions have been proven to help protect children. One is reuniting children as quickly as possible with parents, families, or other primary caregivers, who can buffer children against the disaster's trauma and keep them safe from neglect and abuse. Governments and nonprofits can work together to reunite families, and several organizations have developed identification systems to speed that process; in the United States after Hurricane Katrina, unfortunately, the authorities did a poor job of reuniting children with their families.⁵⁹ In any case, caregivers, too, need support, such as family-friendly shelter and housing and food aid appropriate for infants and children. Direct aid to families is also important. After a disaster, children can benefit from even small cash transfers, which can be used to pay for food, soap, school, or medical care.⁶⁰ Managing spikes in food prices or providing food for families in need can also benefit children. Response must be rapid, however, because delays can lead to stress on the family and/or unnecessary deterioration of the situation, causing greater harm.⁶¹ Quickly reestablishing predisaster routines, such as schooling and other normal activities, can also protect children.

The public health sector has developed a set of interventions and practices that can help children after a disaster. They include providing necessities for hygiene to prevent the spread of disease and making safe drinking water available. Breastfeeding of infants should be encouraged. Young children should be targeted for intervention to prevent dehydration and other illnesses, and vaccinations should be dispatched quickly to protect against the spread of diseases such as cholera. There is no consensus, however, on interventions to protect children's mental health, an area that deserves further attention.

Conclusions

I've reviewed the empirical evidence on how sudden, weather-related disasters affect children. Researchers have shown that disasters can harm children's physical and mental health as well as their schooling. Younger children seem most susceptible. The effects of the severest disasters or of shocks to health and schooling at critical periods in children's development can last for years, even into adulthood. That said, children's responses to disaster vary widely depending on the type of disaster; the countries, communities, and families in which children live; and the characteristics of individual children. We're beginning to understand some of that variation—such as critical ages, differences by gender, or the roles of certain social structures or policies in mitigating impacts—but we need much more work to identify what can make a disaster's impacts more or less severe. One area we know too little about, for example, involves differences between rural and highly urbanized areas. If we better understood what drives variation

in people's responses to disaster, we could improve both mitigation policies and coping strategies.

Three other large gaps in our knowledge stand out. First, researchers have carried out very few careful policy evaluation studies to understand which interventions are most effective. Although this is partly because it's difficult to gather the data needed to do such studies well, further work in this area is warranted. Second, although researchers have uncovered many associations between disasters and outcomes, the pathways by which disasters produce the observed effects are largely unknown. I've discussed many hypotheses in this article, but we poorly understand which mechanisms operate when, or to what degree. Research that identifies such mechanisms could help us develop better responses. Finally, we don't know enough about whether and how living with higher risk of disasters can translate into behaviors that affect children's wellbeing.

As climate change alters extreme events, some places may begin to see more-frequent natural disasters, from floods to heat waves. Households could have a harder time recovering from repeated disasters, and the effects on children could be many times more severe than those from a onetime shock. Studying areas that already face repeated disasters could help identify strategies for other areas as the climate warms. For example, Bangladesh has introduced schools on boats to keep children in school even during a flood. On a warming planet, we may need such responses even in areas that until now have been unaccustomed to considering disaster risk.

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