GOATS AND SODA

This is what could happen to a child who doesn't get vaccinated

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Pneumonia struck first. Then tonsillitis spiraled into sepsis. Malaria battered him next, and after treatment, the other illnesses flared back up again. This unvaccinated 2-year-old boy is trapped in a relentless cycle.

"I was very sad. I knew these things could be prevented by vaccines," his mother Alzhraa Fadul says through an interpreter.

"I feel guilty that I can't do anything to help my son," the 26-year-old adds. "I'm worried about my son every day. I should've gotten vaccines for my son."

But there was nowhere for Fadul to get them. Her family lives in an abandoned classroom with 10 strangers in Kosti, Sudan, where vaccination campaigns were once hailed as a "remarkable achievement" and earned the country a coveted polio-free status one decade ago.

That all changed in April 2023 when civil war broke out. Sudan rapidly rose to the top of the list of countries with the highest proportions of unvaccinated newborns — claiming an unwanted leading position last year, with more than half of its babies missing all immunizations. Fadul's son is one of the 14 million kids worldwide who don't receive any vaccinations.

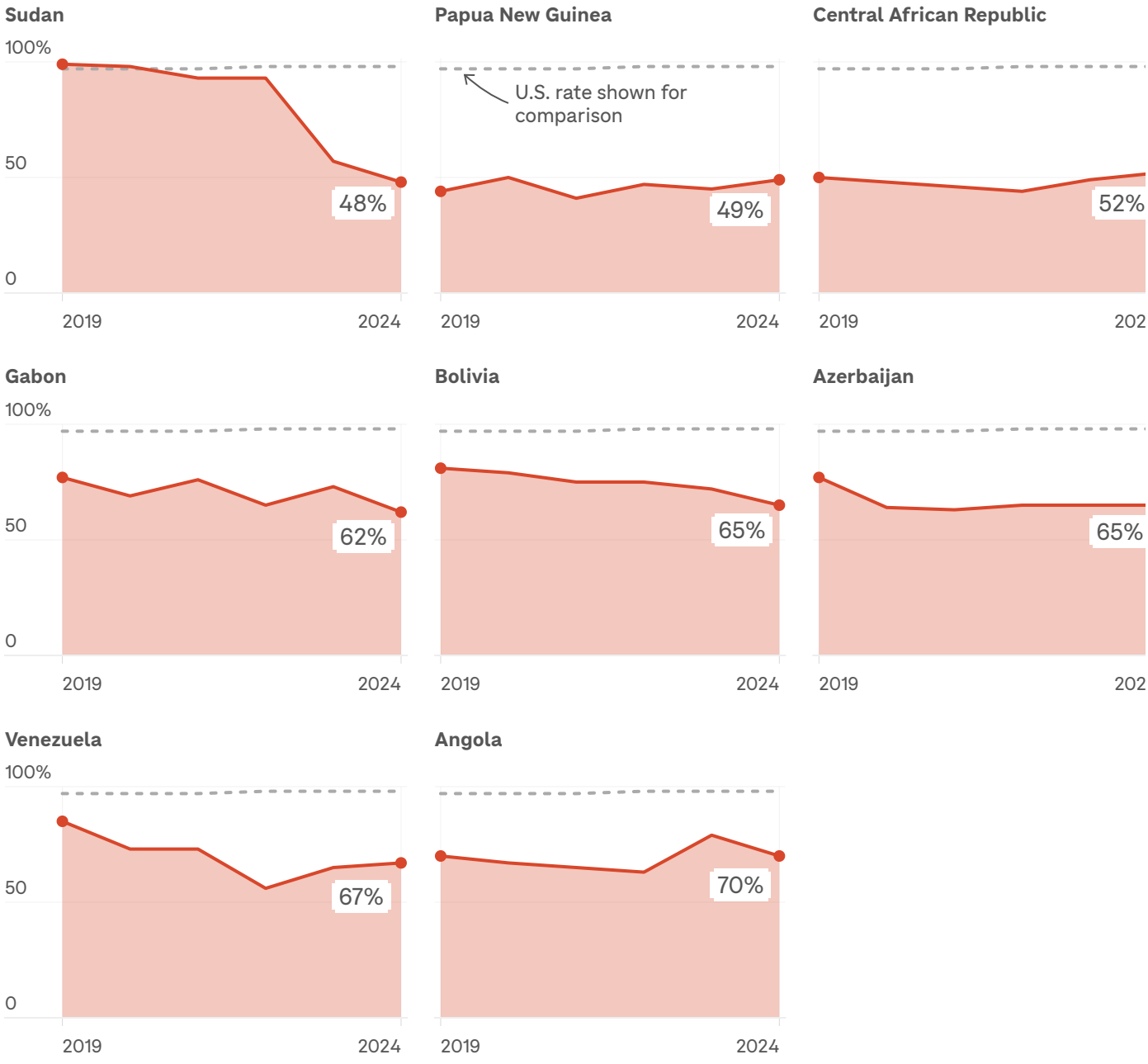
"We're really in the eye of the storm here," Sheldon Yett says. Yett, who is UNICEF's representative in the country, adds that more than 70% of the country's health facilities in conflict-affected areas are in "ruins." "Children who would have

otherwise been able to brave the many things that Sudan throws at children are far more vulnerable. Life is pretty grim."

The Central African Republic, Papua New Guinea and Yemen join Sudan among the hardest-hit countries with immunization programs in dire straits. Two of those countries — Sudan and Yemen — are active war zones, too.

The countries with the lowest rates for a key childhood vaccine

These countries have the lowest vaccination rates of the newborn diphtheria, tetanus toxoid and pertussis (DTP) vaccine — a proxy for how well their health systems deliver other childhood vaccines. By contrast, the percentage of newborns with a first dose of DTP in the U.S. ranged from 97% to 98% over the same period.



Source: World Health Organization

Credit: Connie Hanzhang Jin/NPR

In all, about 55% of unvaccinated kids live in conflict-affected areas. "Being a child growing up in those contexts, you've got the odds stacked up against you,"

says Dr. Naor Bar-Zeev, a pediatrician and vaccine expert at the World Health Organization.

While vaccine experts note that vaccine hesitancy exists in these regions, they say that's not the main reason that children miss vaccinations. In most cases, it's either lack of awareness among caregivers or lack of access to health facilities.

"It wasn't my choice not to vaccinate my child. It was war that prevented me," Fadul explains. "I would sell everything I have to get a vaccine."

The leading causes of infection among unvaccinated kids

"The things we actually worry about are the horses rather than the zebras," Dr. James Conway says. Conway, a pediatric infectious disease expert at the University of Wisconsin School of Medicine and Public Health, uses this metaphor to explain that while rare complications — zebras — can occur, it's important for physicians to first focus on preventing the most common causes of serious illness — the horses. "An ounce of prevention is worth a pound of cure," Conway adds, noting this cliché is truer than ever in countries like Sudan.

Two of those "horses" are pneumococcal disease and rotavirus.

Pneumococcal disease often causes pneumonia, the leading cause of death worldwide for all children under 5, with an annual toll of about 700,000.

Rotavirus is the most common culprit for diarrhea in that same under age 5 group in lower resource countries.

Conway says both are especially dangerous for kids living in crowded environments because those infections are more likely to spread and become dangerous once a child is exposed.

Overcrowding enhances the transmission of respiratory infections like pneumococcal pneumonia because tight living conditions increase the frequency of person-to-person interactions. Densely populated areas often also have limited access to clean water and sanitation, which facilitates the spread of diarrheal diseases through contaminated water, food and surfaces.

"It's sort of like a bucket of gasoline just waiting for somebody to throw a match in," Conway explains. "All it takes is the introduction of one of these diseases."

Vaccines have been available for decades to prevent both pneumococcal disease and rotavirus. In many parts of the Global South, vaccination campaigns target both.

But in low-resource settings, "access to even basic medical care can be really compromised" because of conflict and other factors, Conway notes. And that would have an impact on vaccine uptake.

Other factors that worsen outcomes

The millions of children who don't get vaccines may face other formidable challenges if they fall ill. Malnutrition reduces the production of cells used by the immune system to fight off infections, increasing the risk of disease. Various micronutrient deficiencies can also worsen outcomes. For instance, vitamin A deficiency increases the risk of severe complications and death from measles.

"As that battle rages, malnourished kids don't develop an appropriate immune response," Conway explains.

Once infected, the body demands even more energy to fend off infection, leading to a vicious cycle. "These infections can progress rather quickly, especially in small babies," Conway says.

Pneumonia kills nearly three-quarters of a million kids a year

Cough and difficulty breathing are usually the first signs of pneumonia.

Once the microbe hijacks the body, it damages the lung tissue, making breathing more difficult. It's almost like trying to breathe through a sponge soaked with water.

When the lungs lose their ability to exchange gases, organs receive less oxygen.

"Eventually, you succumb to the inability to breathe properly and oxygenate your blood," Conway says.

As the infection overwhelms the body, severe drops in blood pressure further starve vital organs of oxygen.

Studies have reported that some children die of pneumonia in as few as two days. "These things can progress rather, rather quickly," Conway says.

The danger doesn't end with pneumonia

Looming over unvaccinated children is yet another deadly threat: diarrhea. It comes from many sources, but many kids get immunized against rotavirus — the leading cause of diarrhea in the Global South.

In high-income countries, diarrhea is fairly common but rarely life-threatening because of widespread access to clean water and sanitation, rehydration therapy and adequate nutrition.

The data look starker for children in the Global South. That's because patients with diarrhea are treated with oral rehydration. Conway says, "Oral rehydration is something that we take for granted, but it's really not readily available in a lot of these settings."

As with other infections, malnutrition worsens outcomes for kids with diarrhea. A large study found that children with malnutrition and diarrhea were four times more likely to die compared with those with diarrhea and sufficient nutrition.

Unreliable access to life-saving treatment and poor rotavirus vaccine coverage create a deadly combination. Diarrhea accounts for about one in 10 deaths among children under 5 in low-income countries.

Ongoing diarrhea and vomiting can rapidly lead to dehydration. "We've all been dehydrated out hiking or doing something on a hot day, and you get a headache. Gradually, that transitions to being just more and more lethargic, where these kids just don't have the energy to move and do anything," Conway explains.

If dehydration isn't treated, circulating blood volume and blood pressure plummet. As in pneumonia, the blood pressure drop deprives vital organs of oxygen. The body's balance of salts, acids and blood sugar is also disrupted, causing damage to organs.

Once multiple organs cease to function, death is imminent. Depending on the child's health before the illness, death can occur "within a few days" or take a couple of weeks.

"While the body will do everything possible to maintain blood flow and perfusion of the brain, that's the last thing that starts to suffer," Conway says. "This lethargy then goes into being unresponsive and can progress gradually to coma and then death."

Lingering long-term side effects even after survival

When resources like antibiotics and oral rehydration are available, some children will recover from vaccine-preventable diseases. But that doesn't mean a child will survive unscathed.

"As these viruses run throughout the body, any organ can suffer," Conway says.

Measles, mumps and other vaccine-preventable diseases can cause debilitating and permanent damage. Conway says it's not the organism itself causing the damage, but rather the immune response to the microbe.

Hearing loss is one of the most devastating consequences of measles and mumps, causing deafness in 5 to 10% of cases. The complication is rarer with mumps.

"There are quite a few nerves in the body that are quite fine fibers and very susceptible to damage," Conway explains. "Oftentimes, the most vulnerable nerves are the ones that take a hit, and the nerves that impact hearing are really, really vulnerable."

Other complications include infertility and blindness. Conway added that intellectual disability is another risk because these infections attack the nervous system.

"Nerves are one of the parts of the body that don't recover quickly," Conway says. "You can rebuild lung tissue over time if you survive one of these infections, but nerve tissue just doesn't regrow and replace itself, so many kids do end up with neurologic deficits."

Some kids get vaccine-preventable diseases even before they're born

Newborns can also suffer if their mother isn't immunized against diseases like measles, mumps and rubella. Ideally, pregnant people should receive all recommended vaccines — but there may not be funding for adult immunization.

"This idea of immunizing adolescents and adults is just not as common in the Global South," Conway explains.

And if the pregnant person does not have immunity to a virus like measles, they're at risk of getting infected. That can lead to miscarriage, fetal death or stillbirth

Another harmful pathogen is rubella — an infection that has some symptoms in common with measles but is generally less severe.

If the fetus survives an early rubella infection, some babies are born with a constellation of birth defects known as congenital rubella syndrome, which can include deafness, cataracts, congenital heart disease and neurodevelopmental impairment.

The birthing process also poses dangers. Pregnant people should receive a dose of the tetanus vaccine during each pregnancy. But if the person giving birth doesn't have immunity to tetanus, non-sterile delivery practices can result in neonatal tetanus. From 2000 to 2020, cases decreased by 88% worldwide, with 2,229 being reported in 2020.

"Neonatal tetanus is heartbreaking," Conway notes. "These babies are incapable of doing anything on their own. They're incapable of breathing on their own because all the muscles in their body are contracted."

The emotional toll of missing vaccines

A shadow of guilt follows Fadul, the mother from Sudan. Despite the ongoing war making vaccines scarce, she blames herself for not being able to protect her son.

"I was sad because I knew we would never get a vaccine," she recounts. "There was no light at the end of the tunnel."

Some of the stress experienced by parents comes from seeing the devastating effects of vaccine-preventable diseases in their communities, and sometimes in their own children, as with Fadul.

"There is this sense of complacency in the U.S.," Conway says. "Once the system is sort of humming along and working well, a lot of these diseases do fade into the background. When you go into lower-resourced areas, there's still familiarity with these diseases."

"There is still an appreciation of vaccines. People not only welcome them, but they demand that their kids get immunized," Conway explains. "Parents, especially mothers, are very wired toward being protective. There's a natural, expected stress that happens when you can't provide whatever it is that your kid needs."

Conway thinks that sense of maternal stress is valid. The first 1,000 days of a child's life — a term popularized in the early 2010s to describe the importance of the first two years of life — are some of the most vulnerable periods for growth and development.

"The first 1,000 days are really, in many ways, going to determine sort of who and what you are," Conway says. "That's part of the reason that I think the support of aid agencies is so critical in these disrupted situations."

This year's cuts in U.S. funds for programs like Gavi, the Vaccine alliance, paint an unclear picture of how Sudan and other countries will handle the many obstacles being thrown their way.

Fadul's son is now weakened by infection and hunger, though still alive, but she fears he can slip over the edge at any moment.

"Parents in America have never seen what I have. I've seen kids die in front of me," Fadul says tearfully. "I don't want another child right now. This would mean two unvaccinated kids. I want to have another child when I know they'll be safe. But life is not stopping in Sudan. Every hour, women are still giving birth. These children will face the same problem my son faced. I hope that one day these children will no longer suffer."

childhood diarrhea pneumonia measles