

Shi's work has already shed light on the pandemic's origins. In January, her team published the genetic sequence of a bat virus it collected that shares 96.2% of its genome with SARS-CoV-2, the pandemic coronavirus. The finding suggests SARS-CoV-2 originated in bats, although researchers widely believe it most likely jumped to another mammal before infecting humans.

Among some policymakers and media, however, the finding fed speculation that SARS-CoV-2 had been engineered by scientists at WIV, or was a collected virus that escaped from that laboratory. On 14 April, the speculation mounted after a column in *The Washington Post* reported that U.S. Department of State officials had, in 2018, raised concerns about safety at WIV's then-new biosafety level 4 (BSL-4) laboratory, designed to handle the most dangerous pathogens. The multicampus WIV also has separate, lower containment BSL-2 and BSL-3 laboratories where Shi did her grant-funded work, Daszak says. But after a reporter erroneously informed Trump that NIH had funded work at the BSL-4 lab, he replied: "We will end that grant very quickly."

One week later, Lauer emailed Daszak that NIH was ending the alliance's grant "for convenience." Asked by *Science* to explain the phrase, NIH pointed to a Grants Policy Statement that says it can unilaterally cancel a grant "to protect the public health and welfare from the effects of a serious deficiency."

Administrators familiar with NIH believe the agency might have broken regulations governing grant disbursement, which allow the midstream cancellation of an award for just a few reasons, such as malfeasance.

Virologist Dennis Carroll, who recently retired as director of the emerging threats division of the U.S. Agency for International Development, says he saw the cables on the safety of WIV's BSL-4 lab when he was at the U.S. embassy in Beijing, and doesn't "place an enormous amount of weight on the observations" because they were made by diplomats, not scientists. If any problems were "of substance," he adds, NIH would have "needed to take serious steps" because it funded work at WIV. (There is no public indication NIH took any action.)

Other researchers say there is no evidence that SARS-CoV-2 escaped from WIV, although they concede the scenario can't be completely ruled out. They note that research suggests the bat virus Shi described, although 96.2% similar to the pandemic vi-

rus, evolved in bats at least 20 years ago, meaning it would have taken decades to evolve into the pandemic virus had it escaped from a laboratory. On 1 May, the Office of the Director of National Intelligence said the intelligence community "concurs with the wide scientific consensus that the COVID-19 virus was not manmade or genetically modified," but was still "rigorously" examining whether it spread from infected animals or a lab accident in Wuhan.

Shi has said that virus didn't come from her work. "The closest progenitor of COVID-19 virus is still mysterious and it's definitely not from my lab or any other labs," she told *Science* on 18 April. "It's a shame to make the science so complicated."

The Chinese government has rejected assertions that it bears responsibility for the pandemic—and has suggested that the virus originated in the United States. The government says it has launched investigations

into the origins of the virus, but has provided few details and has placed restrictions on scientists in China who are studying the question. "They're not helping themselves," says James Le Duc, director of Galveston National Laboratory, where he runs a BSL-4 lab.

China is facing growing pressure to allow an independent investigation. On 1 May, the World Health Organization's (WHO's) Emergency

Committee of expert advisers recommended a probe that would involve "field missions" to China and perhaps include the World Organisation for Animal Health and the U.N. Food and Agriculture Organization.

Others have made similar recommendations. "It would seem entirely reasonable and sensible that the world would want to have an independent assessment of how this all occurred, so we can learn the lessons and prevent it from happening again," Australian Prime Minister Scott Morrison said on 23 April in urging a WHO probe.

WHO is not involved in studies in China, says spokesperson Tarik Jasarevic, but it "would be keen to work with international partners and at the invitation of the Chinese government to participate in investigation around the animal origins" of the virus.

Daszak, meanwhile, says he is trying to engage NIH about the future of his group's work. He says he asked on 27 April to speak with Lauer, but had not heard back as of 5 May, when *Science* went to press. ■

With reporting by Kai Kupferschmidt, David Malakoff, Dennis Normile, and John Travis.

## COVID-19

# Children's role in pandemic is still a puzzle

## Some countries reopen schools, hoping it won't accelerate transmission

By **Gretchen Vogel** and **Jennifer Couzin-Frankel**

**F**or families eager for schools to throw open their doors, the tale of a 9-year-old British boy who caught COVID-19 in the French Alps in January offers a glimmer of hope. The youngster, infected by a family friend, suffered only mild symptoms; he enjoyed ski lessons and attended school before he was diagnosed. Astonishingly, he did not transmit the virus to any of 72 contacts who were tested. His two siblings escaped infection even though other germs spread readily among them: In the weeks that followed, all three had influenza and a common cold virus.

The story could be a bizarre outlier—or a tantalizing clue. Several studies of COVID-19 hint that children are less likely to catch the novel coronavirus and don't often transmit it to others. A recent survey of the literature couldn't find a single example of a child younger than 10 passing the virus on to someone else, for example.

Relying on those encouraging if scant data—and the reassuring indications that very few children get severely ill from COVID-19—some governments are beginning to reopen schools. Denmark sent children up to age 11 back on 15 April, and Germany welcomed back mostly older children on 29 April. Some Israeli schools reopened on 3 May; the Netherlands the Canadian province of Quebec plan to reopen many primary schools on 11 May. Most schools are resuming with reduced class sizes, shortened school days, and extra hand washing.

Ending school closures has clear benefits for children's education and mental health—not to mention their parents' well-being—but scientists disagree about the risks. Some worry that even if children transmit less efficiently than adults, they may make up for it by their far more expansive web of contacts, especially at school. "From the data we have so far, it

**"The closest progenitor of COVID-19 virus is still mysterious and it's definitely not from my lab ..."**

**Shi Zhengli,**

Wuhan Institute of Virology



Children are back in class in Copenhagen, Denmark, but must be seated at a safe distance from each other.

is very dangerous to open schools and day cares at the moment,” says Marco Ajelli, an epidemiologist at the Bruno Kessler Foundation in Trento, Italy. Several new studies now underway aim to better gauge the risk, including one announced on 4 May by the U.S. National Institutes of Health (NIH) that will follow 2000 families for 6 months. “We need this information to safely plan for return to school and work and play,” says Catherine Birken, a pediatrician and researcher at the Hospital for Sick Children in Toronto. “Without it, we’re completely in the dark.”

As parents and teachers know all too well, children excel at catching and sharing germs, from influenza to common colds, even when they don’t feel very sick themselves. “Respiratory viruses really like children,” says Isabella Eckerle, a virologist at Geneva University Hospitals.

Could COVID-19 be different? The evidence so far is mixed. Researchers in Iceland, one of the few countries to conduct mass screening, turned up no infections in 848 children under the age of 10 without significant symptoms, compared with an infection rate of nearly 1% in ages 10 and older. A U.S. analysis of nearly 150,000 infected people found that just 1.7% were younger than 18. But a study of 391 cases and almost 1300 close contacts in Shenzhen, China, reported that children were just as likely to be infected as adults. Eckerle cautions that some of these data come from surveys done after shutdowns were put in place. “They were collected in an artificial situation,” she says. Children “weren’t going to the playground and were not going to school.”

Several studies suggest children who do get sick with COVID-19 are just as infectious as ailing adults. Researchers have detected the same amounts of viral RNA in nose or throat swabs from sick children as in those from older patients. Finding RNA does not always mean a person is infectious; it can also come from noninfectious viral remnants. But in a 1 May preprint, Eckerle’s team reported that 12 out of 23 children sick with COVID-19 had virus in their nose or throat able to attack and infect human cells, a rate similar to adults.

Far less is known about the risk posed by infected children with few or no symptoms. But there’s at least one example of a child who didn’t appear sick and was nevertheless a virus factory: In February, doctors in Singapore described a 6-month-old baby, infected without apparent symptoms, whose coronavirus levels were on par with those of sick adults.

Real-life studies of how often children transmit COVID-19 are scarce. Researchers at the Dutch National Institute for Public Health and the Environment (RIVM) looked carefully at how the disease spread in 54 households, together comprising 123 adults and 116 children aged 16 or younger. They didn’t find a single family in which a child was the first patient. This study, too, began only after schools closed, says RIVM epidemiologist Susan van den Hof, but additional evidence comes from Dutch contact tracing studies: Of 43 contacts of infected children and teens who were followed, none became infected.

Critics have noted these numbers, posted on RIVM’s website, are too small to be statistically significant. But combined with

other studies, Van den Hof says, “The data all seem to be pointing in the same direction: that there is not as much transmission from children.” That helped convince the Dutch government to reopen elementary schools—and allow children’s sport teams to practice—starting next week.

Ajelli, who thinks such moves premature, teamed with colleagues in China to estimate the effects of school closures and other social distancing measures in Shanghai and Wuhan, China. Based on contact surveys, which ask subjects how many other people they typically meet during school or workdays and on the weekend, the team found that children have approximately three times as many contacts as adults. Although they were only one-third as likely to be infected, keeping children at home helped curb China’s outbreaks, the team concludes in a paper published online by *Science* on 29 April. Reopening schools will likely accelerate transmission, Ajelli cautions.

To pinpoint the role of children, Birken and her colleague Jonathon Maguire at St. Michael’s Hospital, also in Toronto, plan to scrutinize transmission as it happens. They have begun to recruit 1000 families, all of them part of an ongoing children’s health study in the region, for weekly nasal swabs, symptom checklists, and queries about day-to-day family life. Were children biking with friends? Did parents go to the grocery store? Birken also hopes to see what happens as school closures and other restrictions are lifted. The NIH study has a similar setup and draws from existing pediatric research projects in 11 cities. Another study is ongoing in the Netherlands.

“Doing studies as schools reopen will be really important,” says infectious disease specialist Susan Coffin of the Children’s Hospital of Philadelphia, who is planning one herself in her hometown. It would include regular testing of children, staff, and teachers, along with other members of students’ households. Coffin hopes to trace contacts and sequence the virus from individual patients, which can help clarify who transmitted it to whom.

Even without those efforts, daily case numbers could soon provide a reality check. If children are ample virus spreaders after all, cases could surge in a matter of weeks in the countries reopening their schools. If they aren’t, parents and policymakers will heave a sigh of relief and more countries may follow. “Everyone is looking at each other,” Van den Hof says, “to see what will happen.” ■

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