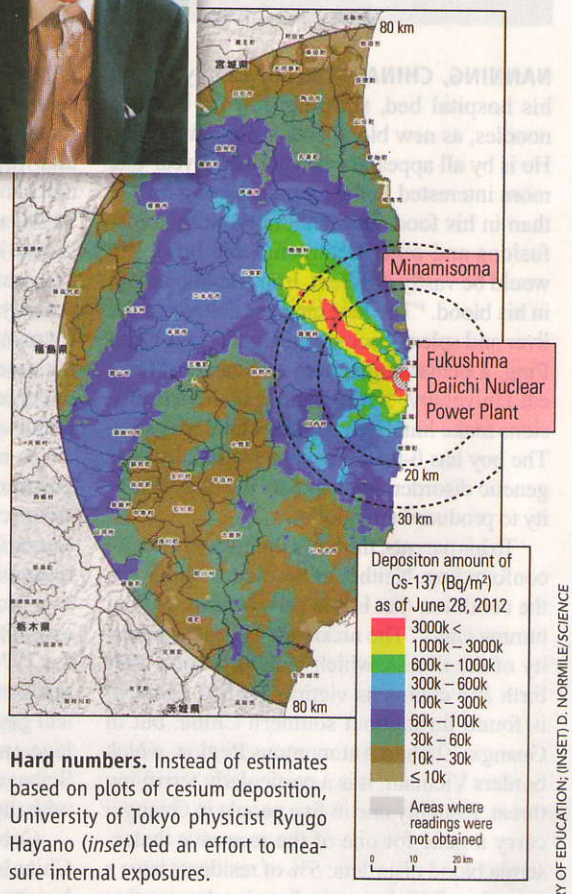
Insistence on Gathering Real Data Confirms Low Radiation Exposures

The massive evacuation and strict monitoring of food appear to have successfully limited the amount of radiocesium ingested by Fukushima residents

TOKYO—As the disaster at the Fukushima Daiichi Nuclear Power Plant was unfolding in March 2011, Ryugo Hayano started posting Twitter observations about radioactive releases. Gradually, the University of Tokyo particle physicist found himself drawn deeper into a debate over the exposure of area residents. Disappointed that authorities were not providing hard facts, Hayano began testing school lunches for radiocesium, the most abundant radionuclide in the environment around Fukushima, and measuring how much of the radionuclide local residents might be absorbing by eating contaminated food. Last month, he and his colleagues reported finding no detectable radiocesium in recently tested children and minimal levels in adults, suggesting that efforts to keep the food supply safe are working.



Hard numbers. Instead of estimates based on plots of cesium deposition, University of Tokyo physicist Ryugo Hayano (*inset*) led an effort to measure internal exposures.

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The findings are drawing both praise and criticism. Goshi Hosono, a politician who was the minister for the government's nuclear accident recovery efforts from mid-2011 until last fall, tweeted, "Thank you for writing the paper," to Hayano, and praised the team's objectivity. Skeptics are unimpressed. "They are missing the cesium level in the body because the detection limit [of the whole body counter] is high and we do not know how cesium in the body affects health," says Atsuhito Ennyu, a geochemist who has been active in citizen efforts to monitor Fukushima fallout throughout the country.

Hayano takes compliments and complaints in stride. "I've asked myself many times, 'Why am I doing this?'" he says with a wide grin. Others are happy to answer that question for him. "The government and the experts in this field lost people's trust due to their lackluster performance after the accident," says Nobuhiko Ban, a radiation protection specialist at Tokyo Healthcare University. By contrast, "Hayano has earned a reputation as an unbiased and conscientious scientist," Ban says. "Hayano recognized that what was important was to measure individual doses so residents personally understood their situation," adds Masaharu Tsubokura, a University of Tokyo medical doctor who works at a hospital near the Fukushima plant.

Hayano is an unlikely hero. Since 1997, he has led the ASACUSA antimatter experiment at CERN, the European laboratory for particle physics. His work on antiprotonic helium atoms netted him the 2008 Nishina Memorial Prize, Japan's most prestigious physics award. He never expected to become

an expert in radiation studies. Launching one initiative after another in Fukushima, Hayano says, "I kept thinking that someone better qualified to do this will show up and take over."

When the Japanese government declared a nuclear emergency on 11 March 2011, about 5 hours after the earthquake, Hayano started keeping an eye on online radiation data streaming from a monitor near the Fukushima power plant. On 12 March, a hydrogen gas explosion rocked one of the reactor buildings. Early the next morning, Hayano tweeted a simple graph showing how radiation spiked at the time of the blast. He started posing questions to educate his Twitter followers: "Why does cesium emit gamma rays?" And, "How do you measure internal radiation?" He would note the correct answer and add a bit of explanation. Within less than a week, he went from 3000 to 150,000 followers.

The education process worked both ways. From his followers, Hayano picked up on concerns about contamination in school lunches, despite government assurances that radioactivity in all food going to market was under 100 becquerels per kilogram, a more conservative threshold than most countries. With the cooperation of Minamisoma, a city straddling the evacuation zone north of the stricken plant, Hayano once a week since January 2012 has had everything from a lunch tray at a grade school and at a nursery school thrown into a blender and tested in a highly sensitive detector, rarely finding samples exceeding 1 becquerel per kilogram. At first, Hayano shelled out for the testing himself, spending about $3000 in 3 months until a government grant kicked in. Twitter followers started sending contributions, as much as $1000, which he has used to "cover everything I do in Fukushima."

Even before his school lunch program, Hayano's tweets were attracting the attention of Fukushima area physicians. Since the disaster, Tsubokura has been volunteering twice a week at Minamisoma City General Hospital, which was left short-handed when doctors and nurses fled the region. In summer 2011, they started measuring radiation in concerned residents. But the results were strange, Tsubokura says. With Hayano's help, they figured out that the whole body counters the hospital was using were not shielded from background radiation.

After getting testing programs in shape, Hayano and his collaborators gathered internal exposure data for more than 32,000 Fukushima residents. Their report, published online on 11 April in the *Proceedings of the Japan Academy, Series B*, indicates that none of the 10,200 children under age 15 who were given individual whole body scans at a hospital with the most advanced, shielded counters between May and November 2012 had detectable radiocesium in their bodies. (The tests focused on cesium-137, which has a half-life of 30 years. Another isotope also released from the Fukushima reactors, cesium-134, has a half-life of about 2 years.) Only four adults had levels that would cause worrisome annual radiation doses. The researchers traced the radiocesium in those adults to wild mushrooms and wild boar meat they had obtained themselves, bypassing mandatory testing of food sold in markets.

"The result was not totally unexpected," Ban says. Internal exposure data gathered by Fukushima Prefecture authorities, for example, also suggest that radiocesium ingestion is low but do not provide individual doses in becquerels or note the number of subjects below the detection limit. "Data in Hayano's paper are given as a cesium concentration in the body, which is more straightforward and precisely interpreted," Ban says. Hayano's monitoring, adds Peter Hill, a radiation health expert at Forschungszentrum Jülich in Germany, "provides information on the real situation" that will help validate models and dose estimates. Indeed, they may influence a draft report on Fukushima for the U.N. Scientific Committee on the Effects of Atomic Radiation due later this month. Hayano's results provide "some necessary initial data that allowed me to assess public internal doses," says Mikhail Balonov, a radiation protection specialist at the Institute of Radiation Hygiene in St. Petersburg, Russia.

Hayano's reassuring findings may be welcomed by governmental leaders, but he is still critical of their handling of the disaster's aftermath. Virtually every Fukushima resident now wears a personal dosimeter that measures external exposure to environmental radiation. But internal and external exposure data are not being combined to assess total individual doses because of incompatible databases and privacy concerns, Hayano says. Merging the data sets would not only give a more complete picture of individual exposures, he says, but it would also be useful for the international community in studying exposure risk and preparing for future accidents.

Hayano would also like to see exposure data used to prioritize decontamination as authorities move toward allowing evacuees to return home. He has set an example here as well. Hayano and Minamisoma officials identified about 100 children with the highest external exposures, based on personal dosimeter data. They then placed in their homes custom-made radiation monitors that plug into wall sockets. Data are transmitted to a central station over mobile phone lines. They also set up solar-powered monitoring stations along the roads children take to school. With radioactive surveillance in place, they can measure the effectiveness of clean-up efforts such as washing buildings, trimming trees, and scraping off topsoil. Identifying individuals who receive elevated doses, and decontaminating their homes and surroundings, should lead to a step-by-step reduction in community exposures. At a talk here last month in Tokyo, Hayano called the current untargeted approach to decontamination "silly" and, turning to Hikariko Ono, a deputy chief cabinet secretary who was in the audience, told her "this is something the government has to work on." Ono later said she would take the matter up with aides to Prime Minister Shinzo Abe.

In the meantime, Hayano is using his ingenuity to fill another data gap. Using tracking data from mobile phone companies, he is estimating acute exposure doses of people in areas subjected to radiation plumes before evacuations were carried out. And he has assembled a team to design a scanner for babies—to provide peace of mind for parents, he says. But Hayano is also looking to wrap up his involvement, so that he can concentrate once again on antimatter physics. After the baby scanner is finished, he says, "I can say I've done enough."

–DENNIS NORMILE

On the road. Solar-powered monitors track radiation near Minamisoma schools.

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