

Rice Is a Significant Source of Methylmercury

Research in China Assesses Exposures

Human activities such as mining, smelting, and coal combustion disperse mercury that can be methylated by bacteria to produce methylmercury, a potent neurotoxicant. Methylating bacteria thrive in aquatic sediments rich in organic matter, and methylmercury biomagnification eventually leads to heavy contamination of top predators, including fish consumed by humans. Although fish and seafood are the most common dietary sources of methylmercury worldwide, new research from China demonstrates that rice, a staple food for billions, can be a primary source of methylmercury in areas where there is substantial inorganic mercury pollution, with calculated exposure exceeding current tolerable daily intakes [*EHP* 118(9):1183–1188; Zhang et al.].

The research was conducted in four regions in Guizhou province, an area of inland China with rich deposits of cinnabar (a mercury ore). Mercury mining and smelting have led to heavy pollution in Wanshan, while zinc smelting and coal combustion, which also release mercury, are the main contributors in Weining and Qingzhen, respectively. The fourth region, Leigong, is a remote nature reserve selected to represent an area with no sources of direct mercury contamination.

Methylmercury and total mercury exposure through drinking water, diet, and respiration were assessed for adults in the four regions. Previous sampling provided data for air, water, fish, meat, and poultry, while agricultural products (rice, corn, and vegetables), drinking water from Wanshan and Leigong, and total gaseous mercury in Wanshan were newly evaluated in this study. These data were collectively used to calculate probable daily intakes for the general adult population.

In all regions rice, vegetables, and meat (not including poultry and fish) accounted for 89–97% of total mercury exposure, whereas rice consumption accounted for 94–96% of methylmercury exposure. Fish contributed little; most of the fish consumed here are farmed species that grow rapidly and eat a diet that precludes significant methylmercury bioaccumulation.

Picture of Better Health

Prioritizing Air Pollution Control in China

China's Yangtze River Delta is one of the most heavily polluted and densely populated areas of the world, with some districts of Shanghai exceeding a population density of 40,000 people/km². Annual average concentrations of fine particulate matter (PM_{2.5}), microscopic airborne particles that cause heart and lung damage, are estimated to vary from 14 µg/m³ in the cleanest areas to 133 µg/m³ in the dirtiest. By contrast, most major cities in the United States have annual average PM_{2.5} levels between 7 and 20 µg/m³. Yet a new study suggests regions as highly polluted as the Yangtze River Delta can clear the air and in the process save thousands of lives by adopting common pollution-control technologies [*EHP* 118(9):1204–1210; Zhou et al.].

The study is believed to be one of the first risk assessments of a developing country using the Community Multiscale Air Quality (CMAQ) modeling system. Although CMAQ is widely used in the United States, most developing countries lack the exhaustive data on emissions, pollutant monitoring, and weather conditions needed to make accurate predictions. The research team capitalized on emissions data from China that NASA estimated using satellite measurements during a 2006 study of intercontinental pollution drift.

The researchers examined emissions of sulfur dioxide (SO₂), nitrogen oxides (NO_x), volatile organic compounds (VOCs), and PM_{2.5}, focusing on the effect of these pollutants on PM_{2.5} and ozone



In Weining, Qingzhen, and Leigong, average exposures remained below provisional tolerable weekly intakes for total mercury and for methylmercury (0.57 µg/kg/d and 0.23 µg/kg/d, respectively) and a more stringent methylmercury reference dose of 0.1 µg/kg/d. However, Wanshan adults averaged 1.9 µg/kg/d for total mercury and 0.096 µg/kg/d for methylmercury. Although methylmercury represented only 5% of the total mercury exposure estimated for that area, it was enough to result in 7% of Wanshan adults exceeding the methylmercury provisional tolerable weekly intake and 34% exceeding the reference dose.

It is unknown whether methylmercury limits, which are based on fish consumption, provide adequate protection for a population with rice-based exposure because rice lacks the micronutrients found in fish that might partly offset neurotoxicity. Given that heavy inorganic mercury pollution exists in other rice-growing regions of Asia, further investigation is critical to assess exposure and correlate it with human biomonitoring (especially for pregnant women) and potential health effects.

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concentrations. Ozone is a gas formed when NO_x and VOCs in the atmosphere react in sunlight. PM_{2.5} is linked to heart and respiratory disease, with resulting effects on premature death, and ozone has been associated with respiratory outcomes and premature death. They considered 10 control scenarios among major pollution sources—industry, power plants, motor vehicles, and domestic life—and focused on the health benefits per ton-of-emission reduction across scenarios.

Computer modeling predicted the greatest decline in mortality would come from reducing SO₂ emissions from power plants and PM_{2.5} emissions from industry, with each technology preventing approximately 1,200–24,000 deaths per year among the more than 80 million people living in the delta. This is based on the significant reduction in SO₂ emissions from coal-powered plants with the use of fluidized gas desulfurization, as well as the large health benefit per ton of avoided emissions of primary PM_{2.5} from industry. Measures to reduce NO_x and VOCs, including tighter vehicle-emissions standards, would have less impact on public health.

The authors point out that understanding sectoral differences in the ways emission-control strategies affect exposures and health risks can help guide strategies that are both economically and environmentally optimal. They conclude that their findings provide the basis for prioritizing pollution-control strategies in the Yangtze River Delta and provide a template for comparable analyses elsewhere.

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