Fluorosis: an ongoing challenge for India

High levels of fluoride from food and contaminated groundwater are putting many people in India at risk of fluorosis, an underappreciated and sometimes debilitating disease.

Sizzling onion, potato, and chickpea preparations flavoured with turmeric, chilli, and fresh coriander are a common sight along the roads of the Indian capital Delhi, where small crowds gather at any time of the day for a quick meal cooked fresh in front of them. Street food is shorthand for a rich host of regional delicacies Indians take great pride in.

But together with homemade beverages, spicy fruit salads, and most Indian curries, street food often hides an ingredient that according to A K Susheela, executive director of the Fluorosis Research and Rural Development Foundation in Delhi and a pioneer in the field, may be playing a part in the silent anaemia epidemic which plagues India, affecting pregnant women and children the most. Rock salt is mined in different areas of India and goes by different names depending on its colour. Known as Kala, Lahori, or Sandha namak (salt), its unique tangy flavour is a taste of home for many Indians.

Calcium fluoride, a mineral present in the popular ingredient, is safe when consumed in tiny quantities, but is found in high concentrations both in untreated groundwater and popular foods all over the country. According to WHO, the safe limit of fluoride consumption is 1·5 parts per million (ppm), or milligram (mg) per litre. "But rock salt contains up to 157 parts per million, and among the groundwater samples we analysed, we found concentrations as high as 48 milligrams per litre," says Susheela. While an occasional sprinkle can be good for you, overconsumption, especially if combined with fluoride-rich water, poses an array of health threats that often go undetected.

In addition to being found in the rock salt that is added to many Indian dishes, fluoride also contaminates aquifers across the country because it easily dissolves in water.

In rural areas where people don't have access to treated drinking water, prolonged intake of fluoride can affect teeth, bones and major joints, including the neck, back, hips, and knees, reducing mobility. As the bones grow stiffer, the condition becomes increasingly painful and can lead to permanent disability.

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Known as skeletal fluorosis, this disease has been widely studied for decades, but according to the Fluoride Knowledge and Action Network, "for a problem of this scale, the response has still been very patchy at the national level".

The Government of India says that as of April, 2014, fluoride prevalence was reported in 230 districts in 19 Indian states, with 14 132 homes in the risk areas still lacking safe drinking water. The population at risk is officially estimated to be around 11·7 million, although NGOs warn that the threat is much more widespread, affecting over 60 million people nationwide.

India has a national programme for the prevention and control of fluorosis that started in 2009. Over the years, the plan has targeted nearly 200 districts in 17 states with increased diagnostic activities, treatment, and rehabilitation at a village and district level. In the early 2000s the government's response also involved installing defluoridation plants in areas at risk such as the desert state of Rajasthan, where to date over 4 million people are still affected by fluorosis.

However Nanak Santdasani, WASH Officer with UNICEF in Rajasthan, says that water purification alone is not the solution. "During our research, we found that skeletal fluorosis is not always irreversible as previously thought", he says. "If we combine access to safe water with nutrition supplements and health services, we can reverse the condition in children younger than 12." Santdasani's integrated fluorosis mitigation was initially met with some scepticism but, after being trialled in Bihar and Rajasthan, it was eventually accepted as an effective response strategy.

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For more on **fluoride contamination** see https://www.who.int/water_sanitation_health/diseases-risks/diseases/fluorosis/en/

For more on **the spread of fluorosis in India** see https://nhm.gov.in/index1.php?lang=1&level=3&sublinkid=1055&lid=611

For more on **integrated fluorosis mitigation** see https://www.ircwash.org/resources/integrated-fluorosis-mitigation-guidance-manual

For more on **previous approaches to fluorosis treatment** see https://link.springer.com/chapter/10.1007%2F978-81-322-3745-7_9

For more on **land use in India** see https://www.downtoearth.org.in/news/climate-change/irrigation-does-more-than-deplete-groundwater-it-changes-climate-too-68858

For more on **the depletion of groundwater resources in India** see *Clim Dyn* 2020; **54:** 1851–72

For more on **trends in global freshwater availability** see *Nature* 2018; **557:** 651–59

For more on the **Jal Jeevan Mission** see https://jalshakti-ddws.gov.in/sites/default/files/JJM_note.pdf

For more on **the outcomes of fluoride intoxication** see *Indian J Med Res* 2018; **148:** 539–47

For **Niti Aayog on the burden of anaemia in India** see https://www.niti.gov.in/niti/content/anemia-alert-government-aiming-cost-effective-interventions

For more on **the correlation between accumulation of fluoride and anemia** see *Int J Curr Res* 2016; **8:** 37700–03.

For **the Indian Government's recommendations for anaemia** see https://www.nhp.gov.in/disease/blood-lymphatic/iron-deficiency-anemia

The notion that some patients can be successfully treated or even cured, reversed decades of convention among the medical community. In 2017, Susheela notes that "the message that the disease has "no treatment or cure" was deeply ingrained in the perception of the medical fraternity. The disease was thus totally neglected." At the time, the study adds, "no patient with fluorosis was admitted to a hospital for fear of blocking a bed."

Vikas Ratanjee, advocacy manager with the India Natural Resource Economics and Management (INREM) Foundation, acknowledges the efforts made by the government over the years, but notes how India's looming water crisis represents an unexpected setback.

India is an agrarian country, with 60% of its land used for agriculture, and, as the economy grows, farmers are expected to feed a growing population as well as continue to increase exports. Over the years, this has increased the need for water for irrigation and, in the absence of stringent regulations, fresh water resources have been overexploited across the country.

In 2018, a study used satellite data to estimate trends in global freshwater availability, identifying India as a major hotspot of water depletion, despite a slight increase in expected precipitation in the coming years. But as climate change alters monsoon patterns in the subcontinent, certain areas are expected to experience more drought, forcing people to dig deeper into the ground to find water to drink. "This is where water tends to be more contaminated, so if we are not vigilant the fluoride epidemic will get worse before it gets better", Ratanjee says. "After several decades since it was identified, the unfettered extraction of groundwater has only exacerbated the issue of fluoride poisoning, and so far there are no signs of abatement."

Last year, the government renewed its push towards better water management across the country by setting up a new ministry of water, the Jal Shakti, and a new initiative, the Jal Jeevan Mission, with a goal to provide piped drinking water to every rural household in India by 2024. If successful, the mission will achieve in just 5 years a goal that has remained out of reach since Indian independence in 1947, drastically curbing the issue of skeletal fluorosis as well as other forms of water poisoning that are still rife in India. "The government's efforts are promising", Ratanjee says, "but efforts need to [be] sustain[ed]."

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In all major cities, people have access to clean water—whether it is bottled, or purified at home with reverse osmosis filters. "Not everybody drinks contaminated water", Susheeta says, "and yet they also suffer from fluorosis. So our question is, what are the other sources of fluoride intake?"

Consumption through food is more difficult to estimate because it comes from myriad sources, and when it leads to toxicity doctors struggle to diagnose it. Skeletal problems are not the only outcome of fluoride intoxication, Susheeta explains: "What we should be investigating right now is anemia", she says, a problem that, according to the government's think tank Niti Aayog in Delhi affects over half of the population, putting pregnant women and newborn babies particularly at risk.

According to Susheeta, rock salt, a staple of Indian diets, is at least partly to blame, although organisations such as UNICEF say that the salt is not toxic and should just be avoided if a patient is already affected by fluorosis. Several studies have identified a strong correlation between the accumulation of fluoride in the body and mild-to-moderate anaemia. The Indian National Health portal recommends supplements and iron rich foods such as beans, meat, and raisins, but as fluoride hampers the ability of the digestive systems to absorb nutrients, a good diet and supplements prescribed by doctors are insufficient to solve the problem.

A growing body of research is now placing greater focus on eliminating excess fluoride from diets rather than replacing missing nutrients with supplements. UNICEF recommends helping people identify safe water sources and promotion of kitchen gardens with plants such as tamarind or guava, that help decrease fluoride absorption. And while promoting dietary changes is a tough battle, especially in a country with ancient food traditions like India, both Susheeta and Santdasani agree that raising awareness among pregnant women may be the best starting point, because they are more at risk and want their babies to be healthy. In addition to advocacy work at a community and political level, "a targeted social media campaign would go a long way," says Santadasani, "because even in rural areas everyone now has a phone with good signal."

With a global pandemic looming at its doorstep, India's health-care providers are currently focused on preventing the spread of Coronavirus in the country, which for now is contained to the tens of cases. But according to Susheeta, long-term goals should never fall off the radar, especially when it comes to maternal health: "When pregnant women consume fluoride they are not able to absorb iron and other supplements that they are provided with in antenatal clinics," she says, "so they often become nearly anaemic, delivering small babies or risking their lives." High infant and maternal mortality are particularly devastating for the country, she warns.

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