

Denser but Not Stronger? Fluoride-Induced Bone Growth and Increased Risk of Hip Fractures

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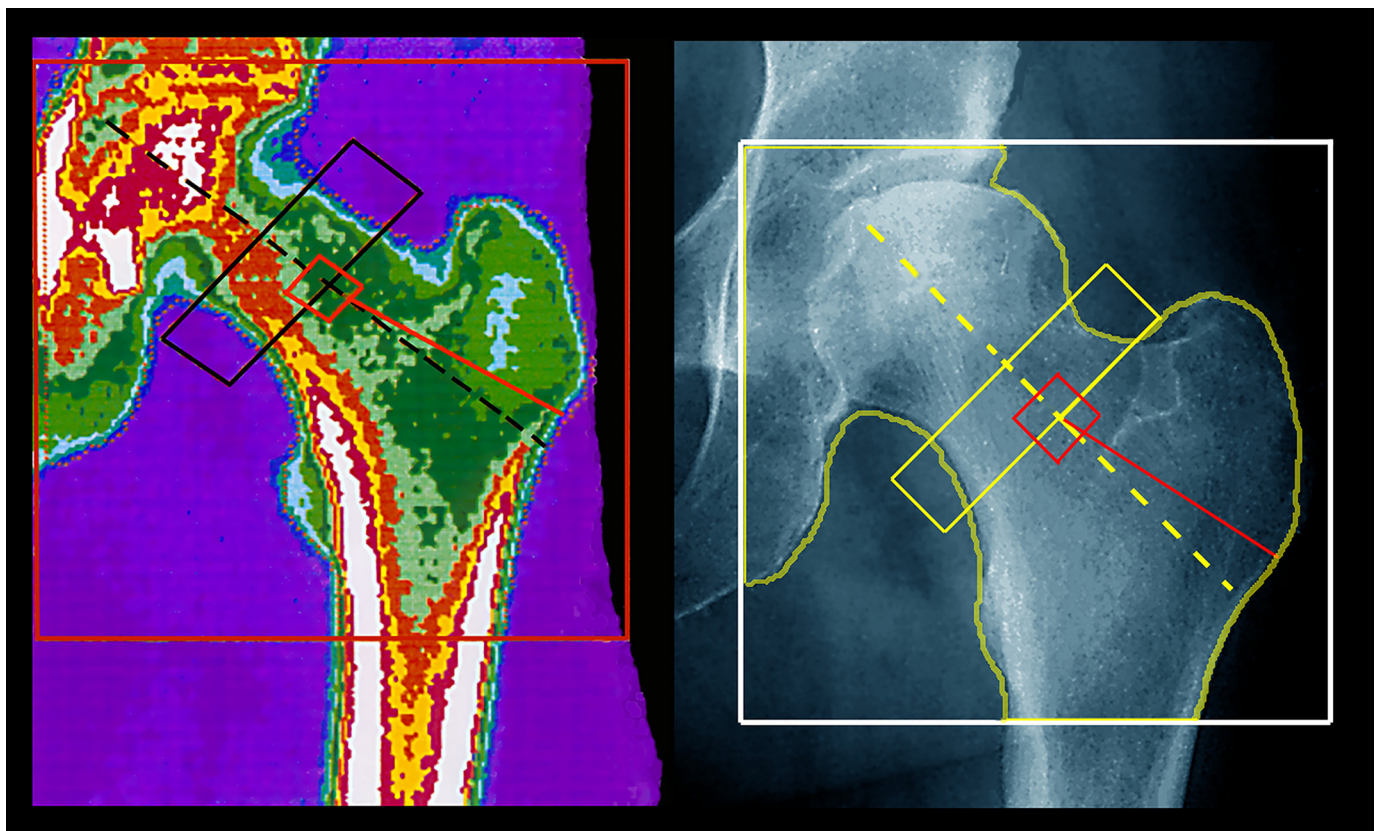
Since the mid-1940s, fluoride has been added to toothpaste and (in some countries) tap water, table salt, or milk to reduce dental cavities.¹ Although low-level fluoride supplementation prevents cavities, higher levels cause white mottling of the teeth.² What is more, some studies suggest fluoride in drinking water may increase the risk of bone fractures, although results have been mixed.^{3,4} A new study in *Environmental Health Perspectives* sheds light on this issue, examining the association of fluoride intake with bone mineral density (BMD) and fracture incidence in postmenopausal women.⁵

The study used data from the Swedish Mammography Cohort, part of the Swedish Infrastructure for Medical Population-based Life-course and Environmental Research (SIMPLER) project. When the cohort was established in 1987, women completed a questionnaire about lifestyle and dietary habits, with a follow-up survey in 1997. Between 2003 and 2009, a subset of more than 4,000 women underwent bone density scans and provided urine samples, which were tested for fluoride.

The new study is one of few that have used individual-level biomarkers to assess fluoride exposure. The researchers estimated fluoride intake from dietary sources and used information on naturally occurring concentrations in local water systems to estimate

intake via drinking water. They further estimated that the women with the highest third of fluoride consumption had a 59% increased risk of hip fractures, but not other fracture types, compared with the third who consumed the least. Limiting the analysis to women who drank the same water for at least 22 years (estimated by residential history) strengthened the association with fractures. The study also found higher BMD in the highest versus lowest third of urine fluoride and dietary intake. This was observed in a population with fluoride concentrations in drinking water below the current maximum limit (1.5 mg/L) recommended by the World Health Organization,⁶ says Emilie Helte, a doctoral student in nutritional epidemiology at the Karolinska Institute and first author on the article.

The study's strengths are its size, individualized measures of exposures based on urinary and estimated dietary intake, and control for many potential confounders. "The increased rate of hip fractures associated with exposure to fluoride is substantial and of public health significance," says Christine Till, an associate professor of psychology at York University, who has studied the effects of fluoride in children and pregnant women. "It's interesting that the associations between urinary fluoride and fractures became stronger when the sample was restricted to women with a



Left to right: Bone densitometry scan and X-ray of the same area of a left hip. High bone mass density does not necessarily make for strong bones. "The hypothesis is that although fluoride stimulates bone formation, the bone that is formed has a lower quality and can more easily break," explains author Emilie Helte. Image: © Zephyr/Science Source.

stable residential status,” she says. This could point to the importance of considering lifetime exposure to fluoride. Till was not involved in the current study.

Jane Cauley, a professor of epidemiology at the University of Pittsburgh, notes that the authors did not speculate on why the association was limited to hip fractures as opposed to major osteoporotic fractures in general. “If the mechanism is an effect on bone strength,” she says, “then why would BMD be higher, and why wouldn’t the effect on bone strength translate to other fractures?” Cauley also was not involved in the study.

BMD measures the mass of minerals, usually calcium and phosphorous, per volume of bone. Perhaps counterintuitively, higher BMD is linked to a higher incidence of fractures, particularly connected with fluoride intake. “The hypothesis is that although fluoride stimulates bone formation, the bone that is formed has a lower quality and can more easily break,” says Helte. “Denser bone doesn’t necessarily mean stronger bones.”

Fluoride has been known to increase BMD for years, and high-dose fluoride therapy was used in the 1990s to reduce bone fracture rates among women with osteoporosis.⁷ “Unfortunately, the treatment was not very successful, since although it increased BMD, it also increased nonvertebral fracture rates,” Helte says.

The new findings for older Swedish women may not apply to men or other populations. However, there may be important implications globally; the findings point to the need for more information on how much fluoride intake is beneficial versus too much, and whether the beneficial range might vary among population

subgroups. Helte says any change in policy should be made only after carefully weighing the positive effects of fluoride on oral health against any potential negative health consequences, such as increased susceptibility to fractures.

Wendee Nicole is an award-winning Houston-based writer. Her work has also appeared in *Discover*, *Nature*, *Scientific American*, and other publications.

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