



Fluoride and IQ Scores: A Closer Look at the Green Study

AUGUST 23, 2019

Background

[A study](#) published in the *Journal of the American Medical Association (JAMA) Pediatrics* has reported an association between fluoride exposure during pregnancy and the IQ scores of Canadian children. Researchers measured fluoride exposure for 512 Canadian mothers through urine samples collected during each trimester of their pregnancy. Roughly 40% of the mothers lived in fluoridated communities, and the remaining 60% lived in non-fluoridated communities. IQ scores were collected in two areas of intelligence: Verbal IQ (VIQ), which includes verbal reasoning and comprehension, and Performance IQ (PIQ), representing nonverbal reasoning, spatial processing and visual-motor skills. The study's lead author is Rivka Green of York University in Toronto.

The American Fluoridation Society (AFS) welcomes robust research on fluoride and fluoridation. However, we are concerned that the Green study may produce headlines that do not accurately reflect the study's data and methodology. It should be understood that an "association" does not prove causation.

Recent Research on IQs

Before taking a closer look at the Green study, it's important to consider the context. In recent years, multiple studies have found no link between fluoride exposure and intelligence/cognitive skills:

- The National Toxicology Program (NTP) conducted a [2018 animal study](#) and reported that "we observed no (fluoride) exposure-related differences in motor, sensory, or learning and memory performance" from this analysis.
- The *American Journal of Public Health* published a [New Zealand study](#) that stands out because it tested subjects' IQs over a 30-year period, making it a particularly robust study. The New Zealand study found no link between IQ scores and whether someone grew up living in a fluoridated community. Like the U.S., New Zealand is a nation where fluoridation programs are common.
- Swedish health economists examined the long-term effects of fluoride exposure on people's outcomes in the labor market. Although Sweden doesn't have local fluoridation programs, the economists compared labor market outcomes with the varying concentrations of fluoride in tap water across the country. In [their 2016 study](#), which has not yet been published, the coauthors concluded that "we find precisely estimated zero effects on cognitive ability, non-cognitive ability and education. We do not find any evidence that fluoride levels below 1.5 mg/L have negative effects . . . (and) we find evidence that fluoride improves labor market outcome later in life, which confirms that good dental health is a positive factor on the labor market."

Soon after the Green study was released, the American Academy of Pediatrics [reaffirmed its support](#) for community water fluoridation. "There are thousands of articles pointing to the safety of community water fluoridation and we need to continue to look at the impacts, but this study doesn't change the benefits of optimally fluoridated water and exposure to fluoride," said Dr. Patricia A. Braun, professor of pediatrics at the University of Colorado.

Kevin McConway, a British expert in applied statistics, reviewed the Green study and [offered his assessment](#):

"This question would need to be researched in a lot more detail, in my view, before any clear conclusions can be drawn. I think that there are far too many questions to be answered before pregnant women should feel they must reduce their fluoride intake, or public health authorities should change their advice of policies."

Let's consider some of the reasons why leading health officials are viewing the Green study with appropriate caution:

1. The data do not provide a convincing case for a fluoride-IQ link. Thom Baguley, a professor of experimental psychology at Nottingham Trent University, [told the Science Media Centre](#) “it is not correct to imply that the data here show evidence of a link between maternal fluoride exposure and IQ. The average change in IQ is not statistically significant.” Grainne McAlonan, a professor of neuroscience at King's College in London, reviewed the Green study and told the Science Media Centre that “if you look at average IQ in the children from fluoridated and non-fluoridated groups these are virtually the same: 108.07 vs. 108.21 respectively. I was therefore surprised that the study went on to look for a relationship between fluoridation and IQ, given these figures.” A senior fellow at the American Council for Science and Health contends that the Green study [does not meet](#) Hill’s Criteria of Causality—nine standards established in the 1960s by a widely respected British statistician.

2. The fluoride exposures which the Green study relied on are not very reliable. The Green study was based on “spot urine samples” instead of 24-hour samples, which most scientists consider the most reliable type of urine sample. Alastair Hay, an environmental toxicologist in England, [told the Science Media Centre](#) that the use of spot samples was “a crucial failure” of the Green study. “For a substance with a short half-life, such as fluoride, urine concentrations vary hugely and are really only representative of the last drink,” Hay added. “Validation of intake is something you must do before looking at associations.”

3. The gender differences have no clear explanation. The coauthors of the Green study called their findings “consistent” with the Bashash study of Mexican mother-child pairs, but Green differs from Bashash in at least one significant way. While Bashash found an association with IQ scores for children of both genders, the Green study did not. Higher fluoride exposure among Canadian boys was associated with lower IQ scores, but higher exposure for girls was linked to *slightly higher* IQ scores. The coauthors were unable to explain why such a gender difference would exist. Hay said he found the gender differences in IQ “difficult to explain. With a neurotoxicant you might expect both sexes to be affected.” Thom Baguley, a professor of experimental psychology, said:

“This is an example of subgroup analysis — which is frowned upon in these kinds of studies because it is nearly always possible to identify some subgroup which shows an effect if the data are noisy. Here, the data are very noisy.”

4. Other factors could have skewed the Green study’s results. When designing and conducting an IQ study, it is crucial to consider all of the other factors (confounders) that could have affected the results. This is particularly challenging for the topic of human intelligence because a wide range of factors can shape a child’s IQ.

- The Green study measured fluoride intake based solely on beverage intake. As the [American Association for Dental Research](#) explained, “Only beverages were considered in the measure of fluoride intake, but there are several common dietary sources of fluoride. Furthermore, data on beverage intake were collected using self-report, which is subject to recall bias, and the authors did not have access to the concentration of fluoride from each subject’s tap but had to estimate based on where the subject lived. As the authors state, an individual’s tap water could be supplied by multiple treatment plants.”
- Lead is another potential confounder. Although the Green researchers looked at lead concentrations in mothers, they did not have data on children’s lead exposure during the three or more years that passed between their births and their IQ tests. Hay called this “the major serious gap” in the Green study.
- The Green researchers did not have data on the IQ scores or educational achievement of mothers. Research has linked these factors to their children’s cognitive ability, so the absence of these data is an unfortunate gap.
- Socioeconomic status (SES) is another factor that could have affected the IQ scores. For example, a [large study in Scotland](#) found that the father’s social class around the time of birth was “an important predictor of childhood intelligence, even after adjustment for maternal characteristics and perinatal and childhood factors.” While the Green study did ask mothers some SES-related questions, the information gathered was not comprehensive — and there is no indication that information specifically about fathers’ SES was collected.
- Dr. Steven Novella, an academic clinical neurologist at Yale’s School of Medicine, has questioned how the Green coauthors interpreted the study’s data and [wrote a recent article](#) pointing to several “red flags” in the study, including “the huge variance in results, and the disconnect between performance and verbal IQ.”



The coauthors of the New Zealand study concluded their *American Journal of Public Health* article with this important advice: “Scientists and policy makers should be reminded of the necessity of caution in attributing causality when evidence for it does not exist.”

Tooth decay is the [most common chronic disease](#) for children and teens. Additionally, tooth decay is a lifelong disease which affects adults and our aging population. Fluoride in drinking water, toothpaste and other modes helps to prevent tooth decay and reduce the severity of it. People and communities should not be scared into making a decision that will harm their oral health and overall health.

Learn more about fluoride and oral health at <https://americanfluoridationsociety.org/>.