December Article of the Month

Prenatal Fluoride Exposure and Cognitive Outcomes in Children at 4 and 6–12 Years of Age in Mexico

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ABSTRACT

Background:

Fluoride is a common substance in our drinking water, dental products, occasionally in processed foods and beverages, and other sources. However, it is not a naturally occurring substance in our water systems or dental products – it was added with the intent of preventing dental cavities and tooth decay [1]. Over the years, research findings suggest that excessive fluoride may cause damage to a child's brain and/or nervous system. For example, some research indicates that higher levels of fluoride can lead to lower IQ in children. Other harmful effects to children may include skeletal fluorosis (denser bones, joint pain, and limited joint movement) as they age. It may also lead to higher risk of bone fractures or memory loss, and some animal studies with rats showed links between high doses of fluoride and decreased fertility and bone cancer [2]. Yet, most of the research on health effects to humans have involved relatively short-term studies. Also, very few studies used individual measures of fluoride exposure, investigated the impact of exposures during pregnancy, or involved more than 100 participants.

Objective:

To estimate the association between mothers' fluoride exposure during pregnancy and the offsprings' brain and nervous system (neurocognitive) development in early childhood.

Methods:

Study population/participants:

Mother-child pairs from the Early Life Exposures in Mexico to Environmental Toxicants (ELEMENT) Project were studied, and because they all lived in Mexico, each one had expectedly been exposed to fluoridated salt as well as to varying degrees of naturally-occurring fluoride in their drinking water.

Exposure assessment:

Individual measures of fluoride exposure were obtained from urine samples taken from mothers during pregnancy and from their children when they were between ages 6 and 12.

Outcome assessment:

Child intelligence was measured at age 4 using performance scores on the General Cognitive Index (GCI) of the McCarthy Scales of Children's Abilities. This testing evaluated the children's verbal, perceptual-performance, quantitative, memory, and motor abilities. The Wechsler Abbreviated Scale of Intelligence At was used to determine the children's full scale intelligence quotient (IQ) at age 6-12.

Results:

Complete data was collected from 299 mother-child pairs. The study found that an increase of maternal fluoride exposure predicted lower GCI and IQ scores in the offspring. Specifically, an increase of 0.5mg/L of maternal urine fluoride led to an average of 3.15 points lower GCI and 2.5 points lower IQ in children.

Conclusion:

In this study, higher prenatal fluoride exposure was associated with lower scores on tests of cognitive function in the offspring at age 4 and age 6–12. These findings must be confirmed in other studies, and more research on how urine fluoride concentrations result from intentional consumption versus environmental exposures is needed. The findings, combined with evidence from already existing animal and human studies, reinforce the need for additional research on potential harmful effects of fluoride, especially in pregnant women and children. This would also be to ensure that the benefits of population-level fluoride supplementation to prevent tooth decay outweigh any potential risks.

POLICY IMPLICATIONS

The U.S. Environmental Protection Agency (EPA) is responsible for establishing acceptable standards of fluoride in public drinking water systems. Standards of fluoride in toothpaste are regulated by the Food and Drug Administration (FDA) if the toothpaste is classified as a "drug" (to prevent cavities with fluoride) rather than a cosmetic (to whiten teeth only) [3]. Some toothpastes are classified as both, and are also FDA-regulated. The FDA Code of Federal Regulations, Title 21, shows that the range of acceptable fluorine (of which fluoride is a chemical ion) is between 850 to 1,500 parts per million (ppm) [4]. While there is controversy regarding added fluoride to anything humans use or consume, including toothpaste, most of the focus has been on fluoride in public drinking water.

In 2006, in order to determine if the drinking water standards were acceptable in protecting the public health, the EPA asked the U.S. National Research Council (NRC) to reexamine the standards for fluoride contamination, including the maximum contaminant level goal (MCLG, a concentration at which no negative health effects are expected) of 4 mg/L.

The NRC concluded that the EPA's drinking water standard MCLG of 4 mg/L is "not adequately protective of health", as it increases risk of severe enamel fluorosis (highly noticeable staining of the teeth), skeletal fluorosis, as well as potentially increased risk of bone fractures. This federal scientific review also noted the mixed findings with regard to fluoride exposure and risk of cancer, and potential brain function risks [5].

The EPA recently announced their third Six-Year review of national drinking water regulations, but determined that a change in fluoride standards is not appropriate at this time [6]. Fluoridated public drinking water has been shown to successfully improve dental outcomes for children, which is particularly important for low-income children who may not have adequate access to dental care. The

American Dental Association says that studies show water fluoridation has effectively reduced dental decay by 20-40%, and thus the Centers for Disease Control and Prevention named it one of the top 10 greatest public health achievements by the 20th century [7]. As such, more significant evidence of harm, from rigorous studies, would be necessary before re-examining the benefits of fluoridated drinking water.

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