INTRODUCTION

Water fluoridation represents a public health intervention that has been shown to be effective in preventing dental decay. The safety of fluoridation is well established and the process for assuring safety is ongoing. Because of concerns about the effects of environmental agents such as lead, mercury and arsenic on developing brain, some researchers are curious to see if there is a similar effect of fluoride on the brain.

If fluoride exposure at levels commonly seen in the US is causing adverse effects on the brain and neurodevelopment, this would be a serious concern. Some recent studies that have been widely cited raise questions about the potential effects of high levels of fluoride on intelligence and behavior. Here we present a summary based on expert reviews regarding the potential for toxic effects on brain (neurotoxicity) and behavior arising from fluoride exposure.

The National Research Council’s (NRC) Committee on Fluoride in Drinking Water examined the evidence on the potential adverse health effects of much higher levels of fluoride in drinking water. According to that Committee, “At the present time, questions about the effects of the many histological, biochemical, and molecular changes caused by fluoride cannot be related to specific alterations in behavior or any known disease.”

Recently, several low quality studies conducted in China, Mexico and India have claimed that fluoride in drinking water could lead to lower IQ levels among children. These are cross-sectional or ecological studies. These study designs are inherently weak in terms of their ability to draw conclusions about cause and effect. For example, with cross sectional study designs, it is not clear whether people with higher IQ move out of the polluted areas because of concerns about health effects thus leaving behind people with lower IQ or lower IQ is a result from the effects of pollution.

Several of the studies were conducted in rural China where the living conditions are poor and water is not clean. According to one of such study by Wang San-Xiang and colleagues “This region is very poor, even by Chinese standards, with an annual income of approximately US$120 per family.”

To assess the quality of these studies, the South Central Strategic Health Authority in the United Kingdom requested an independent group of experts at Bazian, a reputable group of researchers to conduct a review. According to this review, “In our appraisals we found that the study design and methods used by many of the researchers had serious limitations. The lack of a thorough consideration of confounding as a source of bias means that, from these studies alone, it is uncertain how far fluoride is responsible for any impairment in intellectual development seen. The amount of naturally occurring fluoride in drinking water and from other sources and the socioeconomic characteristics in the areas studied is different from the UK and so these studies do not have direct application to the local population of Southampton.” Regarding a systematic review Tang QQ, et al. Fluoride and children’s intelligence: a meta-analysis. [Biol Trace Elem Res. 2008;126:115-201], the reviewers state that “The authors of one of the systematic reviews have combined the results of these confounded observational studies into summary measures by meta analysis in a way that is not statistically appropriate or valid. The authors’ interpretation of the results is incorrect.”

Whitford et al. tested the effects of high levels of fluoride on the ability to learn in rats under controlled experimental conditions. The authors concluded that there were no significant differences among the groups in learning or performing the response.
SUMMARY OF RELEVANT ARTICLES


The authors conducted a laboratory study using 32 female rats. These rats were provided with water containing different doses of fluoride (0, 2.9, 5.7, 11.5 mg/kg body weight/day) for eight months. These rats were tested for their ability to learn a response for food.

The authors observed that there was no evidence of learning deficits in any of the fluoride-exposed groups. Although not statistically significant, it was the non-fluoridated control group that took longer to reach criterion for acquiring the bar-press response ((0 fluoride 6.38 ± 0.38 days), (2.9mg/kg 5.75 ± 0.37 days), (5.7mg/kg 5.63 ± 0.46 days), (11.5mg/kg 5.63± 0.42)). The authors concluded that there were no significant differences among the groups in learning or performing the response. “Chronic ingestion of fluoride at levels up to 230 times more than that experienced by humans whose main source of fluoride is fluoridated water had no significant effect on appetitive-based learning.”


The authors measured the intelligence quotient (IQ) in 720 school-age children, 8-12 years old, residing in rural villages in China. The study was conducted to determine the effect of high arsenic and high fluoride (190±183microgram/L As and 8.3 ± 1.9 mg/L F) on IQ. A control group of people receiving low arsenic and low fluoride (3 ±3micrograms/L As and 0.5±0.2 mg F/L) was used as a comparison group. It should be noted that the level of fluoride in the control group is similar to a fluoridated community in the US. Hence, the study population in the high fluoride exposure is not representative of individuals drinking fluoridated water in the US. Also, the authors acknowledged the fact that the distribution of children’s IQ is slightly skewed in the control group. The average IQ for the high fluoride group was 100.5 ± 15.8 while the average IQ for the control group was 104.8 ± 14.7. The average IQ of Chinese children was reported to be 103.5±17.7. Children exposed to high arsenic had an average IQ of 95.1±16.6.

The authors observed the significant effect of arsenic exposure on children’s intelligence. The author’s also expressed caution in interpreting the results of the study by acknowledging that children’s intelligence, growth and development can be influenced by many factors such as inheritance, nutrition, geography, education and society. The authors state that they could not rule out the effect of arsenic in the high fluoride group as they did not assess the exposure in a large proportion of children in the high fluoride group.

Independent critical appraisal of selected studies reporting an association between fluoride in drinking water and IQ: a report for South Central Strategic Health Authority. London, UK: Bazian Ltd; 2009 February 11.

The report noted that reviewed primary studies were conducted in China, Mexico, Iran and India. These studies used cross sectional or ecological methods to investigate whether high environmental exposure to fluoride or arsenic or low exposure to iodine was associated with lower IQ.

According to this independent report, the lack of a thorough consideration of confounding as a source of bias means that, from these studies alone, it is uncertain how far fluoride is responsible for any impairment in intellectual development seen. Bazian acknowledged that these confounding factors (parental education, socioeconomic measures and environmental exposures to other chemicals such as arsenic and iodine in water) could explain some or all of the impairment in IQ. The report also mentioned that sources of fluoride exposure that exist in China and India do not exist in the UK, for example high fluoride coal and eating contaminated grain, which can substantially contribute to fluoride exposure.
ADDITIONAL CREDIBLE ONLINE RESOURCES

U.S. Centers for Disease Control and Prevention: Infant formula and fluorosis
http://www.cdc.gov/fluoridation/safety/infant_formula.htm

American Dental Association: Infant formula and fluoridated water
http://jada.ada.org/content/142/1/79.full

American Dental Association: Reconstituted Infant Formula and enamel fluorosis: