



Critical Review and Appraisal:

Malin & Till, 2015. Exposure to fluoridated water and attention deficit hyperactivity disorder prevalence among children and adolescents in the United States: An ecological association.¹

a) Critical Appraisal – Using 11 questions to help you make sense of descriptive/cross-sectional studies²

Poor quality ecological study. Limitations are:

- Unclear if sample was representative of the population;
- Power calculation was not provided;
- Measurement of fluoride exposure was ecological, and ADHD prevalence was based on parental self-report;
- Other sources of fluoride exposure were not quantified; and
- Key confounders other than SES (prenatal and neonatal exposure to lead, arsenic and manganese, and other neurological conditions or brain trauma) were not controlled for in the analysis; and
- Inadequate description and interpretation of the results (e.g., authors did not adequately explain why their results showed no/negative association between ADHD prevalence in areas with natural fluoride).

b) Key Findings (as reported in the study)

- Parents reported higher rates of medically-diagnosed ADHD in their children in US states with a greater proportion of people receive fluoridated water.¹
 - State prevalence of artificial water fluoridation in 1992 predicted state prevalence of ADHD in 2003 ($p = 0.004$), 2007 ($p = 0.011$) and 2011 ($p = 0.002$), after controlling for socioeconomic status.¹
- Each 1% increase in artificial fluoridation prevalence in 1992 was associated with approximately 67,000 to 131,000 additional ADHD diagnoses from 2003 to 2011.¹

c) Limitations/Considerations

- Poor quality ecological study with important design limitations – e.g., at high risk of ecological fallacy, measurement error (ADHD prevalence based on self-report), and confounding bias.
- The authors' provide a bias view of the effects of fluoridation on children's cognitive functions in their "introduction" and "discussion" sections; they state "Fluoride is a developmental neurotoxin associated with impaired cognitive functioning in infants and children" (page 9)¹. Their conclusion is misleading for three reasons:
 1. They reference Grandjean & Landrigan (2014)³, a poor quality literature review, as evidence that fluoride is a neurotoxin. Grandjean & Landrigan conclusions are based on Choi et al. (2012)⁴ systematic review, which included poor quality primary studies that did not control for confounders and not applicable to community water fluoridation.
 2. They fail to cite a recent strong quality cohort study by Broadbent et al. (2014)⁵, which reported New Zealand children (followed from birth) living in fluoridated communities (0.85 ppm) did not differ in IQ compared to those living in non-fluoridated communities (0.0-0.03 ppm). This held true at age 38 years, both before and after adjusting for confounders.
 3. They fail to report three scientific reviews that have concluded insufficient evidence of an association between optimal fluoride consumption and adverse health effects.^{6,7,8}



d) Final Summary Analysis

- The quality of the evidence is poor with important methodological limitations, and should be interpreted with great caution (e.g., at high risk of ecological fallacy, measurement error and confounding bias).
- The authors' assessment of the evidence-base is unbalanced, misleading and lacks citation of key studies.
- The results of this study do not support the consistent findings of three scientific reviews, which report insufficient evidence of an association between optimal fluoride consumption and adverse health effects.

References

1. Malin AJ, Till C. Exposure to fluoridated water and attention deficit hyperactivity disorder prevalence among children and adolescents in the United States: an ecological association. *Environmental Health*, 2015; 14 (17).
2. Questions to help you make sense of descriptive/cross-sectional studies. Albert Einstein College of Medicine of Yeshiva University NY. 2002 [cited November 18, 2014]. Retrieved from <http://reache.files.wordpress.com/2010/03/cross-sectional-appraisal-tool.pdf>.
3. Grandjean P, Landrigan PJ. Neurobehavioural effects of developmental toxicity. *The Lancet Neurology*. 2014; Volume 13, Issue 3, Pages 330-338.
4. Choi AL, Guifan S, Zhang Y, Grandjean P. Developmental Fluoride Neurotoxicity: A Systematic Review and Meta-Analysis. *Environmental Health Perspectives*. 2012; 120 (10): 1362-1368.
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6. Center for Reviews and Disseminations. *Fluoridation of Drinking Water: A Systematic Review of its Efficacy and Safety*. York, UK: University of York, 2000.
7. Health Canada. *Guidelines for Canadian Drinking Water Quality: Fluoride Guideline Technical Document*. Environmental and Workplace Health, Prepared by the Federal-Provincial-Territorial Committee on Health and the Environment. December 2010.
8. McDonagh, M S, et al. Systematic review of water fluoridation. *Br Med J*, 2000; 321: 855-859.