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A safe level of fluoride in water for pregnant women in order to prevent foetal IQ loss

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ABSTRACT

A recent study by Grandjean et al. concluded that the pooling of results from three prospective cohorts, conducted in areas with wide ranges of overlapping fluoride exposure levels, to produce more than 1500 mother-child pairs, offers strong evidence of prenatal neurotoxicity from fluoride, and that these findings should inspire a revision of water fluoride recommendations aimed at protecting pregnant women and young children. The benchmark concentration lower confidence limit (BMCL) for the maternal urinary fluoride level in pregnancy which results in the loss of 1 IQ point was found to be 0.3 mg/L. This corresponds to a drinking water fluoride level of approximately 0.3 mg/L and suggests the currently recommended level of fluoride for community water fluoridation of 0.7 mg/L needs to be lowered to provide a safe level of fluoride in water for pregnant women in order to prevent foetal IQ loss.

Key-words: Developmental neurotoxicity; Fluoride level in water; IQ.

A recent paper by Grandjean et al. provides further evidence that foetal toxicity can occur with a reduction in IQ when the maternal urinary fluoride is above 0.3 mg/L.[1] Grandjean et al. noted that fluoride may be a developmental neurotoxicant at elevated exposures. They merged new data from a prospective Odense Child Cohort (OCC) in Denmark with results from two previous birth cohort studies from Mexico[2] and Canada[3] to characterize the dose–effect relationship in greater detail. The OCC contributed 837 mother–child pairs to the total of >1500. They measured creatinine-adjusted urinary fluoride concentrations in maternal urine samples obtained during late pregnancy. Child IQ was determined at age 7 years using an abbreviated version of the Wechsler Intelligence Scales for Children. Findings from the three cohorts were used to calculate the joint benchmark concentration (BMC) and the lower confidence limit (BMCL) after adjustment for covariables. BMC calculations were carried out to assess the maternal urinary fluoride concentration associated with a benchmark response of a one point reduction in child FSIQ score, as compared with an unexposed mother and the same profile of covariates.

The covariables possibly associated with the full-scale IQ (FSIQ) considered in the OCC statistical analysis were sex, preterm birth (gestational age <37 weeks), parental education, maternal smoking, alcohol intake during pregnancy, duration of breastfeeding, school type, school grade. In the Mexican study (Early Life Exposure in Mexico to Environmental Toxicants [ELEMENT])[5] the covariables studied included gestational age in weeks, birth weight, age at outcome measurement, maternal parity, maternal smoking history, marital status, age at delivery, maternal IQ, education, and the specific sub-cohort identity. In the Canadian study (Maternal-Infant Research on Environmental Chemicals [MIREC])[3] the covariables examined included sex, city of residence, HOME (Home Observation for Measurement of the Environment) score, maternal education, and maternal race/ethnicity.

The authors found that in the OCC, the urinary fluoride concentrations varied between 0.08 and 3.04 mg/L (median 0.52 mg/L) but were not significantly associated with full-scale IQ at age 7 years ($\beta = 0.08$; 95% confidence interval –1.14 to 1.30 for a doubling in exposure). No difference was apparent between boys and girls. In the OCC, the BMC was 0.92mg/L, with a BMCL of 0.30 mg/L.

The joint analysis of all three cohorts showed a statistically significant association between urinary fluoride and IQ, with a BMC of 0.45 mg/L (BMCL, 0.28 mg/L), slightly higher than the BMC previously reported for the two North American cohorts alone. Grandjean et al. concluded that the BMCL reflects an approximate threshold for developmental neurotoxicity and that the results suggest that pregnant women and children may need protection against fluoride toxicity.

The authors considered that the findings supported the view that fluoride is a developmental neurotoxicant, causing adverse effects on brain development in early life, when exposures exceed a low background level. They observed that given the ubiquity of elevated fluoride exposure, the population impact of adverse effects from fluoride may exceed that associated with other toxic elements like lead, mercury, and arsenic.[4,5]

The authors noted that individual vulnerability, including genetic predisposition, and iodine deficiency in pregnancy may affect the outcome. Prenatal and early postnatal exposure to lead did not affect the fluoride associated IQ deficits in the ELEMENT study. Similarly, adjustment for arsenic, lead, perfluoroacetic acid, and mercury exposure did not appreciably change the estimates in the MIREC study.

Grandjean et al. concluded that the pooling of results from three prospective cohorts conducted in areas with wide ranges of overlapping exposure levels offers strong evidence of prenatal neurotoxicity, and these findings should inspire a revision of water fluoride recommendations aimed at protecting pregnant women and young children. They give, as an example of the need for revision, the World Health Organization's recommendation of 1.5 mg/L as an upper limit for fluoride in drinking water which was made without consideration of developmental neurotoxicity. The BMCL fluoride concentration in maternal urine during pregnancy of about 0.3 mg/L suggests that public health attention should be given to elevated fluoride intakes during pregnancy, whether from drinking water, black tea, or other sources.

A Polish study of 31 pregnant women aged 22 to 34 years, and 30 non-pregnant women, aged 21 to 34 years, using drinking water with fluoride levels of 0.4 to 0.8 mg/L found a mean urinary fluoride level in the control group of 1.300 mg/L and of 0.653 and 0.838 mg/L at 28 and 33 weeks of pregnancy, respectively.[6] The lower urinary fluoride levels in the pregnant women was attributed to the incorporation of fluoride into foetal hard tissues with a resultant decreased elimination of fluoride in the urine.[6] In the discussion it was noted that key sources of fluoride intake apart from water included tea, fish, chicken, and meat.[6] With the mean urinary fluoride levels of 0.653 and 0.838 mg/L found in pregnant women using water with fluoride levels of 0.4 to 0.8 mg/L, an estimate can be made of the drinking water fluoride level likely to result in a urinary fluoride level of 0.3 mg/L. As an approximation, if a urinary fluoride level of 0.7455 mg/L (average of 0.653 and 0.838) is produced by a water fluoride level of 0.6 mg/L (average of 0.4 and 0.8), then a urinary fluoride level of 0.3 mg/L would be produced by a water fluoride level of 0.24 mg/L ($0.6 \times 0.3/0.7455$) or approximately 0.3 mg/L This is significantly less than the level of 0.7 mg/L recommended for community water fluoridation.[7] As noted by Grandjean et al., the current guidelines may need to be lowered to provide a safe level of fluoride in drinking water in order to prevent foetal IQ loss.

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