

# Health effects on IQ of fluoride

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**A**lthough the 2014 report, *Health effects of water fluoridation: a review of the scientific evidence*, found that water fluoridation did not adversely affect brain development, it recommended that a similar review should be repeated if a large well-designed study was published that appeared likely to have shifted the balance of health benefit vs health risk.<sup>1</sup> Three such large well-designed prospective studies on fluoride and IQ published since 2014,<sup>2–4</sup> found through PubMed searching and involving 65, 299 and 601 mother-child pairs, respectively, concluded that fluoride, at the levels found with water fluoridation, 0.7–1.0mg/L,<sup>1</sup> does adversely affect brain development. These studies were better designed than two earlier prospective studies from New Zealand which were ecological studies of groups rather than using individual data from mother-child pairs.<sup>5,6</sup>

In the recent studies,<sup>2–4</sup> substantial IQ losses were associated with higher urinary and water fluoride concentrations. In the study by Bashash et al, an increase in the maternal urinary fluoride by 0.5mg/L (approximately equalling the difference between fluoridated and non-fluoridated regions) predicted a decrease in the IQ of the offspring at ages 6–12 years of 2.50 IQ points.<sup>2</sup> In the study by Green et al, an increase in the water fluoride concentration of 1mg/L was associated with a decrease in the 8.8 IQ points in the children who have been formula fed in the first six months of life, while no such difference was seen among the exclusively breast-fed children.<sup>4</sup> These IQ impairments are consistent with the difference of almost 7 IQ points between the exposed groups and controls found in a 2012 meta-analysis<sup>7</sup> and with a statistically significant loss of 8.6 IQ points for each increase by 1mg/L in the fluoride concentration in water found in a large

cross-sectional study from 2018.<sup>8</sup> In other recent studies from 2020, Wang et al,<sup>9</sup> in a study of 572 children, found a lower loss of 1.6 IQ points for each increase by 1mg/L in the fluoride concentration in water while Till et al,<sup>10</sup> in a study of 398 mother-child dyads, found that an increase of 0.5mg/L in water fluoride corresponded to a 9.3 and 6.2 IQ points decrement in performance IQ among formula-fed and breast-fed children, respectively, which remained significant after controlling for fetal fluoride exposure. A 0.5mg increase in fluoride intake from infant formula corresponded to an 8.8 IQ points decrement in performance IQ and this association remained significant after controlling for fetal fluoride.<sup>10</sup>

Although these recent studies<sup>2–4</sup> showed a dose-dependent fluoride neurotoxicity that appeared to be statistically significant at water concentrations of or below 1mg/L, they did not identify a likely threshold. Bench mark dose (BMD) calculations may be used to develop non-cancer health-based limits for dietary intakes, such as drinking water, and Hirzy et al<sup>11</sup> used this approach to generate benchmark results from a study by Xiang et al<sup>12</sup> of more than 500 children in China. The lower confidence limit for the benchmark dose (BMDL) of 1 IQ point was calculated to be a daily intake level of 0.27mg/day.<sup>11</sup> Using the average water intake of 1.24 L/day in non-pregnant women, this BMDL corresponds to a water concentration of 0.22 mg/L.

Grandjean<sup>13</sup> used the regression coefficients and their standard deviations in the studies by Bashash et al<sup>3</sup> and Green et al<sup>4</sup> to estimate tentative BMD values and found a BMDL of about 0.2mg/L or below, a level that is similar to the result calculated by Hirzy et al<sup>11</sup> and clearly below the exposure levels in communities with drinking water fluoridation.

In my opinion, there now little doubt that developmental neurotoxicity, with permanent adverse effects, is a serious risk associated with elevated fluoride exposure during early development. In conclusion,

these three recent studies should be quality reviewed to determine whether or not, in the context of the existing evidence, they shift the balance of health benefit vs health risk for water fluoridation.

**Competing interests:**

Nil.

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