

# Health Effects of Mercury: New Insights

## Issue Brief

Public health concerns about exposure to mercury arise from the possibility of developmental effects on children if they are exposed to high levels before birth. Children are primarily exposed to mercury before birth if their mothers ingest mercury-tainted fish while pregnant. The U.S. EPA has developed a regulatory standard for mercury ingestion for women of childbearing age which is referred to as the Reference Dose. The standard is based on data from studies of mercury-exposed populations in island nations and incorporates a number of numerical adjustment factors designed to ensure protection of the most sensitive individuals. New evidence shows that the use of these adjustment factors is highly conservative based on results from neurological tests used on the populations studied. The standard already accounts for a range of children born “at risk.”

### How Was the EPA Mercury Health Standard Derived?

EPA has defined an exposure standard, called a Reference Dose (RfD), for methylmercury, the form of mercury to which people are most likely to be exposed via consumption of fish. The standard was developed by examining results of neurological tests administered to a group of about 700 children who had a range of mercury exposures. First, EPA selected the lowest level of mercury exposure at which effects were observed in the children tested. They then applied numerical adjustment factors to lower this level to a value that would assure protection of the most sensitive individuals. EPA then calculated what rate of ingestion of mercury contained in food could lead to this level of exposure.

The current EPA RfD is expressed as a rate of mercury ingestion per unit of body weight per day for each individual. This ingestion rate is defined as a level of exposure that is without risk of adverse effect even if it continues over an entire lifetime. The current RfD for methylmercury is 0.1 micrograms of methylmercury per kg of body weight per day.

### Have the Appropriate Tests Been Selected for Establishing the Mercury Reference Dose?

In establishing the RfD, EPA examined results from several tests administered to 7-year-olds living in the Faroe Islands in the North Sea. These children were selected because their diet is dominated by seafood. Mercury exposure among women and their newborns in the Faroes is primarily from the ingestion of pilot whale meat, rather than from local fish (which are relatively low in mercury). A number of diverse tests were administered to these children to assess their neurological well-being. The Boston Naming Test (BNT) was selected as the test whose scores were most sensitive to developmental differences. Those test scores for each child were the primary basis for setting the RfD.

The BNT consists of displaying illustrations of individual objects or animals on large cards to the child being tested, and awaiting the child's naming of the object (in this case in Faroese). The person giving the test is allowed to “cue” or provide a hint to test subjects who exhibit long delays in responding. Cued correct answers are scored lower than uncued correct answers.

The BNT was originally developed in the United States as a tool for identifying adults with aphasia, a deficit in language use or comprehension. The

expected scores for BNT administered to groups of unimpaired children (that is, children whose other developmental test scores lie within the normal range) tend to fall in the range of 35 to 40. Notably, after much research on a number of groups of U.S. children, investigators concluded that the BNT score corresponds more closely to acquired word knowledge than to neurological development traits (such as verbal memory) that might be impacted by excess levels of mercury prior to birth.

The BNT test results for the Faroe Island children exposed to methylmercury in their mothers' wombs showed scores ranging from 25 to 27 for those who had the lowest mercury exposure. There was no control group in this study, i.e., there were no children tested who had not been exposed to some level of mercury via the seafood their mothers had consumed. The difference of 10 to 15 score points between the lowest-exposure Faroese children and "normal" U.S. children suggests that other or additional exposure factors – such as prior word knowledge or test administration procedures – may have influenced test scores in the Faroe Island study.

#### Are Newborns "At Risk" if Their Mothers Have Blood Mercury Levels Above the Reference Dose?

Data collected by federal and state agencies on the blood mercury levels of U.S. women show that about 4% of women, corresponding to about 160,000 U.S. newborns per year, have blood mercury levels above the EPA Reference Dose. Characterizing children exposed above the RfD as being born "at risk" for neurological or developmental harm from mercury implies that the RfD represents a "bright line" separating safe from harmful exposures.

In fact, test data indicate that a child's intellectual abilities developed prior to and following birth are not well-measured by the BNT scores (nor by the other tests used in the Faroe Islands, which showed less dependency on mercury exposure levels than did the BNT). Nevertheless, this single set of tests involving Faroese children was used to gauge the outcome of exposure to mercury for children born to

U.S. women and to derive a dose-response relationship leading to the methylmercury RfD.

#### How Well Does the Derived Dose-Response Model Reflect the Range of Mercury Effects?

Using the Faroes BNT data, a National Research Council specialist panel derived a dose-response model during a scientific review of the basis for the EPA Reference Dose. The model predicts that Faroese children's BNT scores are lowered proportionally to the methylmercury in their umbilical cord blood at birth. It follows that this model can then be used to compare what the BNT test scores would be in children unexposed to mercury versus those whose mothers were exposed to mercury equal to the RfD. The difference between these two levels of exposure corresponds to a change of 0.25% in the average score on a BNT test.

For the 160,000 U.S. children born yearly "at risk," (e.g., their mothers have blood mercury levels at or above the RfD equivalent) the expected BNT score is 38.73 while the mean BNT score for all U.S. children is 38.83. This difference of a 0.1 score point on the BNT is insignificant, given that the standard deviation of BNT test scores is in the range of 4 to 6. In other words, exposure at or above the Reference Dose results in a change in developmental scores that is indistinguishable from the normal range of scores in an average, unexposed group of American children.

Similarly, the EPA dose-response model indicates that the test scores for children of the most highly exposed U.S. women will be 1.6% lower than those for children unexposed to mercury. Again, this difference is insignificant given the much higher range in test scores for "normal" children."

#### How Many U.S. Women Are Exposed Beyond the Reference Dose Each Year?

Since 1999, a federal health survey has been collecting data on mercury blood levels of U.S. women. The test results are released in two-year cycles. The data for 2001-2002 show a (statistically

significant) decrease in the number of U.S. women of childbearing age with blood mercury above the RfD equivalent, compared to women in the 1999-2000 data set. The more recent data set, for 2003-2004, shows yet another drop in the number of women above this RfD level. Yet each later group of women tested had consumed more of the same kinds of fish than the earlier groups did.

Data show that mercury levels in fetal blood are consistently higher than in their mothers' blood by a ratio of about 1.7:1. However, EPA has stated that this difference in blood mercury levels is already accounted for in one of the numerical adjustment factors used in setting the Reference Dose. Thus, any additional adjustment to lower the numerical value of the RfD because of this ratio would be "double-counting," and would introduce a numerical adjustment factor that is unwarranted by the data.

#### What is the Bottom Line Concerning Mercury Exposure and Health Effects?

While mercury is a potent neurotoxin at sufficiently high exposure levels, studies of low-level exposures have provided the basis for establishing the Reference Dose in the United States. This level should be realistically based on the data available. The current Reference Dose for methylmercury more than sufficiently accounts for differences in mercury levels between mothers and developing fetuses and is highly conservative. Tests administered to children to quantify the effects of mercury exposure should be selected to clearly indicate effects of mercury alone; tests used to-date appear to be more sensitive to other factors instead.

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