

Feature Articles

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Scientists Expose Health Consequences of Environmental Contaminants on Mothers and Children in the Faroe Islands

By: Paula T. Whitacre

For more than three decades, the [Children's Health and Environment in the Faroes \(CHEF\) Project](#) has boosted understanding about the effects of environmental contaminants — particularly [methylmercury, polychlorinated biphenyls \(PCBs\)](#), and [perfluorinated chemicals \(PFCs\)](#) — on human health. This research, supported by the National Institute of Environmental Health Sciences (NIEHS), has demonstrated how these contaminants affect fetal and child development by studying pregnant women who consume seafood containing the contaminants. CHEF has also shown that research-based public health interventions can reduce the negative consequences of such exposures.

CHEF, led by [Philippe Grandjean](#), M.D., D.M.Sc., and [Pál Weihe](#), M.D., has focused on the Faroe Islands, a cluster of self-governing islands within the Kingdom of Denmark that is located between Norway and Iceland. Yet, the findings extend beyond the islands and their population of about 50,000. CHEF research has revealed that people are far more vulnerable to contaminants than previously thought and experience adverse outcomes related to neurobehavioral, cardiovascular, endocrine, and immunological functions.

NIEHS has been an early and consistent supporter of the research, from a grant to study the neurobehavioral effects of intrauterine mercury exposure in the 1990s to current funding that also looks at effects on adults (at the end of this article, see the list of NIEHS Support of CHEF Research in the Faroe Islands from 1992 to 2018).

CHEF Findings

The Faroe Islands provide a unique research opportunity because of their ethnic homogeneity, egalitarian society, well-characterized population, and the dietary habits of the communities, according to



Boats docked at the Faroe Islands.



The Faroe Islands (Copyright Visit Faroe Islands: Used with Permission)

Grandjean. Weihe also noted, “There is a lot of stability in the society, which is very important when looking for tiny signals like chemical exposures.”

The Faroese diet includes meat and blubber from long-finned pilot whales, a nonendangered species of the mammal. The initial research showed that when pregnant women ate the meat of the pilot whales, the methylmercury in the meat negatively affected their children’s neurodevelopment. This finding challenged the existing view that only high levels of mercury are dangerous and could cause serious disability. “Could there be a graded response? We did not know, but we were inspired to look,” said Grandjean.

Between 1986 and 1987, approximately 1,000 Faroese mother–child pairs became the first of five cohorts in the research project. The scientists collected samples of hair from the mothers and cord blood from the infants at birth. They followed up with the cohort when the children turned 7 years old. Through extensive neuropsychological and neurophysiological examinations, the researchers concluded that mercury was a stronger neurotoxicant at lower exposures than previously thought.

Using these findings, Weihe set out to develop public health interventions to reduce the health impacts. Within a year of publishing the results, he and other health officials coordinated an advisory recommending that women of child-bearing age avoid eating whale meat. He said the recommendation generated opposition, given the central role of pilot whales in Faroese culture.

Pilot Whales and Pollution

The problem with pilot whales, from a health perspective, is that the toothed mammals sit at the top of the marine food chain and are particularly susceptible to contamination. Weihe noted that mercury concentration is 2 micrograms per gram of whale meat (2 parts per million [PPM]) compared with 0.02 PPM in cod, another local staple. “Our message is very specific to whale meat and blubber,” he said. “It would be far more complicated if we were telling people to avoid all seafood and fish.”



Philippe Grandjean enjoyed a meal of whale meat while on recent trip to the Faroe Islands. “If I eat it on a rare occasion, that’s fine,” he said, reflecting the current recommendation for consumption: no more than once or twice a month.

(Photo courtesy of P. Grandjean)



Pál Weihe has sought ways to apply the CHEF research findings to improving health outcomes in the Faroe Islands, with positive results.

(Photo courtesy of P. Weihe)

Mercury has a half-life of about 45 days. Thus, if a woman stops eating whale meat just before or early in her pregnancy, she will have excreted a good portion of it before the brain of the fetus undergoes significant development.

Women heeded the message. When the scientists compared the umbilical cord blood samples of children in Cohort 1 with those of children in Cohort 5, which was recruited between 2008 and 2010, they found that methylmercury of the Cohort 5 children was reduced by a factor of 5 and PCBs by a factor of 3 to 4. “This is because women followed the public health advice, not because the pollution in the food items — pilot-whale meat and blubber — decreased from Cohort 1 to 5,” Weihe said. In other words, children’s contaminant levels decreased because their mothers followed the research-based advisory.

Beyond the Brain

Since the initial focus on mercury’s effect on the developing brain, CHEF researchers have looked more closely at the impact of mothers’ intake of PCBs and PFCs on other systems, particularly their children’s immune systems. PCBs and PFCs, unlike mercury, have long half-lives: once they enter the human body, they take several years to excrete.

Immunologists suggested looking at response to routine immunizations as measured by antibody concentrations. The results showed that higher PCB exposure resulted in a 15 to 20 percent decline in vaccine effectiveness in children at 11 and 18 months old ([PLOS Medicine, 2006](#)), whereas PFC exposure resulted in a reduction of as much as 50 percent ([JAMA, 2012](#)). (Response was less marked at age 5 years, possibly because of other confounding factors in the older children.)

“This is clearly a DOHaD effect,” Grandjean stated, referring to the field known as the [developmental origins of health and disease](#), or the study of how prenatal exposures can affect health later in life.

According to Jerrold Heindel, Ph.D., health science administrator at NIEHS, the CHEF studies strongly supported the developmental origins of diseases hypothesis when it was just gaining momentum. “Their data on developmental exposures to mercury, PCBs, and PFCs have contributed greatly to the acceptance of this new paradigm and also highlighted the sensitivity of the brain to environmental toxicants,” he said.

Research and Action

The researchers working on the CHEF Project have published extensively — more than 100 articles have received more than 5,000 citations, according to Weihe.

In addition to informing other research globally, the project has resulted in action in the Islands and elsewhere. In the Faroe Islands, Weihe and the islands’ chief medical officer issued a second advisory in 2008, this time recommending that the entire population limit their consumption of meat and blubber to

once or twice a month and that women who are planning to become pregnant within three months to abstain completely.

Heindel noted the impact of their work. "Importantly, they did not just publish results but also translated them into action resulting in reduced exposures, which are likely to lead to improved health of the Faroese people and be a model for translational studies," he said.

CHEF research also contributed to the United Nations Environment Programme's development of a convention to phase out the use of mercury. More than 125 countries have agreed on the wording of the Minamata Convention, named for the Japanese community where severe mercury poisoning occurred in the 1950s. The convention must gain ratification by 50 countries; the U.S. ratified it in 2013. "This is an important example of international collaboration by research, public health, and pollution control," said Grandjean.

However, even if pollution stopped completely today, it will take decades before ocean contamination disappears. For this reason, dietary advisories to protect the health of young children remain an important tool," Grandjean said. "We need to translate the research we have carried out in the Faroes and that of other scientists in numerous other countries to protect the next generation's brains," he said.

Thirty Years and Counting

It was a bird watching expedition in 1968 that first brought Philippe Grandjean to the Faroe Islands, where Pál Weihe grew up in the village of Søvágur. The two met in 1984 when Weihe was in Odense, Denmark, studying medicine. After obtaining his specialty license, Weihe returned to the Faroe Islands to take the position of chief physician. He and Grandjean decided to undertake a small project to study the effects of mercury exposure, thus forming the basis of what would become the Children's Health and Environment in the Faroes project.

Some of the project's research participants go back almost as long as the research team. The more than 2,300 participants in the five cohorts now range in age from 6 to 29 years old. Weihe estimated that cohort participants have spent between 35,000 and 40,000 hours being examined over the life of the project. Retention rates in the cohorts are extremely high at about 90 percent.

Although CHEF researchers cannot yet do conclusive research on a second generation, they have begun to examine some of the children of participants from the early cohort.

NIEHS Support of CHEF Research in the Faroe Islands

1992-1995 NIEHS R01ES006112

Neurobehavioral effects of intrauterine mercury exposure

1996-2000 NIEHS R01ES006894

Neurobehavioral effects of environmental PCB exposure

2000-2006 NIEHS U01ES009797

Mercury associated neurobehavioral deficit in children

2003-2006 NIEHS R01ES011681

Effects of perinatal endocrine disruptors in children

2004-2011 NIEHS R01ES012199

Epidemiology of immunotoxicant exposure in children

2006-2012 NIEHS R01ES014460

Three-generation human study of reproductive effects of marine food contaminants

2007-2013 NIEHS U01ES009797

Mercury associated neurobehavioral deficit in children

Current Funding

2011-2016 NIEHS R01ES012199

Epidemiology of immunotoxicant exposure in children

2012-2017 NIEHS R01ES021993 and NSF OCE-1321612

Immunotoxicity in humans with lifetime exposure to ocean pollutants

2013-2018 NIEHS R01ES021477

Glucose metabolism in adults prenatally exposed to diabetogenic pollutants