CASE STUDY

Canadian Inuit and the Arctic Dilemma

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THE SITUATION

Human exposure to anthropogenic contaminants is now a well-known phenomenon in the Canadian Arctic. Early work conducted on Baffin Island and in Nunavik has demonstrated that because of their traditional dietary habits (Dewailly et al., 1989; Dewailly et al., 1993; Kinloch et al., 1992; Muckle et al., 2001), Inuit populations are exposed to environmental contaminants by eating their traditional foods, and their infants are exposed through transplacental and breast milk transmission from the Inuit mother (Figures 1 and 2).

The two main groups of contaminants that may affect human health are the heavy metals (e.g., mercury), and the persistent organic pollutants (POPs) (e.g., polychlorinated biphenyls [PCBs], DDT, and other pesticides). POPs form a class of persistent organic pollutants including polychlorinated dibenzo *p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), PCBs, and various chlorinated pesticides or industrial products. A new generation of POPs has recently been found in the Arctic food chain. These new chemicals include the brominated flame retardants, in particular polybrominated diphenyl ethers (PBDEs), and the perfluorinated alkane compounds (PFAs). These new POPs were first measured in freshwater and marine organisms, then subsequently in Inuit foods. Furthermore, there is also concern because the levels of all these substances are increasing. The high lipophilicity and resistance to biodegradation of POPs allow their bioconcentration and prolonged storage in the fatty tissues of animals. As the Inuit diet is comprised of large amounts of tissues from marine mammals, fish, and terrestrial wild game, the Inuits are more exposed to food chain contaminants than human populations living in temperate regions.

Figure 1. Inuit capturing a seal.

Figure 2. Inuit boy eating traditional diet.

EPIDEMIOLOGIC STUDIES

Various studies have been conducted in Nunavik (northern Québec) over the past decade on the characterization of exposure of Inuit populations. Moreover, biological markers were also validated to detect and evaluate early biological changes that could result in altered immune and nervous system function, oxidative stress, and in subsequent chronic diseases. Most of these studies have focused on maternal and cord-blood analyses because of the susceptibility of the fetus to contaminant exposures.

In Nunavik, an epidemiological study conducted from 1989–1991 investigated whether organochlorine exposure was associated with the incidence of infectious diseases and immune dysfunction in Inuit infants (Dewailly et al., 2000b). The number of infectious-disease episodes during the first year of life of 98 breast-fed and 73 bottle-fed infants was determined. Concentrations of POPs were measured in early breast-milk samples and used as surrogates for the prenatal exposure levels. Otitis media (middle-ear infection) was the most frequent disease, with 80 percent of breast-fed and 81 percent of bottle-fed infants experiencing at least one episode during the first year of life. However, the risk of otitis media was significantly increased with a history of prenatal exposure to dichlorodiphenyldichloroethylene (DDE), hexachlorobenzene (HCB), and dieldrin. The relative risk for the 4- to 7-month-old infants most exposed to DDE was twice that of the less exposed infants. Furthermore, the relative risk of *recurrent* otitis media (i.e., three or more episodes) increased with prenatal exposure to these compounds. Therefore, prenatal and breast-milk exposures to the POPs was associated with an increased risk for infection in this Inuit population.

A second study investigated the effect of prenatal exposure to PCBs and DDE on the incidence of acute infections in Inuit infants. The medical charts of a cohort of 199 Inuit infants during their first 12 months of life were reviewed, and the incidence rates of upper and lower respiratory tract infections, otitis media, and gastrointestinal infections evaluated. Maternal blood plasma during delivery and infant blood plasma at seven months of age were sampled and assayed for PCBs and DDE. Compared to the rates for the less exposed, the infants whose mothers had the highest levels of PCBs and DDE at their birth had generally a 30 percent excess of infections during their first six months of life. These results demonstrated a possible association between prenatal exposure to organochlorines and acute infections early in life in this Inuit population, and supported previous findings (Dallaire et al., 2004)

RISK MANAGEMENT

Taking action to modify life-style habits and diets in order to reduce environmental exposure to POPs and heavy metals must be done carefully, taking into consideration not only the risks associated with diets including fish, seafood, and sea mammal meals (i.e., exposure to contaminants), but also the benefits of such diets and the benefits of breast feeding.

Although the contaminants found in Inuit foods (especially those from the aquatic food chain) may pose a public-health risk, dietary studies conducted recently have shown that these traditional foods are important sources of nutrients such as protein, vitamins, minerals, and omega-3 fatty acids (EPA and DHA) (Blanchet et al., 2000). For example, high exposure to omega-3 fatty acids during prenatal life increases birth weight and visual acuity of newborns. Inuit people, in particular, have very high levels of omega-3 fatty acids in their blood due to their high consumption of fish and marine mammal meals. These substances are transmitted to the fetus during pregnancy and have a direct effect on the weight of the newborn and on beneficially prolonging the gestational time. Furthermore, the Inuit diet, which is rich in fish and marine mammals, has been linked to a lower incidence of thrombotic disease; this beneficial effect can be attributed to the high omega-3 fatty-acid intake obtained from seafood consumption. A recent study conducted by our team among the Inuit of Nunavik showed that their high plasma concentrations of omega-3 fatty acids protect them against some cardiovascular risk factors (Dewailly et al., 2001b).

Selenium (Se) is another essential nutrient found in sea products. This element is an antioxidant, as well as a micronutrient that regulates the action and/or enters in the composition of several essential enzymes. Furthermore, Se interacts with mercury in an antagonistic way; hence, it exerts a protective effect with regards to mercury-induced toxicity (AMAP, 2004). In addition, it is currently believed that Se has a role of antioxidant in the prevention of atherosclerotic diseases and prostate cancer (Dewailly et al., 2003).

Of note, changes in lifestyle and dietary patterns have been observed among Inuit populations during the last decades. Because of rapid societal transitions, a shift away from traditional lifestyle and diet has been observed in these populations (Bjerregaard and Curits, 2002; Kuhnlein and Receveur, 1996). Traditional food use is declining rapidly, although not uniformly across the Arctic. For most circumpolar regions, dietary intake from store-bought foods now exceeds those from traditional foods (Figure 3). As a result, in Greenland, Alaska, and Canada, ischemic heart disease and diabetes are on the increase among native populations (Young et al., 1993). Thus, while there is clearly a need to reduce the exposure of Inuits to POPs and heavy metals, there is, at the same time, a need for preventive action to ensure that the levels of protective factors in their diet are not diminished.

Figure 3. Inuits shopping for western diet.

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