EXPOSURE TO PERSISTENT ORGANIC POLLUTANTS IN THE INUIT POPULATION OF NUNAVIK: TEMPORAL TRENDS AND POTENTIAL HEALTH EFFECTS

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RATIONALE

Persistent organic pollutants (POPs) are characterized by their long-range oceanic and atmospheric transport, limited biodegradation and bioaccumulation along the trophic levels of the food chain [1]. Concentration of POPs in several species of the marine artic food chain can be very high, especially in fat of marine mammals. Consequently, human population in the Arctic that rely mainly on traditional foods, including consumption of marine species, can be exposed to levels of POPs exceeding established national guidelines [2]. The Stockholm Convention, an international agreement concluded in 2001, identified twelve POPs of most health concern at the global scale: dioxins, furans, polychlorinated biphenyls (PCBs), aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex and toxaphene. International efforts to reduce or cease the production and use of these POPs seem to be fruitful, since concentrations in biological matrices appear to be decreasing. However, time trends of exposure in the arctic wildlife and peoples remain mostly unknown [3]. Furthermore, new toxic substances manufactured in industrial regions of North America and Europe have also been found in environmental media and in species of the arctic food chain [4]. These new chemicals share similar properties with POPs and include polybrominated diphenyl ethers (PBDEs), used as flame retardant and perfluorooctanesulfonate (PFOS) used as stain repellent in commercial products.

Thyroid hormones, which are, secreted by the thyroid gland, play essential functions in brain and bone development, metabolism, fertility and cardiovascular and emotional stability. However, an increasing number of environmentally relevant compounds are known to disrupt the thyroid system in laboratory animals [5] and wildlife [6]. On the other hand, potential effects of chronic exposure on thyroid function in humans are still unclear [7].

Decrease in bone mineral density defined as osteoporosis increases risk of bone fracture in women. Several risk factors are known or suspected to be associated with osteoporosis, including exposure to POPs [8, 9]. Therefore, women consuming large amounts of contaminated fish and marine mammals may be more at risk of osteoporotic fractures.

The Inuit population of Nunavik is one of the most highly exposed populations to several POPs in the Arctic, mainly through the consumption of seal and beluga fat [3]. Thus, it appears crucial to determine actual exposure to environmental contaminants and to investigate potential health effects of these substances in this population.

OBJECTIVES

1. To document contemporary exposure of the Inuit of Nunavik to several POPs, including emerging contaminants.
2. To compare plasma concentrations of contaminants in the population of Nunavik measured in 1992 in the framework of the Santé Québec Health Survey and in the 2004 Nunavik Health Survey.
3. To investigate the potential endocrine effects of contaminants such as thyroid dysfunction among adult men and women and increased risk of osteoporosis in peri- and post-menopausal women.

STUDY DESIGN AND DATA COLLECTION

In autumn 2004, an extensive Health Survey among the Inuit population of Nunavik was carried out in order to assess their health status and identify risk factors of chronic diseases. The 2004 Nunavik Health Survey is a cross-sectional study in which participants constitute a stratified probability sample of the adult Nunavik population living in 14 villages. Blood samples for contaminants, thyroid hormone and nutrient measurements, were obtained from 917 participants 18 years and older. Bone mineral density was measured in 207 women aged between 35 and 74 years. Participation rates for blood sample and bone measurements were 68,9% and 65.3%, respectively. All participants were invited to answer questionnaires designed to collect information on socio-demographic characteristics, environmental factors and lifestyle habits. Written informed consent was obtained for all participants.

LABORATORY ANALYSES

Contaminants

Levels of contaminants (PCBs and their metabolites, chlorinated pesticides, halogenated phenolic compounds, PBDEs and PFOS) were measured by the newly developed SACEMF method (Semi-Automated Comprehensive Extraction Multiple Fraction). This method allows to measure up to 145 analytes by gas chromatography-mass spectrometry from a single 5-ml blood sample. Analysis of contaminants are ongoing at the Laboratory of Human Toxicology of the Institut national de santé publique du Québec.

Thyroid Hormones

TSH, total T3 and free T4 were measured by immunoassays using a commercial Elecsys kit (Roche Diagnostics) at the Hôpital Laval biochemistry laboratory.

Bone Measurements

The risk of osteroporotic fractures was determined using the Achilles InSight ultrasound bone densitometer. Three bone measurements were obtained for each participant: 1) the rigidity of the bone structure identified as the bone stiffness index (SI, %); 2) the T-score; 3) the Z-score.

DATA ANALYSIS

Because the study design developed in this survey used a stratified proportional sampling, data obtained will be weighted using the bootstrap method to obtain estimations representative of the whole Inuit population of Nunavik.

Objective 1: Contemporary exposure to POPs and new chemicals

Descriptive statistics (means, medians, standard deviations and 95% confidence intervals) will be calculated for each POP as well as the percentage of detected contaminants above the detection limit. Exposure levels will be described according to categories of socio-demographic variables (sex, age, village of residence, socio-economic status, etc.) and consumption of various traditional food items.

Objective 2: Temporal comparison of contaminant exposure

Mean concentration of contaminants will be compared between years 1992 and 2004 using multiple regression models adjusted for confounding variables (sex, age, village of residence, etc.).

Objective 3: Effects of contaminants on thyroid hormone concentrations

Descriptive statistics will be produced for thyroid hormone concentrations. Pearson correlation coefficients and multiple linear regression models will be performed to evaluate the relationship between thyroid hormone concentrations and contaminants. Confounding will be verified for recognized or suspected variables. The relation between the presence of overt hypothyroidism and hyperthyroidism and contaminant concentrations will be assessed using logistic regression.

Objective 4: Contaminants and risk of osteoporosis among peri- and post-menopausal women

Descriptive statistics will be produced for bone measurements. Pearson correlation coefficients and multiple linear regressions models will be produced to assess the relationship between SI and contaminant plasma concentration. Potential confounders will be examined in multiple models. Risk of osteoporosis in women will be determine according to their T-score (normal if standard deviation (SD) > -1, osteopenia if -2.5 ≤ SD ≤ -1 and osteoporotic if SD < -2.5) and Z-score (number of SD below age-matched average, where the fracture risk threshold equal –1). Logistic regression will be performed to determine if exposure to contaminant increases the risk of osteoporosis.

RESULTS

This study will permit to quantify levels of exposure to a new generation of persistent pollutants in Nunavik Inuit in relation with nutritional and socio-economic factors and to determine if international efforts to reduce the release of POPs into the environment has had positive impact on POPs body-burden in Inuit. Finally, it will be possible to investigate potential health risks induced by chronic exposure to POPs and to propose effective and viable public health advices respectful of the traditional lifestyle of this population.

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