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"Is it still safe to eat traditional food?" Addressing traditional food safety concerns in aboriginal communities

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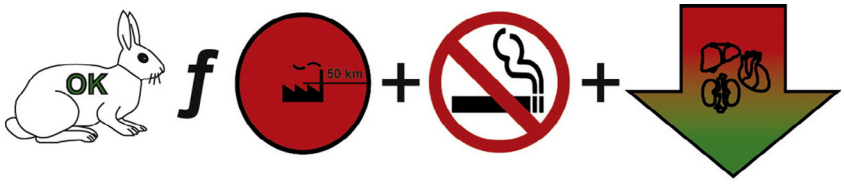
HIGHLIGHTS

- Food insecurity is a growing concern for indigenous communities.
- Few data are available on heavy metal contamination risk in the Boreal zone.
- 196 snowshoe hares were trapped at variable distances from a copper smelter.
- Overall exposition risk was low.
- Nutritional and cultural importance of traditional food must be considered.

GRAPHICAL ABSTRACT



Traditional consumption of snowshoe hare (*Lepus americanus*) entails low risk of heavy metal exposure if animals are trapped more than 50 km from a point emission source (such as a copper smelter in the present study), if risk-increasing behaviours are avoided (such as smoking cigarette or using lead amunition when hunting), and if offal is not consumed every time.

Traditional consumption of snowshoe hare (*Lepus americanus*) entails low risk of heavy metal exposure if animals are tapped >50 km from a point emission source (such as a copper smelter in the present study), if risk-increasing behaviours are avoided (such smoking cigarette or using lead amunution when hunting), and if offal is not consumed every time.

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ABSTRACT

Food insecurity is a growing concern for indigenous communities worldwide. While the risk of heavy metal contamination associated to wild food consumption has been extensively studied in the Arctic, data are scarce for the Boreal zone. This study addressed the concerns over possible heavy metal exposure through consumption of traditional food in four Anishnaabeg communities living in the Eastern North American boreal forest. Liver and meat samples were obtained from 196 snowshoe hares (*Lepus americanus*) trapped during winter 2012 across the traditional lands of the participating communities and within 56–156 km of a copper smelter. Interviews were conducted with 78 household heads to assess traditional food habits, focusing on snowshoe hare consumption. Concentrations in most meat and liver samples were below the detection limit for As, Co, Cr, Ni and Pb. Very few meat samples had detectable Cd and Hg concentrations, but liver samples had mean dry weight concentrations of 3.79 mg/kg and 0.15 mg/kg respectively. Distance and orientation from the smelter did not explain the variability between samples, but percent deciduous and mixed forest cover had a marginal negative effect on liver Cd, Cu and Zn concentrations. The estimated exposition risk from snowshoe hare consumption was low, although heavy consumers could slightly exceed recommended Hg doses. In accordance with the holistic perspective

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commonly adopted by indigenous people, the nutritional and sociocultural importance of traditional food must be considered in risk assessment. Traditional food plays a significant role in reducing and preventing serious health issues disproportionately affecting First Nations, such as obesity, diabetes, and cardiovascular diseases.

1. Introduction

Traditional food carries a great social, cultural, and nutritional importance amongst indigenous people (e.g., Kuhnlein and Receveur, 1996; Pufall et al., 2011). Many communities harvest, prepare and consume a variety of wildlife species, although some species are preferred (Wein et al., 1991; Samson and Pretty, 2006; Hlimi et al., 2011). Consumption of traditional food significantly contributes to a higher daily intake of proteins, vitamins and minerals (Kuhnlein and Receveur, 2007; Gagné et al., 2012). Gradual replacement of traditional food by processed food over the past 30 years has been linked to the declining health in Arctic aboriginal populations (Kuhnlein et al., 2004). Processed food often contains high levels of sugar, fat and salt, and low levels of vitamins and minerals (Gittelsohn et al., 1998). Thus, the prevalence of obesity and diabetes in aboriginal communities is significantly higher than in the overall population, a difference that cannot be explained by genetics alone (Haman et al., 2010). Concurrent with these dietary changes, traditional food has sometimes been found to be contaminated by toxic metals, radionuclides, or persistent organic compounds (Berti et al., 1998; Johansen et al., 2000; Arnold et al., 2006; Liberda et al., 2014).

Pollutants resulting from industrial activities are dispersed in the environment by atmospheric or water transport (Savard et al., 2006; Makinen et al., 2010; Pennington and Watmough, 2015). Along with local geological sources of contamination, anthropogenic point emitting sources can affect specific areas more directly (Aznar et al., 2008). Contaminants can be found in soils, vegetation, lacustrine and marine environments. Bioaccumulation and bioamplification occur along food chains, resulting in excess tissue concentrations for various animal species (Beyer et al., 1996). Chronic exposition to small doses of contaminants can seriously impact animal and human health (Environmental Protection Agency, 2015). Human exposure depends on several factors like geographic location, age, and gender, as well as quantity, frequency and types of food consumed (Chan et al., 1995). However, even if contaminants are commonly found in wild food, the causality between contaminated traditional food consumption and adverse health effects is complex to determine and difficult to confirm (Donaldson et al., 2010).

In recent years, research on environmental health risks has increased exponentially (Furgal et al., 2010). Public health authorities have started to raise awareness and indigenous communities are more than ever concerned about food security and safety (Martin, 2011). Risk assessment and communication requires thoughtful consideration of social and cultural specificities, and a multidisciplinary approach is preferable (Kuhnlein and Chan, 2000; Furgal et al., 2005). Minimizing the risks of a traditional diet, while promoting and maximizing its benefits is an emerging challenge (e.g., Loring et al., 2010; Laird et al., 2013; Lemire et al., 2015).

The literature review presented above shows that most studies tackling contaminants in traditional food focused on Arctic regions (e.g., Berti et al., 1998; Van Oostdam et al., 2005; Loring et al., 2010; Schuster et al., 2011; Laird et al., 2013; Lemire et al., 2015). However, aboriginal communities with different cultures and living in different environments such as the boreal and temperate forests are also legitimately worried about traditional food safety. This is the case for the Anishnaabeg First Nations of Eastern Canada, whose traditional hunting and trapping grounds include one of the largest smelting plants in Canada.

In collaboration with four Anishnaabeg communities, we investigated the risk of heavy metal exposure associated with traditional food consumption. Our first objective was to evaluate heavy metal contamination in the meat and the liver of snowshoe hare (*Lepus americanus*), a culturally important species that also plays a major role in boreal forest ecosystems (Krebs et al., 2001). We expected the contamination level to decrease with distance from the local smelter, and to be higher at sites oriented in the direction of prevailing winds (Aznar et al., 2007). We also expected higher concentrations of cadmium (Cd) and lead (Pb) in hares sampled in deciduous tree stands, because early successional tree species are choice forage for snowshoe hare (Pease et al., 1979) and tend to accumulate Cd and Pb in foliage and branches (Mcgee et al., 2007). Our second objective was to assess food habits generally, and snowshoe hare consumption specifically within the four Anishnaabeg communities. Finally, our third objective was to evaluate heavy metal exposure and possible health risk for Anishnaabeg communities, with respect to the recommended maximum intake.

2. Material and methods

2.1. Study area

Our study took place in Abitibi-Témiscamingue and Northern Quebec, on the traditional territories of four Anishnaabeg (Algonquin) communities. It covers roughly 50,000 km^2 of hunting and trapping grounds, still frequented regularly by the people of Timiskaming, Winneway, Pikogan and Kitcisakik First Nations (Fig. 1). These communities are located near one of Canada's oldest and most notorious copper smelters, the Horne Smelter in Rouyn-Noranda, in operation since 1927. Although the filtering technology has greatly improved in recent years, resulting in reduced emissions (Savard et al., 2006), ore refining and electronic waste recycling activities still emit important amounts of various heavy metals (Table 1).

2.2. Ethics

This research project was initiated by the four Anishnaabeg communities. The research methodology was developed in close collaboration with the communities to ensure research relevance and legitimacy (Asselin and Basile, 2012). We obtained a certificate from Health Canada's Research and Ethics Board (#2010-0090). The project complies with the aboriginal research guidelines of the Canadian *Tri-Council Policy Statement*: *Ethical Conduct for Research Involving Humans* (Canadian Institutes of Health Research et al., 2014). Participants signed a consent form and were offered a monetary compensation for their contribution. Interviews were conducted with the help of aboriginal collaborators and interpreters, through a participatory research philosophy (Saint-Arnaud et al., 2009). Local collaborators were key to maintain an efficient communication with community members.

2.3. Snowshoe hare sampling

We collected snowshoe hares at different distances and orientations from the Horne smelter (Fig. 1). Typical brass snares were set by skilled aboriginal trappers at strategic and accessible sites, georeferenced for each successful capture. A total of 196 snowshoe hares were collected during winter 2012, and meat (from the thigh) and liver samples were taken. Samples were transported in a cooler and kept in the freezer before being analyzed. All remaining snowshoe hare meat was given to elders and families or reserved for community feasts. Fur was saved for traditional handicraft. For each captured snowshoe hare, distance