

ALLOWING FIRST NATION CHILDREN TO REACH THEIR FULL COGNITIVE POTENTIAL: QUESTIONING THE USE OF LEAD SHOTSHELL FOR THE HARVESTING OF ALL GAME

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Abstract / Résumé

Lead is a neurotoxin that adversely affects children. Studies have shown that as tissue lead levels in children increase, neurocognitive functions decrease. Children with elevated lead levels may exhibit increased distractibility, an inability to inhibit inappropriate responses, and a decrease in the ability to follow directions. The use of lead shotshell in subsistence harvesting can be a significant source of lead exposure for children.

Le plomb est une neurotoxine qui affecte défavorablement les enfants. Les études ont démontré qu'à mesure que le niveau de plomb chez les enfants augmente dans les tissus, les fonctions neurocognitives décroissent. Les enfants souffrant de niveaux élevés de plomb peuvent se montrer plus distraits, être impuissants à maîtriser des réactions mal à propos et présenter une capacité plus faible à exécuter des ordres. L'utilisation de cartouches à plombs dans la chasse de subsistance peut être une source significative d'exposition au plomb chez les enfants.

Introduction

Lead poisoning among children must be eliminated. Lead, which is not an essential element, damages all bodily systems but has its most devastating effects on the developing brain. The damage that lead causes to developing brain cells has lifelong, albeit sometimes subtle, effects. All parents want their children to reach their full potential, but the damage caused by lead can rob children of their right to a productive and full life (United States Centers for Disease Control [USCDC], 1991:7).

Lead is neither essential to live nor of any benefit to living organisms, being a neurotoxin that adversely affects humans exposed to it (Eisler, 1988; USCDC, 1991). Children are especially sensitive to lead toxicity for several reasons (Bellinger, 1997). First, behaviour—children often place items other than food in their mouths. This activity is designated pica (Bartrop, 1966). Even normal hand-to-mouth activities of children can result in lead particles from different environmental media (e.g., soil, paint chips) being introduced into the child's digestive system (Weitzman *et al.*, 1993). Second, physiology—approximately 5 to 10% of ingested lead is absorbed in adults (Kehoe, 1964), while approximately 40 to 50% of ingested lead is absorbed by children (Ziegler *et al.*, 1978). Further, children's bodily systems are rapidly developing, so that children are more susceptible to the detrimental effects of lead. Third, diet/nutrition—children often do not eat regularly with fasting increasing the amount of lead that is absorbed. Another important predisposing factor for children is related to iron-deficiency anaemia; this state enhances lead absorption. Lastly, diets low in calcium content have also been found to increase lead absorption (Mahaffey, 1990; USCDC, 1991, 1997; International Programme In Chemical Safety, 1995). Iron-deficiency anaemia and low-calcium diets are important predisposing factors for lead poisoning in First Nation (FN) children (Smith, 1995; personal observations).

Numerous epidemiological studies (cross-sectional and prospective) using either blood lead or tooth lead levels in children have shown neurocognitive functions to be inversely correlated with lead levels even when confounding variables were controlled (USCDC, 1991; Winneke, 1995; Bellinger, 1997). In other words, as tissue lead levels in children increased, neurocognitive functions decreased. However, a lead specific neuropsychological "signature" (i.e., a symptom/characteristic specific for lead poisoning) has yet to be identified (Bellinger, 1997). A wide variety of symptoms have been reported, as noted by Rice and Silbergeld (1996:673).

Tests of specific functions in children have revealed perseveration, increased distractibility, inability to inhibit inappropriate

responding, and decreased ability to follow sequences of directions in addition to global decrements in IQ...potential long-term sequelae such as school drop-out and increased antisocial behavior.

Moreover, there may be no threshold to the effects of lead. In other words, there may be no safe level of lead exposure (Schwartz, 1994). Data collected from animal and human studies

suggest that a concurrent blood lead level of 10 micrograms/dL [current blood lead level of medical concern] does not protect against lead-induced behavioral deficits, that is, there are effects observable in both animals and children at lead exposures at or below current pediatric guidelines [10 micrograms/dL]...considerable evidence that lead-induced cognitive deficits are not reversible (Rice and Silbergeld, 1996:672).

Thus, exposure to lead should be kept to a minimum, especially for children. The implications with respect to the education of children are clear.

In the past, lead was ubiquitous in the environment, being present in a variety of media, such as air, food, drinking water, soil/dust, and consumer products (Davis *et al.*, 1997). Within the last two decades, substantial progress has been made to decrease the amount of man-made lead in the environment. The virtual elimination of leaded gasoline, the use of lead-free solder in cans, and the decrease in lead content in new paint have all been contributing factors in North America (USCDC, 1991; Fleming, 1994; Davis *et al.*, 1997). As a result of these initiatives, according to recent United States national estimates, the percentage of children with blood lead levels greater than or equal to 10 micrograms/dL (the established level of health concern) has fallen from 89% to 8.9%, during the time period 1976-1991. Thus, approximately 1.7 million children (ages 1 to 5 years) in the USA still have blood lead levels greater than or equal to the identified level of concern (Brody *et al.*, 1994; USCDC, 1997). Comparable national data for Canada does not exist.

Although the USCDC (1997) has identified lead content in paint of housing units built prior to 1950, as the major source (reservoir) of lead for children, there are still other sources of man-made lead that must be considered. One significant source that has been identified for Native Canadians and Aborigines in general is the use of lead in ammunition, such as lead pellets used in the harvesting of game (Tsuji *et al.*, 1996; Tsuji and Nieboer, 1997; Tsuji *et al.*, 1997; 1999). In this paper, we will briefly discuss the use of lead shotshell for the harvesting of all game animals as a source

of lead exposure for First Nation children and make some recommendations aimed at decreasing lead exposure in these children from this source.

The Use of Lead Shotshell for Harvesting Game: A Possible Source of Lead Exposure

Recently in the United States and other countries (e.g., Norway, Netherlands), the use of lead shot has been banned for waterfowl hunting due to the toxic nature of lead (United States Fish and Wildlife Service [USFWS], 1988; Pain, 1992; Annema *et al.*, 1993). In Canada, the use of lead shotshell was scheduled to be banned for all migratory bird harvesting on September 1, 1997; however, the nation-wide ban will not take effect until September 1, 1999 (Canadian Wildlife Service [CWS], 1997; Press Release August, 1997; a detailed account is given in Tsuji, 1998). At present, lead shot is still widely used by Native harvesters as well as sport hunters.

The use of leaded ammunition can be a source of airborne lead through the ignition of primer (lead styphnate) and from the mechanical abrasion of lead shot as it passes through the barrel of the gun (Valway *et al.*, 1989). Particles of airborne lead can be a potential source of lead (Zelikoff *et al.*, 1993). Further, lead exposure may result from the handling of lead shotshell and the cleaning of firearms; thorough washing of hands is recommended (Union Metallic Cartridge Company "warning" on lead ammunition box). Another possible source of lead exposure that has been investigated for First Nation subsistence harvesters relates to the consumption of game harvested with lead shot.

Two possible sources of lead exposure from the consumption of game harvested with lead pellets have been identified for children (Scheuhammer and Norris, 1995). The two potential sources are: ingestion of game containing whole and/or lead pellet fragments embedded in wild meats (Frank, 1986; Madsen *et al.*, 1988); and ingestion of game with biologically incorporated lead (Ontario Ministry of Health [OMH], 1993).

The Evidence: Lead Pellet Ingestion

In a recent study (Tsuji and Nieboer, 1997), the incidence of lead shot exposure via the ingestion of tissue embedded lead shot for First Nation Cree of the Mushkegowuk Territory (western James Bay and south-western Hudson Bay regions of northern Ontario) was quantified, using radiography. It was shown that approximately 15% of the radiographic charts (views: abdominal; kidney, ureter, bladder) examined (randomly selected), had evidence of lead pellets contained in the digestive tract, intraluminally (inside the intestine) and/or in the appendix. This information is of great importance because it has been reported that individuals with lead pellets

contained in their appendix (identified radiographically), had blood lead levels significantly higher than those of the control group (Madsen *et al.*, 1988). Moreover, evidence exists that lead pellets or leaden objects that have been ingested by children and shown to be located intraluminally in the digestive tract can cause lead intoxication (Biehuseu and Pulaski, 1956; Greensher *et al.*, 1974). The main point is that any ingested lead pellet and/or fragment can add to an individual's lead body burden.

The Evidence: Contamination of Wild Meats

No consumption guidelines exist for lead in tissues of game birds, although 0.5 micrograms of lead per gram of tissue wet weight (micrograms/g ww) has been set for fish protein by Health Canada (1995). Thus, 0.5 micrograms/g ww has been the lead contamination level of medical concern that has been used (Scheuhammer *et al.*, 1998; Tsuji *et al.*, 1999).

It has been suggested that humans harvesting waterfowl have a greater probability of harvesting lead-poisoned birds due to changes in the central nervous system that affect the birds' evasive response (Bellrose, 1959). Using this type of reasoning, the probability should increase that tissue-bound lead will be ingested by subsistence harvesting people. Tissue-bound lead is lead that becomes biochemically bound to tissue components as compared to lead pellets or fragments that are physically trapped in the wild meat. Of the livers of game birds harvested in the Mushkegowuk Territory, only 2% (5 of 233) exhibited lead concentrations greater than 0.5 microgram/g ww (Tsuji *et al.*, 1996). The most probable source of lead found in these livers is from lead shot, because it has been shown that waterfowl of this region ingest lead shot at a rate that warrants concern (Tsuji *et al.*, 1998). Taking into account that ingested lead concentrates disproportionately in livers and other internal organs of waterfowl, other edible tissues of the birds would not usually pose a problem with respect to lead concentration. Ingested lead does not normally concentrate in parts of game birds commonly eaten (e.g., striated muscle: breast, leg, wing).

In contrast, a large portion of the striated tissue samples (edible portions of meat) from birds harvested with lead shot by First Nation people (33 of 371; 9%), showed elevated lead levels greater than the level we adopted for human consumption (Tsuji *et al.*, 1999). Lead levels in the tissues examined reached as high as 19,900 microgram/g ww. Similarly, researchers for the Canadian Wildlife Service have reported that of 827 pooled breast samples from game birds harvested with lead shot, 10% of these samples (92 of 827) contained lead levels above the level set for human consumption (Scheuhammer *et al.*, 1998). In addition, these two studies showed (through radiography and atomic absorption spectrometry)

that elevated lead levels in wild meats were the result of whole and/or lead pellet fragments being embedded in the tissues sampled. Obviously, the ingestion of tissue from game harvested with lead shot is a significant source of lead exposure for First Nation children and other subsistence harvesting groups.

The Evidence: Elevated Tissue Lead Levels in Aboriginal Children

The Cree of the Mushkegowuk Territory have been the most widely studied First Nation group with respect to tissue lead levels in children. In 1987, the children of Moosonee were reported to have higher blood lead levels (mean±standard deviation: 8.9±3.2 micrograms/dL) than other northern towns and urban centres (Ontario Ministry of Health and the Environment [OMHE], 1989). This finding was surprising because the town of Moosonee was considered a remote site where water and soil lead levels have been found to be very low (OMHE, 1989). In addition, air lead levels were reported to be well under the established safe level (OMHE, 1989). A follow-up study in 1992 was conducted in Moosonee and Moose Factory (Ontario Ministry of Health, 1993). Even though blood lead levels in this study were found to be reduced compared to the earlier study, probably due to the advent of unleaded gasoline, lead levels were still reported to be comparable to or slightly higher than southern urban centres (Ontario Ministry of Health, 1993). Moreover, 5% of the children examined had blood lead levels greater than or equal to the level of medical concern (Ontario Ministry of Health, 1993). Although the source of lead was never identified in the study, it was suggested that lead shot or contaminated wild meats might have been the source (Ontario Ministry of Health, 1993; Smith, 1995). Similarly, Tsuji *et al.* (1997) and Tsuji *et al.* (MS) have found elevated lead levels (teeth) in First Nation adults and children of the Mushkegowuk Territory, respectively.

A recent study by Hanning *et al.*, (1996) examined the relationship between consumption of wild meats (fowl, mammals, and fish) and lead concentrations in cord (baby at birth) and maternal blood, in the Mushkegowuk Territory. It was reported that cord and maternal blood lead correlated with the consumption of a traditional diet. Also, cord and maternal blood lead levels were highly correlated, with a small number of cord-blood levels exceeding the medical level of concern. In other words, some fetuses were being exposed to a significant amount of lead prior to birth (Hanning *et al.*, 1996). Further, in a sample of 238 Inuit newborns from Nunavik (Northern Quebec, Canada), 7.6% had cord-blood lead levels at or exceeding 10 micrograms/dL; this is in comparison to 0.2% of 955 newborns examined from southern Quebec (Levesque *et al.*, 1998). The source of

lead exposure was identified by determining stable isotope ratios for 60 Inuit and 89 southern Quebec newborns. Stable isotope data collected for Inuit (Mean lead 206/207=1.195) and southern Quebec (mean lead 206/207=1.167) newborns were found to be significantly different. The mean isotope ratio for Inuit newborns was similar to that reported for four major brands of leaded ammunition commonly used in Nunavik (n=10; mean lead 206/207=1.193). By contrast, the mean isotope ratio for southern Quebec newborns compared well to that found for lichens (indicators of atmospheric pollution) collected from Nunavik (n=4; mean lead 206/207=1.164). These findings suggest that leaded ammunition was the source of contamination for Inuit newborns with the ambient atmospheric deposition of lead being the source for southern Quebec newborns (Levesque *et al.*, 1998).

Elevated blood lead levels in Aboriginal children have also been found in other remote regions of the world where traditional lifestyles are still maintained, such as the Kola Peninsula of Russia (Odland *et al.*, 1999). When all these studies are viewed as a whole, it appears that game harvested with lead shot can be a significant source of lead exposure for Aboriginal adults, children, and fetuses.

Recommendations to Decrease Lead Exposure from the Use of Lead Shot

Ideally, lead shot should not be used to harvest game because of human health concerns. Both the United States Fish and Wildlife Service and the Canadian Wildlife Service recommend steel shot as the best alternative to lead shot (United States Fish and Wildlife Service, 1988; Scheuhammer and Norris, 1995). Other types of non-toxic shotshell have been approved for use (e.g., bismuth/tin), but questions remain about whether the new shotshells are really non-toxic (Tsuji and Nieboer, 1997). Moreover, non-toxic shot is a "hard sell", due to its high purchase price compared to lead. The unit price in Toronto, Ontario for one shotshell (#2-6, 2 3/4", 12 gauge, lite magnum or magnum) of the various types is as follows: lead, \$0.30; steel, \$0.68; and bismuth/tin, \$2.45 (Tsuji, 1998). One solution would have First Nation communities or First Nation organizations purchase steel shot directly from the ammunition manufacturer and sell the non-toxic shot at cost to their community members. The new ammunition would be made available and affordable to First Nation people. A reasonable price would be secured from the ammunition manufacturer because Native organizations could guarantee large annual orders of the new non-toxic shot (Tsuji *et al.*, 1996). It should be stressed that in a comprehensive review by

Morehouse (1992:33) of the performance of steel versus lead shot, it was concluded that there was "no clear advantage to either lead or steel".

Realistically, lead shot will be used legally (with some restrictions) to harvest migratory game birds, until September 1, 1999. More important, there are no restrictions on the use of lead shot for harvesting other game birds, such as grouse and partridges. This is strange, since human health concerns are the same for harvesting these species of birds, as for harvesting waterfowl with lead shot. In addition, compliance with the new non-toxic regulations may be low with enforcement in remote regions of Canada being extremely difficult (Tsuji *et al.*, 1998). However, First Nation children should be given the opportunity to reach their full cognitive potential. Thus, it is urged that First Nation people begin to practice with the new types of non-toxic shot (i.e., shooting clinics), to allow a phase-in period where the people can get used to the different ballistic characteristics of the new shot prior to September 1, 1999. Steel shot requires more skill to use than lead shot. Becoming familiar with the new shot is especially important to First Nation communities that still maintain a traditional lifestyle. For sport hunters who are not familiar with the new shot, it does not really matter if they do not get their quota; however, for First Nation subsistence harvesters, being able to harvest enough game to feed their family is a necessity.

During the period of time when lead shot is still being used to harvest migratory game birds (note: no restrictions have been legislated for the harvesting of upland game birds or small mammals), we offer several recommendations to decrease lead exposure in First Nation children. First, boxes of lead ammunition should be stored in airtight containers. Second, do not allow children to handle unused lead shells as well as spent lead shotshells. Third, adults and children should always wash their hands after handling guns and lead shot. Fourth, clothes used while harvesting game with lead shot should be stored away from children in airtight bags. These clothes should be washed separately because clothing often collects lead particles which can be brought into the bush camp or home, exposing the children. The United States Centers for Disease Control (1997) has designated this type of lead exposure as occupational or hobby exposures. Fifth, children should not eat any wild meat with lead shot or shot holes in it. This type of meat should be thoroughly washed in water with the contaminated portions (tissue surrounding lead pellets and/or shot holes), being discarded. The meat that is left, can then be saved for adult consumption. Sixth, wild meat should be cut in thin pieces prior to cooking and manually examined for lead shot or fragments. Seventh, liver, kidneys, brains, and marrow from bones should not be consumed by children because these tissues tend to accumulate lead. Children should only eat the tissue that

has been shown to typically contain the lowest levels of biologically incorporated lead, striated muscle (e.g., breast, leg, and wing).

First Nation children should be allowed to reach their full potential. Empowerment of First Nation communities cannot be achieved if First Nation children are not given the chance to be the best they can be. The continued use of lead shot for the harvesting of all game is detrimental to the health of children, especially FN children of subsistence harvesting cultures. However, as explained earlier, a period of adjustment is required to adapt to the new non-toxic shot types. Perhaps a longer period than the one mandated by the Canadian Wildlife Service is required for Native people, because of cultural and economic concerns (Tsuji, 1998). Government legislation is not just affecting a sport (hunting), as is the case for non-Status people, but also an entire way of life, subsistence harvesting. More information concerning the lead shot issue in Canada can be obtained from the INTERNET:

<http://www.ec.gc.ca/cws-scf/pub/ops/op88/home.html>

<http://www.ec.gc.ca/cws-scf/pub/hunting/lead.html>

<http://www.ec.gc.ca/cws-scf/pub/hunting/toxic.html>

http://www.ec.gc.ca/press/lead_n_e.htm

http://www.ec.gc.ca/press/lead_b_e.htm

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