FISH DIET AND MERCURY EXPOSURE IN A RIPARIAN AMAZONIAN POPULATION

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Abstract. The incorporation of mercury into the food chain and its assimilation by humans is a universally recognized potential health hazard. Studies carried out in the Amazon Basin have shown that mercury (Hg) is present in fish and in humans, however, the relation between fish diet and human exposure has received limited attention in this region. The present study focused on a small village, Brasilia Legal (3°59'00"S, 55°0'00"W), situated on the banks of the Rio Tapajós. A total of 181 fish (40 species) were captured in March, 1995 and analysed for Hg concentration. Of these, 132 fish were among species consumed by the population during the rainy season (mid-November to mid-May) and the dry season (mid-May to mid-November). Wide intra- and inter-species variations in Hg concentrations were observed. Thirty four fish (25.8% of the consumed species) had levels above 0.5 μg/g Hg fresh weight; all were among the piscivorous and omnivorous species. Hair Hg concentrations (HHg), showed that villagers with a high fish diet (n=31; median HHg=16.1 μg/g) and mixed fish diet (n=36; median HHg=14.8 μg/g) had significantly higher HHg concentrations compared to the low fish diet group (n=29; mean HHg=7.8 μg/g). Time series function of HHg measurements, made for 26 persons with over 24 cm of hair, revealed sinusoidal variations, with peaks during the rainy season and troughs during the low water period, paralleling the seasonal shift in dietary habits. Piscivorous and omnivorous fish species, with higher mercury levels, are the main component of the fish diet during the rainy season, while herbivorous fish species predominate during the dry season. Preventive actions should take into account the risk to human health, particularly for fetal and neonatal development, the importance of fish in the riparian diet, the wide intra- and inter -species variations in mercury content and seasonal fluctuations in diet.

1. Introduction

The incorporation of mercury into the food chain and its assimilation by humans is a universally recognized potential health hazard. When mercury is released into aquatic environments, it can be methylated by bacteria, present in river sediments, to its organic form: methylmercury. In this form, it then becomes bioavailable to the ichthyofauna, where it can be biomagnified through every step of the food chain up to humans (WHO, 1989). In areas where fish are highly contaminated by mercury, populations, who frequently consume these fish, are at risk for neurotoxic and teratogenic damage, resulting from mercury poisoning (WHO, 1990).

Since the late eighties, numerous studies have reported the presence of mercury in different compartments of the Amazon Basin ecosystem. Two mercury sources appear to be implicated in this contamination: gold mining activities (Martinelli et al., 1988; Malm et al., 1990; Lacerda and Salomons, 1991; Pfeiffer et al., 1991; Pfeiffer et al., 1993) and slash and burn agricultural practices resulting in lixiviation of soils, loaded with natural mercury, to the aquatic system (Roulet et al., 1996a,1996b). The studies on mercury content of fish in the Amazonian river system have shown that levels often surpass 0.5 μg/g fresh weight (Pfeiffer et al., 1991; Lacerda and Salomons, 1991; Barbosa et al., 1995; Boischio et al., 1995; Malm et al., 1995a), a value that is considered in many countries as a standard not to be exceeded for safe consumption.

Hair mercury levels, assessed in human populations living in various areas of the Brazilian Amazon, are in the range of a few μg/g up to 300 μg/g, with median exposure values in the order of 2 μg/g up to ± 20 μg/g (Akagi et al., 1995; Malm et al., 1995b; Barbosa et al., 1995; Boischio et al., 1995; Grandjean et al., 1993; Nakanishi, 1992;
Lebel et al., 1996; Boischio et al., 1996). Even if many of these studies report results from small, heterogeneous samples, the general conclusion is that methylmercury exposure in the Amazon could present a risk for the health of these populations.

The toxic effects of methylmercury were dramatically brought to light following the Minamata and Niigata poisonings. In these disasters, consumption of highly contaminated fish by the local population, over a short period of time (few months), resulted in high exposure levels (> 50 μg/g Hg in hair), followed by the apparition of a neurologic syndrome and teratogenic damage, later called Minamata Disease (WHO, 1976; WHO, 1990). The exposure profile in the Amazon is different. Low-level methylmercury has probably been present for at least 20 years, when gold mining activities started and possibly as long as 40 years, with the introduction of slash and burn activities (Roulet et al., 1996a, 1996b). Recent investigations of communities living on the banks of the Tapajós River have shown dose-related nervous system dysfunction, in the absence of classic Minamata disease symptomatology (Lebel et al., 1996).

Although there is information from the Amazon Basin on mercury levels in fish and in humans, the relation between fish diet and exposure has received limited attention. The Amazonian environment is complex: there is great biodiversity, extreme climatic conditions (high temperature and humidity with important precipitation) and seasonal fluctuations of the water levels that can reach a difference of 6 meters between the rainy season (Mid-November to Mid-May) and the dry season (Mid-May to Mid-November). These characteristics greatly influence fish behaviour and the availability of fish resources (Goulding, 1980).

The objective of the present study was to characterize methyl mercury exposure of a riparian population in the Amazon Basin by: i) determining mercury concentration in a large sample of fish from their fishing grounds ii) surveying fish consumption during the rainy and dry season, and iii) examining hair mercury concentration with respect to diet and over time.

2. Materials and Methods

STUDY SITE. The study focused on a small village, Brasilia Legal (3°59'00"S, 55°30'00"W), situated on the banks of the Rio Tapajós, a main tributary of the Amazon River. The village is approximately 250 km downstream from the most extensive currently operated gold-mining fields in Brazil (Malm et al., 1995b) and in the midst of extensively deforested river banks. Brasilia Legal is accessible only by water, a 12-18 hour boat trip from Santarém, a city of three hundred thousand. The villagers are not exposed to mercury vapours.

FISH COLLECTION AND ANALYSIS. Fish were collected in March 1995 at 16 sites within a 1 km radius of Brasilia Legal at sites identified by local fishermen as commonly used for their fishing activities. Sample collection was done using the same type of fish nets as the local fishermen. The nets were 20 m long with mesh size of 40 mm x 40 mm. Fishing activities were conducted between 5:00 AM and 10:00 PM with collections in the morning, noon and night.

Immediate identification of fish was done with a taxonomic key and with the help of fishermen. Weight, length, sex determination, and stomach content analyses were performed on every captured fish. A piece of muscle tissue, without the skin, was taken laterally, below the dorsal fin and frozen individually in polyethylene vials for future mercury analysis. Total mercury analyses were performed in the laboratories of the