PERSISTENT ORGANIC POLLUTANTS IN NICARAGUAN WOMEN WITH HIGH CONSUMPTION OF FISH FROM LAKE XOLOTLÁN, AND IN CHILDREN WORKING IN A WASTE DISPOSAL SITE IN MANAGUA

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Introduction

Persistent organic pollutants (POPs) are lipophilic chemicals, accumulating in the lipids of living organisms, and increasing in quantity up the food chain. Most human exposure to POPs in the general population comes from dietary sources, and occasionally through inhalation of contaminated soil and dust. Twelve POPs, including 9 pesticides, have been identified by the United Nation Environmental Program as powerful threats to the health of humans and wildlife and have been targeted for elimination[1].

Managua, the capital of Nicaragua, is situated at the shore of Lake Xolotlán. The lake, which is the second largest lake of Nicaragua, has been used as the recipient of domestic and industrial wastewater from the city, and receives the superficial run-off from its drainage basin, which is intensively cultivated. Toxaphene was produced between 1974 and 1991 at a plant, located at the lake shore. DDT is still used in vector control programs, and toxaphene, p,p'-DDT, and its metabolites have been detected in specimens of the two most highly consumed species of fish from Lake Xolotlán and in sediment samples in 1991[2]. More recent data are not available.

The municipal domestic and industrial waste disposal site in Managua is located on the south shore of lake Xolotlán, covering an area of 7 km^2. Approximately 1000 persons, of which more than 50% are children under age 18, work at the site, collecting recyclable waste for selling. A thick cloud of smoke covers the area as the waste is burned to retrieve iron and other materials. The waste is not compressed, the sun is intense, and a constant breeze from the lake sweeps the area. Thus, substantial amounts of airborne dust are generated. Fish from Lake Xolotlán is an important part of the diet for the population living at and around the waste disposal area.

There is little information about the background level of POPs in human populations in the Latin American countries, with the exception of pesticides[3]. The aim of the present study was to assess selected POP levels in blood in young female high consumers of fish from the lake Xolotlán, and in teenagers working and sometimes also living at a waste disposal site, and in appropriate reference populations.

Methods and Materials

Study groups

We obtained venous blood samples from 5 women aged 15-17, living in fishermen´s families in San Fransisco Libre, a fishing village on the rural north-east side of the lake, and 4 women aged 15-32 from another fishing village, Mateares, on the south-west shore of the lake, 25 km from the city of Managua. The subjects ate median 2 (range 1-4) fish meals/week. As referents we used 4 women from urban Managua, aged 18-25 and living in similar socio-economic conditions, who never ate fish. The blood sampling was performed in July, 2002.

We also studied teenagers working in the waste disposal area, and referents, all sharing the same underprivileged socio-economic situation. This was part of a larger study, investigating also heavy metal exposure, exposure to air contaminants, respiratory health, and injuries. Five pools were assembled: #1:11 teenagers living at the waste disposal area, having worked there for 4 years or more, eating fish from the lake, #2:23 teenagers living in a near-by area, Acahualinca, having worked at the waste disposal area for 4 years or more, eating fish from the lake, #3:16 teenagers living in Acahualinca, eating fish from the lake, #4:10 teenagers living in Acahualinca, not eating fish, #5:11 teenagers living in a remote urban area, not eating fish. The pools were comparable as to age and gender. Details on fish consumption is given in Table 1. The overall median age was 14 (12-16) years, and 47% were females. The blood sampling was performed in May, 2002.

Chemical analysis

The chemicals used, extraction of serum, lipid determination, partitioning with base and clean-up procedure, and analysis has been described in detail elsewhere[4]. The lipid removal step chosen was sulfuric acid treatment for both neutral and phenol-type substances followed by an additional clean-up step on sulfuric acid silica gel columns (1 gram). The column with the phenolic fraction was eluted with 10 ml of dichloromethane (a slight modification of the method). Reference compounds, synthesized in house, were used as standards. All solvents were of the highest available commercial grade. Identification and quantification were performed using gas chromatography with an electron capture detector as described by Hovander et al[4]. The dichloromethane was replaced by n-hexane prior to GC/ECD analysis. The column used was a DB5 column (30 m x 0.25 mm i.d., 0.25 μm film thickness).

Results

The concentrations found in individual and pooled samples are given in Table 1 and 2. Pesticides and PCBs were detected in almost all samples. The most abundant compound was p p'-DDE. Toxaphene could not be identified in any sample.

Women from fishing villages with high consumption of fish from Lake Xolotlán had higher concentrations of p,p'-dichlorophenyldichloroethylene (p,p'-DDE), γ-hexachlorocyclohexane (γ-HCH), and several PCB-congeners compared to urban women not eating fish. In contrast, the urban women had higher concentrations of 2,4,6-tribromophenol (2,4,6-TBP).

The teenagers working in the waste disposal area had higher levels of p,p'-DDE, γ-HCH, the sum of PCBs and 4-hydroxy-2,2',3,4',5,5',6-heptachlorobiphenyl (4-OH-CB187) compared to the non-working referent groups. In teenagers not working in the waste disposal area there was also a gradient. Those who lived in the vicinity of the waste disposal area and ate fish from the lake had higher sum of PCB levels than those who did not eat fish. Teenagers who lived far from the waste disposal area and never ate fish had the lowest concentrations. Moreover, the teenagers working in the waste disposal area had higher sum of PCBs than young women from the fishing villages with much higher fish consumption.

For pentachlorophenol (PCP) and 2,4,6-TBP an environmental exposure from the waste disposal area is indicated. A notably increased level of PCP was observed among the teenagers who both lived and worked in the waste disposal area.

Discussion

These results suggest that that consumption of fish from Lake Xolotlán plays an important roll as a source of PCBs, influencing the level of these compounds in human population around the lake.

Although food accounts for the majority of PCB intake, it is obvious that the waste disposal area is a source of specific local contamination for PCBs. The CB-153 levels observed among teenagers working at the waste disposal area, and in women from fishermen´s families are comparable to those found in fishermen´s wives[5], in no- or low fish consumers living around the Baltic Sea in 1991[6], Spanish adults[7] and in pregnant Faroe women not consuming pilot whale blubber[8], in which median CB153-levels in the range 150-200 ng/g lipid weight were reported. Moderate and high fish consumers from the Baltic Sea area had concentrations up to 500-1000 ng/g lipid weight or more[6], and even higher levels are observed in Faroe[8] and Inuit[9] populations.

The waste disposal area is also a source of specific local contamination for PCP and 2,4,6-TBP. The levels of PCP in the teenagers from the waste disposal area are comparable to those observed in Swedish and Latvian men in 1991[6].

Although the use of DDT is banned in Nicaragua, DDT is still used in vector control programs. DDT is likely to be more extensively used in the villages at the lake shore, and in the waste disposal area, which may explain the group difference observed. p,p'-DDE was found in all samples. However, in areas with intense DDT use for vector control much higher serum concentrations than those we observed have been reported[10,11]. Similarly, it has been observed that p,p'-DDT and p,p'-DDE levels in Nicaraguan mother´s milk were lower than in other Latin American and African countries, although higher than in countries in which the DDT ban was enforced.

Our main finding is that there is an occupational and environmental exposure to persistent organic compounds at the waste disposal site. Here not only teenagers but also younger children are working, and some of them also live there since early childhood. There is a need to adopt a protecting policy.

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Table 1. Concentrations of p,p'-DDE, p,p'-DDT, γ-hexachlorocyclohexane (γ-HCH), pentachlorophenol (PCP) and 2,4,6-tribromophenol (2,4,6-TBP) in women with varying fish consumption (medians and range, ng/g lipid weight, ppb), and in teenagers working at a waste disposal site, and referents (pooled samples).

GROUP	N	Fish meals/month	Waste disposal area	p,p'-DDE	p,p'-DDT	γ-HCH	PCP	2,4,6-TBP
San Fransisco	5	4 (4-8)		1450 (250-3420)	19 (7-52)	31 (19-92)	235[2] (126-720)	0.6[2] (nd-0.8)
Mateares	4	8 (4-16)		2800 (1240-10600)	20 (nd-220)	42 (32-67)	150 (79-270)	0.4 (0.2-0.6)
Referents	4	0		790 (160-1870)	8 (nd-33)	13 (6-38)	230 (210-350)	1.3 (0.6-2.5)
p-value[1]				p=0.2	p>0.25	p<0.05	p>0.25	p<0.05
Pool 1	11	2 (0-8)	Work, live	1590	35	42	1210	2.1
Pool 2	23	2 (0-8)	Work	1180	27	142	513	1.3
Pool 3	16	2 (2-8)	No	994	20	20	479	1.1
Pool 4	10	0	No	1002	12	10	354	0.9
Pool 5	11	0	No	986	nd	6	377	0.6

nd=not detected
[1]Mann-Whitney U-test; San Fransisco and Mateares *vs* referents
[2]4 samples only

Table 2. Concentrations of selected PCBs, sum of PCBs and 4-OH-CB-187 in young women with varying fish consumption (medians and range, ng/g lipid weight, ppb), and in teenagers working at a waste disposal site, and referents (pooled samples).

GROUP[1]	CB 118	CB 153	CB 105	CB 138	CB 187	CB 183	CB 128	CB 180	CB 170	ΣPCB	4-OH-CB187
San Fransisco	11 (nd-196)	45 (7-103)	7 (nd-123)	39 (6-181)	16 (3-16)	6 (2-8)	5 (nd-49)	36 (7-42)	nd (nd-22)	171 (26-712)	7[3] (2-10)
Mateares	40 (11-62)	101 (49-223)	16 (5-24)	100 (44-195)	28 (15-69)	15 (7-28)	13 (6-17)	70 (33-171)	26 (13-66)	386 (170-783)	16 (9-27)
Referents	9 (nd-113)	14 (6-61)	7 (4-76)	16 (nd-105)	3 (2-6)	3 (2-5)	3 (2-31)	9 (nd-18)	2 (nd-11)	58 (24-415)	2 (1-5)
p-value[4]	p>0.25	p=0.1	p>0.25	p=0.2	p<0.05	p=0.1	p>0.25	p=0.1	p<0.05	p=0.1	p<0.05
Pool 1	62	148	26	149	32	17	16	89	37	539	29
Pool 2	77	139	34	151	29	13	15	77	38	535	29
Pool 3	46	147	21	90	17	10	11	47	20	389	12
Pool 4	38	52	25	64	11	8	12	24	-	234	6
Pool 5	29	29	26	37	5	4	9	19	5	158	3

nd=not detected
[1]For description of groups, see Table 1
[2]sum of CB118, 153, 105, 138, 187, 183, 128, and 180
[3]4 samples only

[4]Mann-Whitney U-test; San Fransisco and Mateares *vs* referents