

Full Length Research Paper

Organochlorine pesticides contamination in human milk in Abidan (Côte d'Ivoire)

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Organochlorine pesticides belong to the class of persistent organic pollutants (POPs). They are deeply involved in environmental issues and represent a real threat for human health. The aim of this study was to assess the level of organochlorine pesticides contamination in human milk through two studies of POPs biomonitoring performed in 2010 and 2015 in Côte d'Ivoire. Primiparous breastfeeding mothers were selected from maternal and child healthcare centers in the district of Abidjan. A grouped human milk sample was prepared from individual sample collected from each mother. The grouped sample was frozen at -20°C, packaged and shipped to a World Health Organization (WHO) reference laboratory in Germany for the determination of persistent organic pollutants. Analysis of samples from both studies revealed the presence of several organochlorine pesticides such as dichlorodiphenyltrichlorethane (DDT), hexachlorocyclohexane (HCH), dieldrin, chlordane, heptachlor and heptachlorobenzene. Some organochlorine pesticides such as DDT (1073 to 491 ng/g) (54.24%), chlordane (5.7 to 3.6 ng/g) (36.84%), heptachlor (4 to 2 ng/g) (50%) and dieldrin (4.6 to 3.3 ng/g) showed an outstanding decrease. However, HCH and heptachlorobenzene increased in human milk from 2010 to 2015. Values increased from 13.8 to 18.2 ng/g for HCH and from 2.6 to 3.4 ng/g for heptachlorobenzene. Despite their ban, humans are still subject to a long term exposure to organochlorine pesticides.

Key words: Organochlorine pesticides, human milk, biomonitoring.

INTRODUCTION

Organochlorine pesticides belong to the class of persistent organic pollutants (POPs). These chemicals are lipophilic molecules and very stable. They are accumulated in body fats of long lived species found at the top of the food chain (Porpora et al., 2016). They are at higher concentrations in food products containing fat such as milk. In humans, POPs and organochlorine

pesticides are basically found in breast milk, blood lipids and other tissues (Porta et al., 2008; Waliszewski et al., 2011; Bräuner et al., 2012; Porpora et al., 2013). The commonly found organochlorine pesticides are dichlorodiphenyltrichlorethane (DDT), hexachlorocyclohexane (HCH), chlordane and heptachlor. POPs are deeply involved in environmental

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issues and represent a real threat for human health. Organochlorine pesticides toxicity in humans results in neurological, mutagenic, carcinogenic, teratogenic, and dermatological effects as well as hormonal disorders (Freire et al., 2012; Boccolini et al., 2013). The Ivorian government, being aware of the adverse health effects of POPs on its population and environment signed in 2001 and ratified in 2003 the Stockholm Convention, focusing on measures aimed at implementing a National policy for persistent organic pollutants control.

In 2005, a pilot study on human milk jointly carried out by Global Environment Monitoring System (GEMS/Foods) and the Chemisches und Veterinäruntersuchungsamt (CVUA Laboratory), confirmed the economic efficacy by measuring each of the 12 POPs, major targets of the Stockholm Convention, in grouped samples of human milk. World Health Organization (WHO) and United Nations Environment Programme (UNEP) have jointly set up a memorandum of understanding to coordinate studies on human milk according to the Stockholm Convention. Two national surveys supervised by WHO/UNEP were conducted in October 2010 and December 2015 to determine the presence of POPs in human milk. The aim of this study was to assess the impact of the national policy for POPs biomonitoring in compliance with the Stockholm Convention.

MATERIALS AND METHODS

Selection of subjects

The study was conducted on primiparous breastfeeding mothers birthing only one child (no twins). Mothers who have been living in the region for the last ten years were selected from health centers hosting a Maternal and Child Healthcare Center in the district of Abidjan. Donor mothers were selected by the national coordinator after obtaining their informed consent. A survey sheet on participants' food habits was filled in. For donors who did not speak French, a local language translation was performed by a qualified interpreter.

Sample collection

Fifty milliliters (50 ml) of human milk were manually collected using a breast-pump. The collected sample was immediately put in a container (vial), then sent to the Laboratory of Toxicology at the Department of Biological and Pharmaceutical Sciences of the University of Félix Houphouët Boigny (Côte d'Ivoire) and kept at -20°C during the study.

Treatment of samples

Individual milk samples were homogenized and heated at 38°C in a Bain Marie under constant stirring for 10 min. The grouped samples were prepared from individual samples of 50 ml collected from sites. 25 ml of each sample was collected and mixed up in a vial of 2,000 ml. A single grouped sample containing 1,250 ml was

obtained from 50 individual samples.

Determination of POPs

The grouped sample was frozen at -20°C, packaged and shipped to a WHO reference laboratory in Germany (CVUA, Freiburg, Germany).

RESULTS

Socio-demographic surveys

A total of 50 primiparous mothers were selected to participate in these biomonitoring studies. The mean age of mothers was 21.85±3.08 years in 2010 and 22.20±3.44 in 2015 (Table 1). About 96% in 2010 and 87.75% in 2015 lived in urban areas. All mothers had a varied diet during both studies. They were exposed to domestic insecticides at a rate of 53% in 2010 and 50% in 2015 (Table 1).

Determination of organochlorine pesticides

Analysis of samples from both studies revealed the presence of several organochlorine pesticides such as dichlorodiphenyltrichlorethane (DDT), hexachlorocyclohexane (HCH), dieldrin, chlordane, heptachlor and heptachlorobenzene. Some organochlorine pesticides showed a decrease in concentration from 2010 to 2015, it is the case of DDT (1073 to 491 ng/g; 54.24%), chlordane (5.7 to 3.6 ng/g; 36.84%), heptachlor (4 to 2 ng/g; 50%) and dieldrin (4.6 to 3.3 ng/g) (Figure 1 and 2). However, HCH and heptachlorobenzene increased in human milk from 2010 to 2015. Values increased from 13.8 to 18.2 ng/g for HCH and from 2.6 to 3.4 ng/g for heptachlorobenzene (Figure 2).

DISCUSSION

Many organochlorine pesticides were found in human milk in both studies. However, concentrations of dichlorodiphenyltrichlorethane (DDT) in these studies were higher. Since the signature of the Stockholm Convention in 2001 by the Ivorian government, a series of measures has been implemented for persistent organic pollutants control (MFN, 2006; PSAC, 2012). The different studies jointly conducted by World Health Organization (WHO) and United Nations Environment Programme (UNEP) were to ascertain whether national policies for persistent organic pollutants (POPs) reduction provided outstanding results. Encouraging results were noticed in this study, particularly for DDT, chlordane and heptachlor showing an outstanding decrease in human

Table 1. Socio-demographic parameters.

Particular	Years	
	2010	2015
Samples (n)	50	50
Mean age of mothers (years)	21.85±3.08 [14 – 29]	22.20±3.44 [15 – 29]
Age of breastfed children (weeks)	5.85 [3 – 8]	5.79±2.15 [3.5 – 7.5]
Place of residence for the last ten years	Urban	96%
	Rural	4%
Varied diet	100%	87,75%
Exposure to domestic insecticides	100%	12,24%
	53%	50%

The age of mothers in both studies ranged from 14-29 years old with an average of 21.85±3.08 years in 2010 and 22.20±3.44 years in 2015. All mothers had a varied diet.

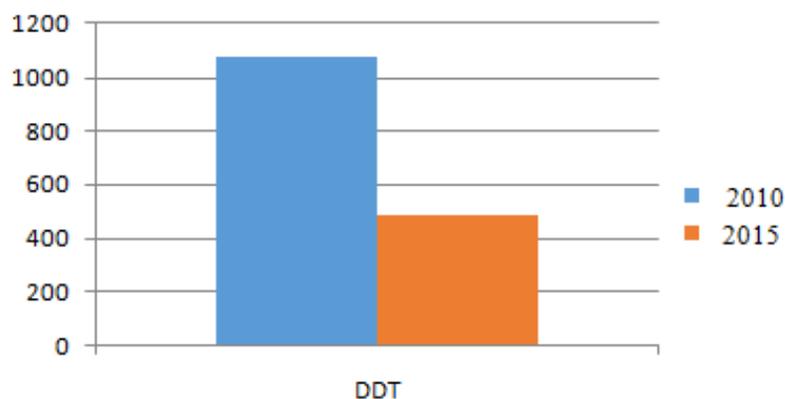


Figure 1. Content of DDT in human milk (ng/g of fatty matter) (WHO campaigns 2010, 2015).

milk. Levels of DDT reduction are so higher as previous studies reported a concentration of 2671.5 ng/g in human milk (Traoré et al., 2002). Restrictions and prohibitions on the use of some organochlorine pesticides were not well followed. As a result, some organochlorine pesticides such as hexachlorocyclohexane (HCH) and heptachlorobenzene have been increasing in human milk. In 1984, Food and Agriculture Organization/World Health Organization (FAO/WHO) established acceptable daily intake of 20 µg/kg/day and 0.1 µg/kg/day for DDT and dieldrin, respectively, in human milk (FAO/WHO, 1985). These values can be converted for DDT to an acceptable level of 5000 to 6000 ng/g in lipids (Smith, 1999). Concentration levels of DDT obtained are below the Ivorian reference values. Surveys of organochlorine pesticides in human milk from developing countries were carried out because of the concern about the use of these compounds for agricultural and sanitary purposes

in recent years (Kaunisue et al., 2004). Organochlorine pesticides are all banned in agriculture and public health today. Contamination of organochlorine pesticides in human milk were found in various environmental and food matrices in Côte d'Ivoire such as sediments, foodstuffs and fishes (Traoré et al., 2003, 2008; Ouffoue, 2009; Manda et al., 2017). The widespread contamination of the environment and foods by pesticides inevitably leads to human contamination. The most persistent and lipophilic pesticides possessing bioaccumulation properties are often found in human organs. Breast milk, the first human food, is an indicator in terms of bioaccumulation of pesticide residues in human body (Somogyi and Beck, 1993; Della et al., 2012). Contamination of organochlorine pesticides in human milk is a global phenomenon. Moreover, the levels detected in some parts of the world, such as Africa and Asia, are appalling.

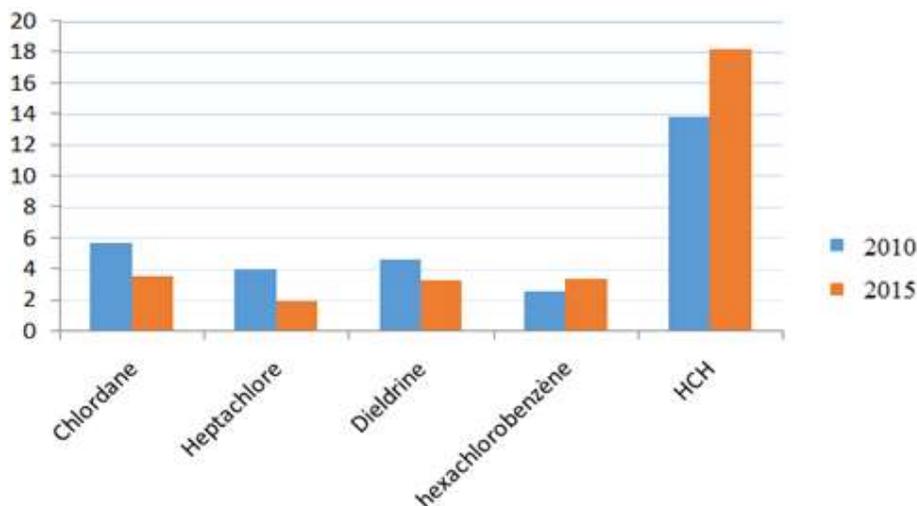


Figure 2. Content of POPs in human milk (ng/g of fatty matter) (WHO campaigns 2010, 2015).

The total DDT level in breast milk is significantly lower than that found in Mali (2081 ng/g) (UNEP-Mali, 2012), in China (1960 ng/g) (Yu et al., 2003), but higher and Libya (220 ng/g) (Zeinab et al., 2011) and India (170 ng/g) (Kumar et al., 2005).

Conclusion

Many organochlorine pesticides banned by the Stockholm Convention have been found in breast milk in Ivory Coast. These organochlorine pesticides were sometimes detected in higher concentrations. These levels highlight the weakness of the implementation of the national policy for persistent organic pollutants (POPs) control. A rigorous implementation of texts and conventions signed by the Ivorian government should be a priority. Further monitoring of human milk is necessary to determine whether the observed outbreak of organochlorine pesticides is due to a previous contamination or to a new source of exposure.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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