Organochlorine pesticides (OCPs) in Breast milk in Hong Kong-Review

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Abstract: Organochlorine pesticides (OCPs) contaminant in human breast milk research is an environmental indicator. Because, diet is a major factor that influences breast milk levels of persistent organic pollutants, with patterns in fish consumption playing a particularly significant role. In this paper review available data on levels of organochlorine pesticides (OCPs), polychlorinated dibenzodioxins (PCDDs) in breast milk of Hong Kong. After reviewing all available data demonstrated that organochlorine pesticides consumption in Hong Kong is decreasing according to time trend.
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1.Introduction

Organochlorine pesticides (OCPs) with their high persistence in the environment accumulate in fatty foods and human adipose tissues. Contamination of human milk by organochlorine and other related compounds has been reported throughout the world (GEMS, 1998). During the recent decade, investigations on POPs pollution in the Asian regions and found that relatively high residue levels of DDTs and HCHs exist in foodstuffs (Kannan et al., 1997), mussels (Monirith et al., 2003) and avian species (Kunisue et al., 2003) from some developing countries and these contaminants are possibly in use for public health purposes even now. Among Asian developing countries, concentrations of DDTs in human breast milk from Vietnam, mainland China, Cambodia, and Malaysia were relatively higher than those from other countries (Kunisue et al., 2004).

Human milk, at the top of the food chain, represents the major route of elimination of OCPs by lactating women (Rogan et al., 1986; Sim and Neil, 1992; IARC, 1991) concluded that there is insufficient evidence in humans but sufficient evidence in experimental animals to classify DDT as a possible carcinogenic to humans. However, body loads of DDT also raise concerns about potential effects on developing infants and children because DDT transfers across the placenta from mother to fetus and exposure continues through breastfeeding after birth (Shen et al., 2007).It is well known that they are very dangerous if ingested as an overdose but there is also biological evidence that chronic low-grade exposure to these chemicals, which are very easily absorbed into the body through the skin and lungs, may have adverse effects on mental health (Zhang et al., 2009).

The rapid socio-economic development during the past two decades in China, especially the coastal area and the Pearl River Delta has given rise to severe economic, environmental and health problems. In 1983 use of DDT in agriculture was banned. However, high residue concentrations for both two substances still existed in sediments, soils, foods and human organisms (Liu et al., 2003). In addition, technical DDTs remain in use in some parts of China for Malaria control and as additives in anti-fouling paints for fishing ships (Li et al., 2007).Organochlorine pesticide residues in animal tissues and other products are likely to occur from the accumulation of these lipophilic chemicals through the food chain and are closely associated with fats in the sample. In this paper review the sources of organochlorine in breast milk of Hong Kong and decrease level.

2.Usage of POP pesticides in China

Being one of the largest agricultural production country, China has been a major producer and consumer of pesticides, until its ban on production and agricultural use were enforced in 1983. China had been a significant producer and user of DDT since the 1950s. In Hong Kong Special-Administrative Region (SAR), DDT was banned from use on 31 December 1987, and currently can be traded only under permit (Wong et al., 2002).From 1979 to 1982, however, between 5032 and 5380 kg of DDT pesticide was imported into Hong Kong annually. Furthermore, there was a net gain of 736 tonnes of DDT between 1986 and 1988 in Hong Kong (Ip, 1990).DDT, HCH, toxaphene, HCB, chlordane, heptachlor, and mirex were produced in China. According to Stockholm Convention persistent organic pollutants (POPs) were banned in China and

Hong Kong as shown in Table 1

Table 1: Data on usage, ban and exemption from Stockholm Convention of POP pesticides in China and Hong Kong (Wong et al., 2002)

POPs pesticides	China				Hong Kong
	Starting of usage	Ban of usage	Production quantity (tones/year)	Request for Specific exemption	Ban of usage
Aldrin	Not used	1983 (2)	None	---	1988 (2)
Chlordane	1945	1999	160 (1998) 500[a]	Produced and used locally as a termiticide	1991 (2)
DDT	1950s	1983 (1)	4000-6000 3000-4000[a]	(building and dams) Use for control of mosquito and export to countries needed, based on prior	1988 (2)
Dieldrin	Not used	1983 (2)	None	informed consent procedures	1988 (2)
Endrin	Not used	----	None	(PIC)	Not
Heptachlor	1948	1982	1 (1969)	-----	registered
Hexachloro-benze ne (HCB)	1945	No information	1000-10000 3000-4000[a]	----- ----- Produced and used locally as an intermediate in the	Not registered Not registered
Mirex	1958	Banned as pesticide	10-30[a]	production of other chlorinated substances.	
Toxaphene	1948	1982(2)	3000 (maximum Quantity in 1970s)	Produced and used locally as a termiticide with limited production and some local use.	1997 (2) 1984 (2)

Note: banned from agriculture (1); banned from all purposes (2).
[a] UNEP, 2005

Historically, there were about 60 POP pesticide-producing enterprises located in 18 provinces in China. The accumulated output of DDT, toxaphene, and HCB were 459,000, 20,660, and 79,278 MT, respectively, while the accumulated output of HCH was 141,366 MT during 1990-2003. In the 1980s, China set up the legal framework for controlling organochlorine pesticides, and the production and use of organochlorine pesticides for agriculture were banned. Presently, DDT and HCH can still be detected in air, water, sediment, field soil, grains, vegetables, fruits, meat, animals and human tissue in many areas. Suggest that government of China could keep the view in the pesticides problems and find the alternative ways to make sustainable environment. Pesticides were destroying the ecosystem and it brings the climate change issue in China.

The total amount of pesticides demand in 2008 was 298,200 tons nearly same as 2007. The pesticide varieties with more than 10,000 tons demand amount all over China will include dichlorvos, acetochlor, copper sulfate, glyphosate, trichlorfon, disosultap etc, 5,000 to 10,000 tons varieties include phoxim, carbendazim, monosultap, butachlor, atrazine, omethoate, triophanate-methyl, chlorpyrifos, 2,4-D butyl ester, dimethoate, acephate etc. In addition, the provinces with more than 20,000 tons of pesticide demand amount are Heilongjiang and Hunan, and the following provinces are ranging from 10,000 tons and 20,000 tons, like Guangdong, Yunan, Shandong, Henan, Anhui, Hubei, Hebei, Jiangsu, Liaoning, Guangxi, Fujian, Jiangxi, and Zhejiang.

Emission of Dioxin in Hong kong

The current and future polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/F) inventory for Hong Kong is lower (Table 2) than that for other national inventories per head of population, owing to a generally low level of combustion and industrial activity, but more significantly to the fact that Hong Kong has adopted a PCDD/F emission limit of 0.1 ng I-TEQ m^{-3} for all existing and proposed waste incineration facilities, in line with the best practice elsewhere.

Table 2: Estimated PCDD/F emissions to atmosphere from the HKSAR (1997-2007)

Sources	Activity 1997	Inventory (1997, g I-TEQ)	Activity (2007)	Inventry (2007 g I-TEQ)
Coal combustion	6.1 MT	0.4-2.0	5.6 MT	0.3-1.8
Municipal soil waste	116,508 t clinker	0.32	1000000	0.5
Clinical waste combustion	3,650 t	0.4-1.8	5,290t	0.2
Diesel	2515MKm	0.002-0.03	2515MKm	0.002-0.03

Estimate of daily dietary exposure to POPs

Human exposure to POPs through dietary intake was estimated based on measurement of the level of POPs contamination in various foods and information on daily food consumption pattern of the local population. Dietary exposure of Hong Kong residents to DDT, HCB, PCBs and dioxins/furans was estimated to be 29.3 ng, 1.11 ng, 8.31 ng and 0.91 pg-TEQ kg^{-1} bw d^{-1}, respectively. The major food groups contributing to POPs exposure were cereals, seafood's and dairy products.

The dietary exposure of the local population to DDT was comparable to the range reported in many European countries and the US (Herrera et al., 1996); higher than that in Australia (Miller et al., 2002) and New Zealand (http://www.pan-uk.org) but substantially lower (by 1–3 orders of magnitude) than that in Mainland China (Chen et al., 1993), Vietnam, India (Kannan et al., 1992) and Egypt (http://www.pan-uk.org) (Table 3).

Table 3: Comparison of dietary intake of POPs by the residents of Hong Kong and other urban locations.

Location	Dietary intake (ng kg^{-1} bw d^{-1})		Reference
	DDT	HCB	
Hong Kong, China	29.3	1.1	(EPD, 2005)
Australia	7	4.67	(Milleretal., 2002; EPD, 2005)
China, Mainland	341	-----	(Chen and Gao, 1993)
Egypt	13,700	-----	(http://www.pan-uk.org)
Findland	26	------	(http://www.pan-uk.org)
India	800	2.17	(Kannan et al., 1992)
New Zealand	3	------	(Buckland et al., 1998)
Slovakia	95.8	3.75	(Prachar et al., 1996)
Spain	20.3	17.2	(Herrera et al., 1996)
Switzerland	28.3	18.3	(Herrera et al., 1996)
Thailand	70	1.3	(Kannan et al., 1992)
Netherlands	16.7	3.33	(Brussard et al., 996;Freijer et al., 2001)
UK	50	-----	(FSA UK, 2003)
USA	26	0.5	(Herrera etal., 1996;USEPA, 2001)
Vietnam	320	1.7	(Malish, 1998)

The estimated dietary intake of HCB was found to be generally similar among residents of Hong Kong, other Asian countries/regions (Kannan et al., 1992), Australia (Miller et al., 2002; Kannan et al., 1995), the US (Herrera et al., 1996), the Netherlands (Brussard et al., 1996) and Slovakia (Prachar et al., 1996), but lower than the value reported in Spain or Switzerland (Herrera et al., 1996). Based on the few published data available for comparison, the level of local dietary PCBs exposure was found to be much lower than in other Asian countries (Kannan et al., 1992). The estimated dietary exposure of Hong Kong residents to dioxins/furans was generally comparable to the level reported in most European countries (Malisch, 1998), Canada and the U.S. (USEPA, 2001); slightly higher than the values recorded in Australia, New Zealand (Buckland et al., 1998) or the UK (FSA Uk, 2003), but appreciably lower than that found in Norway and Spain (Jimenez et al, 1996).

3.Organochlorine pesticides (OCPs) in Human milk

DDT levels in Hong Kong breast milk

The DDT levels in breast milk from Hong Kong indicate a marked decline in DDT human body load in Hong Kong in the past thirty years, assuming reasonable comparability of assay results in different previous surveys (Ip, 1983; 1989). Human breast milk is a convenient medium for monitoring levels of lipophilic organochlorine compounds such as DDT, first because of obvious concern over exposure to the suckling infant, but also because it is easier to obtain than, for example, adipose tissue (Sim and Neil, 1992).The most direct concern with toxic compounds in breast milk, of course, relates to potential exposure to the infant. While breast-feeding is usually considered to have overwhelming advantages (Newman, 1995), there has been concern that breastfeed infants in some areas could be exceeding recommended limits of various organochlorine compounds (Mitchell, 1997). Both *p,p′*-DDT and *p,p′*-DDE concentrations in breast milk in Hong Kong decreased over time. The ratio of *p,p′*-DDT to *p,p′*-DDE decreased from 0.38 in 1976 to 0.07 in 2002. This observation is consistent with a worldwide downward trend in DDT body load (Smith, 1999) and it was even suggested that the decline in average levels of DDT in breast milk in most countries was strongly correlated with the length of time since DDT restriction. However, the time trend in mainland China is not clear because there is only published data on the DDT body load in mainland China in recent years (Nakata et al., 2002; Kunisue et al., 2004).The level of DDT in human breast milk in Hong Kong was the second highest in the 1970s among 21 countries worldwide (Solomon and Weiss, 2002).The DDT produced and applied in south-east mainland China, where DDT had been extensively used, could also be an important source of exposure to Hong Kong residents. High levels of DDT in foodstuffs in Hong Kong have been reported (Ip, 1990).However, an apparent decreasing trend of organichlorine pesticides were observed in Hong Kong human milk 1980s further decrease was found in the (Hedley et al., 2010)(Figure 1).Lower levels of α-HCH and γ-HCH were also found compared with the 1985 level (Ip and Philips, 1989).

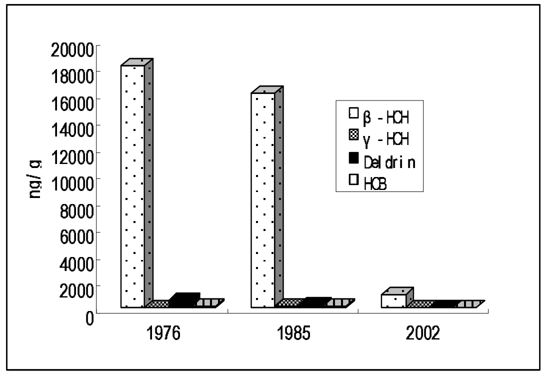

Figure 1.Time trend mean concentration (ng/g in fat) of OCP in breast milk in Hong Kong Review from (Ip, 1983, 1989; Hedley et al., 2010)

Comparison of OCP in breast milk Hong Kong with other countries

To understand the magnitude of contamination in human breast milk in Hong Kong, OCPs were compared with inside the China (Wong et al., 2002; Kunisue et al., 2004) further compared with other countries (Cok et al., 1997; Waliszewski et al.,2001; Hooper et al., 1997; Harris et al., 1999) as shown in (Table 4).

Table 4. Domestic and international comparison of organochlorine concentrations in human breast milk

Country	Year	DDTs	HCHs	Unit	Reference
China					
Hong Kong	1999	2900[b]	950[g]	ng/g lipid wt.	(Wong et al., 2002)
Hong Kong	2001	----	----	TEQ pg/g fat	(Soechitram et al., 2003)
Guangzhou	2000	3220-5980	700-2600	ng/g fat	(Wong et al., 2002)
Dalian	2004	2100[a]	1400[e]	ng/g lipid wt.	(Kunisue et al., 2004)
Shenyang	2004	870[a]	550[e]	ng/g lipid wt.	(Kunisue et al., 2004)
Developing and former socialist countries					
Turkey	1995-1996	2400[b]	480[e]	ng/g lipid wt.	(Cok et al., 1997)
Iran	1991	2000[b]	600[e]	ng/g lipid wt.	(Cok et al., 1997)
Mexico	1997-1998	4700[c]	60[e]	ng/g lipid wt.	(Waliszewski et al., 2001)
Kazakhstan	1994	2300[b]	1300[f]	ng/g lipid wt.	(Hooper et al., 1997)
Russia	1996	2000[b]	560[i]	ng/g lipid wt.	(Hansen et al., 1998)

Developed country					
Japan	1998	290[b]	210[g]	ng/g lipid wt.	(Konishi et al., 2001)
Sweden	1997	170[b]	---	ng/g lipid wt.	(Noren et al., 2000)
Germany	1995-1997	240[b]	40[g]	ng/g lipid wt.	(Schade and Heinzow, 1998)
Canada	1996	470[d]	23[e]	ng/g lipid wt.	(Newsome and Ryan, 1999)
UK	1997-1998	470[b]	100[h]	ng/g lipid wt.	(Harris et al., 1999)

[a] *p,p'*-DDE+*p,p'*-DDT+*p,p'*-DDD.
[b] *p,p'*-DDE+*p,p'*-DDT.
[c] *p,p'*-DDE+ *p,p'*-DDT+*p,p'*-DDD+ *o,p'*-DDT.
[d] *p,p'*-DDE+*p,p'*-DDT+*o,p'*-DDT.
[e] α-HCH+β-HCH+γ-HCH.
[f] α-HCH+β-HCH.
[g] β-HCH only.
[h] β-HCH+γ-HCH.
[i] Total.

Concentrations of DDTs and HCHs in human breast milk from Dalian were similar to those from Hong Kong and Guangzhou, while those from Shenyang were somewhat lower. This indicates that the residents living closer to the costa in China have been exposed to relatively high levels of DDTs and HCHs. However, further study in Hong Kong human milk found to be lower concentration of OCPs consumption. It demonstrated that uses of pesticides in Hong Kong were lower and peoples were following the permissible limit according to world health organization. The developing country like Mexico concentration of DDT was higher than Hong Kong, further total HCHs concentration in Kazakhstan also higher than Hong Kong. Hence, organochlorine pesticides consumption in Hong Kong is decreasing due to time trend.

4. Conclusion

We have review the available data/information of organochlorine pesticides contamination in breast milk of Hong Kong, China. In 1976 concentration of β-HCH was very higher than γ-HCH, deildrin and HCB. Further, monitored in 1985 and 2002 demonstrated that organochlorine pesticides concentration in Hong Kong breast milk found to be must lower than before. In view of our observations suggest that further investigation on human exposure in organochlorine pesticides are needed to elucidate future pollution trends and to assess infant health risk.

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