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Organochlorine pesticides residue in breast milk: a systematic review

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Abstract

Background: Chlorinated pesticides have been used in pest control for several decades in the world. These compounds are still applied in many regions, and their continuous usage has resulted in their bioaccumulation and residue in the food chain. These residues could transfer to food products and accumulate in fat tissues. Undoubtedly, the breast milk could be a significant biomarker for estimation of these residues in the human body. This study was conducted to review and compile the results of the studies undertaken in the world which surveyed the organochlorine pesticides residue in breast milk.

Methods: A total of 710 national and international articles and texts related to the focused subject were extracted from the virtual databases using the following key words: Chlorinated pesticides, residue and breast milk. Thirty articles published between 1980 and 2013 were selected and reviewed.

Results: The majority of the reviewed articles indicated the presence of two or more organochlorine pesticides in the collected samples of breast milk. Based on the reviewed studies, dichlorodiphenyltrichloroethane (DDT) had the highest level of concentration in the collected samples of breast milk. Moreover, there was a statistically significant positive correlation between mother's age, her multiparty and concentration of chlorinated pesticides in breast milk.

Conclusion: The organochlorine pesticides are still applied in some developing countries including some regions of Iran. Thus, it seems essential to inform the community about the adverse effects of this class of pesticides; and most importantly the governments should also ban the use of such compounds.

Keywords: Chlorinated Pesticides, Residue, Breast Milk.

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Introduction

Increase in population size as well as development in agricultural activities have led to the increased usage of pesticides for plant protection. Moreover, pesticides are widely used to control the vectors of various diseases such as malaria and contribute to prevention of vector borne diseases.

However, these compounds are considered as chemical pollutants and might be viewed as a serious threat for human health and environment. Agric ultural pests are becoming widespread in the world, and huge pesticides are being used for pest control in many regions. Hence, concerns about environment pollution by these chemical compounds used in agriculture and in vector control have been recently justified. Some workers investigated the pesticide residues in food and environment;

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for instance, the residues of different pesticides have been reported in streams, groundwater, soil, fish, wild and domestic animals, vegetables and even breast milk (1, 2).

Among different classes of pesticides, organochlorines have been widely used worldwide because of their persistence, low cost and their toxicity against various pests. For example, the main antimalaria measures have been the use of chlorinated hydrocarbons as a residual spraying against the adults and larvae of malaria vectors in some areas through several previous decades (3-5). Obviously, it could be suggested that the major concern has been directed to this class of pesticides.

Environmental impact of these chemical compounds are of high concern because of their resistance to heat, humidity, radiation and biodegradation; and thus, they are extremely persistent in water, soil and can be a real danger to wildlife. Also, they could enter the food chain due to their hydrophobic chemical structure.

Organochlorine pesticides, based on their bioaccumulative nature, are also persistent in animal and plant tissues (6). Continues application of this class of pesticides against harmful insects has resulted in toxic effects on the environment and accumulation of high level of residues in agriculture and dairy products (7). The first chlorinated hydrocarbon DDT was successful in controlling louse borne typhus and malaria during world war II. However, just like most of the chlorinated hydrocarbons, this pesticide was banned in 1972 in many countries due to its toxic effect (such as bioaccumulation and bioconcentration) on the environment. It has been revealed that the concentration of DDT could be increased by 1000 fold through the trophic levels (1,8). However, the organochlorine pesticides are still used in some developing countries to control the vectors of diseases and agricultural insect pests (2,9,10).

The organochlorine pesticides are usually divided into three main groups including DDT and its derivates, gama isomer of hexachlorocyclohexane, HCH and chlorinated cyclodiene such as aldrin and dieldrin. Exposure of the man and animals to organochlorine pesticides and polychlorinated biphenyls can cause some side effects including reproductive toxicity, teratogenic effects and preterm labor. In addition, it has also been suggested that long-term exposure of humans to organochlorine pesticides may damage their central nervous system, liver, kidney and bladder (6).

Humans could be exposed to these chemical compounds via several routes including breathing polluted air, dermal penetration and ingesting contaminated food. The two former routes comprise approximately less than 2% of the total absorption of pesticides, whereas residues of pesticides remained in the crops might appear in food products; and therefore the ingesting contaminated food is considered as the main source of human exposure to pesticides (11). The levels of residues of these compounds in living organisms are based on their habitat and their positions in the food chain (12). The most important human health problem is associated with chlorinated hydrocarbons, and their tendency to accumulate in fatty tissues; and the occurrence of residues of these poisons in fatty tissues can be considered as the best indication for the presence of these compounds in the human body (13).

Considering the adverse effects of the organochlorine pesticides on humans' health due to their highly significant position in the food chain as the secondary consumers, we deemed necessary to carry out a systematic review of the literature on the residues of these chemical compounds in breast milk and on the factors influencing their concentration levels.

The aim of this study was to conduct a systematic review on the residues of this group of pesticides in breast milk and to survey the influencing factors in different countries.

Methods

This systematic review was conducted

Table1. Characteristics and main results of the studies of 17 regions of the world

Population					Intervention/issue	comparatives groups	outcome			paper
Country	Calendar period	No. of samples	Age of mother	Analytical method	Type of Intervention/issue		Measured compound	Pesticide level	Significance Difference	
Indonesia	2002	10	18-33	GC-ECD	Despite Organochlorine pesticides have been banned since the 1980s, the use of these pesticides has continued in Indonesia.	Rural and urban	p,p0-DDE p,p0-DDT HCB β-HCH a-endosulfan dieldrin	 0.01–3.75 mg/kg 0.01–7.50 mg/kg 0.01–7.50 mg/kg	NO (Rural and urban)	Emma et al., 2003
Russia	1996-1997 Cross sectional	140	21.6-28.9	GC	As a result of the climatic conditions, substantial amounts of food are imported from the southern parts of Russia, the Russian Federation and Ukraine where HCHs and DDTs still are the most used chlorinated insecticides.	Parities(nursing first and nursing second child)	DDT HCH HCB a-, b- and g-HCH chlordane p,p9-DDE, p,p9-DDD[1], p,p9-DDT, 30 PCBs	660 ng/g 810 ng/g	Yes (between the mothers nursing first and nursing second child)	Polder et al., 2003
Taiwan	2000-2001 cohort	36	20-36	GC-MS	historical DDT use play a role in determining current exposure patterns.	Taiwan compared to Hong Kong, Guangzhou, Beijing, and Liaoning	p,p0-DDE p,p0-DDT a-CHL, heptachlor epoxide, heptachlor b-HCH, c-HCH	228 ng/g 19 ng/g 7.4 ng/g 4.0 ng/g 2.3 ng/g 1.2 ng/g 0.8 ng/g	Yes (OCP levels in human milk of Taiwanese were obviously lower than those).	Chao et al., 2006

based on the national articles which were extracted from three virtual databases of Iranmedex, Irandoc and SID and international articles and texts extracted from the following virtual databases: Google Scholar, Scopus, Science Direct, Index Medicus /WHO/EMdR, Elsiver, Directory of Open Access Journal and PubMed. A total of 710 articles and texts were collected based on the following key words: Chlorinated pesticide, residue, breast milk; and finally 32 articles and texts published between 1980 and 2012 were reviewed. From these articles, the list of 17 selected studies, classified according to the characteristics of the population, intervention, comparison and outcomes of each paper (PICO frame), was prepared (Table 1). In this study, the data bases and the extracted documents were evaluated and checked by the authors in order to make the study more valid and reliable. Fig. 1 illustrates the search process.

Results

The selected studies were conducted to investigate the residue levels of organochlorine pesticides in breast milk by residue analytical methods based on the age of the mother, body mass index and body weight. The majority of these studies used gas chromatograph equipment (GC) to measure detectable quantities of organochlorine compound. Table1 demonstrates the results of the studies measuring the content of residue of organochlorine pesticides in breast

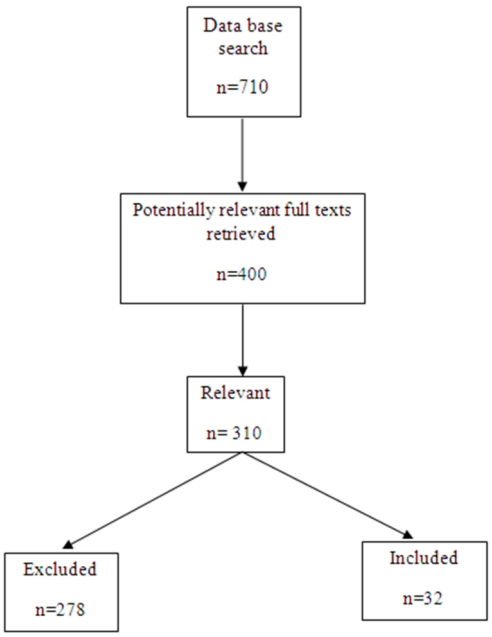

Fig. 1. Search Process

Table 1. Con

Poland	2000-2001	27	25.2	GC	resulting from a published report , assessment of the human exposure to POPs faces a serious obstacle in Poland due to the lack of systematic and credible measurements of the levels of these compounds in specific environmental media.	analysis of human milk of mother with first breast-fed infants in Poland and other European countries	HCB p,p0-DDT p,p0-DDD p,p0- DDE a-HC b-HCH c-HCH P7PCB	EDI =0.086 lg/kgbw/day EDI =3.495 lg/kg bw/day EDI =0.063 lg/kg bw/day EDI =0.364 lg/kg bw/day	Yes (OCPs is comparable Or higher than in other European countries)	Szyrwin´ska & Lulek, 2007
India (Madres)	2006	46	23-28	GC-ECD	Many of the studies in the past two decades have shown that India has the highest concentrations of HCHs in its environmental and biological samples than in several other countries	samples from southern India,Chennai (urban),Perungudi (dump site), Parangipettai (fishing village) and Chidambaram (agricultural town)	HCHs DDTs HCH PCBs CHLs HCB	100 -1000 ng/g 100 - 1000 ng/g 10^4ng/g	Yes DDTs in Chennai mothers were 2.6, 3.6 and 5 times higher than in the samples from Perungudi, Parangipettai and hidambaram, respectively	Subramanian et al., 2007
Australia	2002-2003	173	24-37	GC	It remains unclear whether the decrease in OCP concentrations in human milk samples observed after the ban in the 1980s has continued or is approaching a steady state.	comparison of the samples that collected in 2003 from those samples collected in 1993	Dieldrin Heptachlor p,p0-DDT HCB b-HCH p,p0-DDE transnonachlor	 7 ng/g 14 ng/ g 21 ng/g 279 ng/g 9 ng/ g	Yes concentrations of DDTs have decreased from 1990s.	Jochen et al., 2008
Brazil	2007	69	17-40	GC-ECD	Until the 1990s the 1,1,1-trichloro-bis-2,20-(4chlorophenyl) ethane (DDT) was sprayed in the walls of the house along the Madeira River basin, Brazilian Amazon, a region well known for its large number of malaria cases.	comparison of DDT concentration between primipara and multipara mothers	p,p0-DDT p,p0-DDE, p,p0-DDD	25.4 -9361.9ng/g	Yes The value of DDT concentration in primipara mother were higher than the multipara mothers.	Azeredo et al., 2008
North and west of Norway	2000-2001	29	29.3	GC	because of food traditions of Northern Norway it is important to continue Monitoring studies in Northern to determine the levels of OCPs in breast milk of primipara mothers.	primipara women from Northern and Southern Norway collected, comparison with 1991	HCBs- HCHs- DDT- MIREX- PCBs Toxaphen chlordane	Sum-PCBs and sum-DDTs were the major (OCs) (170 and 110 ng g¡1 lipid weight,respectively).Other OCs werefound in levels of 10- to 300-fold lower than sum-PCBs.	Yes OCs in primipara breast milk have decreased 50–60% since 1991. Concentrations of sum-HCHs were significantly higher in breast milk from Oslo compared to Trom ($p < 0.05$).	Polder et al., 2008

milk in the world.

Table 1 shows the PICO description of 17 selected papers in the order of year of publication. The reported data from each country was separately evaluated.

The Concentration of Chlorinated Poisons in Breast Milk in Asian Countries

In our review, the concentration of chlorinated poisons in breast milk in eight Asian countries was surveyed (14-21). Based on the results from measuring the concentration of these compounds in breast milk in those countries, the maximum quantity 3210 ng/g and the minimum quantity 19 ng/g of DDT were detected in India and Taiwan, respectively (15,19). The maximum 3780 ng/g and minimum 0.8 ng/g quantities of HCH were detected in Iran and Taiwan, respectively (17,19). The maximum 930 ng/g and minimum 3 ng/g quantities of HCB were detected in Iran and Vietnam, respectively (17,18). The maximum 1560 ng/g and minimum 35 ng/g quantities of PCBs were detected in Iran and Bangladesh, respectively (17,21).

Table 1. Con

North of Iran	2006	53	25-35	GC-ECD	it remains unclear whether the decrease in OCP concentrations in human milk samples observed after the ban in the 1980s has continued or is approaching a steady state.	Comparison of organochlorine levels, between mothers who have eaten fish once a week and those who consumed fish more than once.	HCHs, DDTs, PCBs and HCB	3780, 2554, 1560 and 930 ng g_1 lipid wt respectively	difference in the organochlorine levels,between mothers who have eaten fish once a week and those who consumed fish more than once	Dahmardet et al.,2009
Norway	2003-2006	423	16-42	GC	In Norway, breast milk monitoring studies for PCBs and OCPs have been performed periodically since 1970.	comparison of OCPs concentration between primipara and multipara mothers, comparison of OCPs between smoking and none smoking	PCBs p,p′-DDE HCB β-HCH oxychlordane	n=103 34–450 ng/ g n=41 5.4–492 ng/g n=11 3.6–24 ng/g n=47 0.9–37 ng/g n=28 0.5–16 ng/g	There were Significance Difference between (smoking and none smoking) and (primpara and mulipara)	Polder et al., 2009
Northern Vietnam	2007	33	23-35	GC-ECD	Vietnam was reported to be among the countries with the highest levels of (DDTs) and unlike other Asian developing countries because of the extensive use of OCPs in agriculture before their ban in 1995.	comparison of OCPs Rural and urban	PCBs DDTs HCHs	3 ng/g 540-1100 ng/g 5.8-18 ng/g	donors living in the city had significantly higher levels of OCs than those living in suburban and rural areas	Tue et al., 2010
Sweden	2000-2004	204	21-37	GC-ECD	In Sweden , food is an important source of exposure to persistent organic pollutants, such as dichlorodiphenyltrichloroethane (DDT).	Comparison of Regional differences in median organohalogen compound concentrations	DDT PCBs HCH HCB	90 ng/g 113 ng/g 10 ng/g 12 ng/g	Regional differences in median organohalogen compound concentrations were small.	Glynn et al., 2011
India (Nagaon, Dibrugarh)	2010	205	15-40	GC	India is the only country, other than United States, which has applied more than 100,000 t of DDTs, mainly for agricultural and malaria eradication programs, until it was banned for use in agriculture in 1989.		DDT HCH	2870-3210ng/g 2330-2720ng/g		Mishra & Sharma, 2011

Mishra and Sharma (2011) suggested that organochlorine pesticides have been used extensively against malaria vectors as well as agricultural pests in India despite the worldwide prohibition of usage of these compounds. Based on their findings, the average detected quantities of DDTs and HCHs in breast milk were 3210 and 2870 ng/g, respectively (19). According to Burke et al.(2003), there was a significant difference between the levels of residue of organochlorine pesticide in breast milk in urban and rural regions in Indonesia; and 60% and 40 % of breast milk samples collected from the urban and rural regions contained HCB, respectively. Moreover, dieldrin was detected in 80% of breast milk samples which were collected from urban regions. Their results were similar to those found in Japan and England.

Moreover, in a study conducted by Chao et al. (2006), the level of residue of organochlorine pesticides in breast milk in Taiwan were considerably lower than those of some Asian countries such as China, Thailand, Indonesia and Vietnam. Therefore, the authors suggested that those values were comparable to the reported values from some European countries such as Sweden and England (15).

In contrast, Subramanian et al. (2007) proposed that in Chennai (India) the levels of both DDTs and HCH in breast milk had an increasing trend through the two last decades.

In a study by Fujii et al. (2012), the levels of chlorinated cyclodiene pesticides in breast milk samples collected from Japan, China and Korea were compared. The levels of chlordane and PCBs in Japan and Korea were 0.8 – 4.5 ng/g and 0.2 – 4.7 ng/g, respectively. However, the levels of these compounds in breast milk in China were lower than 0.1 ng/g. Heptachlor,

Table 1. Con

China, Korea and Japan	2010	210	------	GC-MS	Historical endosulfan and toxaphene trends showed elevated exposure levels via food intake in these regions.	Comparison of Regional differences in median organohalogen compound concentrations	Heptachlor, Toxaphen, Endrin α and β Endosulfan	Japan 0.8-4.5ng/g Korea 0.2-4.7ng/g China <0.1 ng/g 0.9-1.5 ng/g	dieldrin, endrin and toxaphenes were detected in were ignificantly higher in Japan	Fujii et al., 2012
Tunisia	2010	36	19-39	GC-MS	Old stockpiles of obsolete pesticides, containing mostly HCH, DDT and other OCPs, were identified in Tunisia in 1997	comparison of OCPs concentration between primipara and multipara mothers	DDTs HCB PCB	1163.9 ng/g 286.8 ng/g 331.2 ng/g	There was Significance difference between (primpara and multipara)	Hassine et al., 2012
Turkey (Mercian)	2012	47	------	GC-MS	Although the application of OCPs has been forbidden for a considerable period in many countries such as Turkey since the 1980s, the residues continue to induce a significant impact on the environment and human health.	Comparison of Regional differences in median organohalogen compound concentrations	DDT PCBs	238.38 ng/g 8.07 ng/g	There was regional differences in median organohalogen compound concentrations.	Cok et al., 2012
Bangladesh (Matlab)	2002	72	20	GC	In low-income countries, such as Bangladesh the use of some organochlorine pesticides is still common in order to increase food production.	Comparison of the results with the other countries	DDTs b-HCH PCBs	1645 ng/g 64 ng/g 0.42-35 ng/g	The concentrations of p,p0-DDT and p,p0-DDE are on average over 100 times higher than those in Europe	Begkvist et al., 2012

epoxide, toxaphen, endrin, dieldrin and mirex were detected in the majority of breast milk samples.

Bergkvist et al. (2012), investigated the occurrence and level of organochlorine compounds in breast milk in Bangladesh and found that the level of PCBs in breast milk of the women whose major employment was agriculture was low, but the levels of DDT, DDE and their metabolites were higher than those of the other countries.

The Concentration of Chlorinated Poisons in Breast Milk in European Countries

In this review, the concentration of chlorinated poisons in breast milk in six European countries was surveyed (22-27). Among these countries, the maximum and minimum amount of detected DDT were 660 ng/g and 41 ng/g in Russia and Norway, respectively (22,25). The maximum and minimum amount of detected HCH were 880 ng/g and 0.063 ng/g in Russia and Poland, respectively (22,23). The maximum and minimum amount of detected HCB were 12 ng/g and 0.086 ng/g in Poland and Sweden, respectively (22,23). The maximum and minimum amount of detected PCBs were 113 ng/g and 8.07 ng/g in Sweden and Turkey, respectively (26,27). According to Szyrwin´ska & Lulek 2007, the amounts of detected HCB and HCHs in breast milk were consistent with those of the other European countries; however, the amounts of DDT and DDE in breast milk were slightly higher than those of other European countries (23).

Podler et al. (2003) indicated that the detected quantities of po DDE and βHCH in breast milk were 810 ng/g and 660 ng/g, respectively in Russia. Podler et al. (2008) conducted a study to determine the levels of chlorinated pesticides and PCBs in breast milk in northern and southern Norway. They suggested the order of the levels of studied compounds based on their detected quantities as follows: DDTs>PCBs> HCHs>HCBs>Mirex. It was also suggested that HCBs were only detected in breast milk samples which were collected from northern Norway.

In a study conducted in the vicinity Mediterranean city Mersin, Turkey, Çok et al.

(2012) suggested that the detected quantities of HCHs, DDTs and HCB in breast milk were not higher than the acceptable daily intake (ADI) based on Canadian guideline of ADI. Furthermore, their results indicated a decrease in the levels of organochlorine pesticides in breast milk compared to the previous studies (27).

Polder et al. (2009) suggested that the levels of chlorinated pesticides in breast milk of Norwegian women were lower than the measured quantities during 2000 to 2002 by 29 – 62%.

The Concentration of Chlorinated Poisons in Breast Milk in other Countries

The measured quantities of DDT and HCB in breast milk were 1163 ng/g and 286 ng/g, respectively in an African country, Tunis (25). The measured quantity of DDT in breast milk was 9362 ng/g in an American country, Brazil (28). The results of a study conducted in Australia indicated that the quantities of organochlorine pesticides including DDT, HCH and HCB in breast milk were 7, 21 and 14 ng/g, respectively (29).

Ben Hassine et al. (2012), in a study determining chlorinated pesticides and polychlorinated biphenyls in breast milk, showed that the ratio of ρo DDE / ρo DDT was low, suggesting the high quantities of ρo DDT in breast milk in Bizerte, Tunisia. High usage of DDT could increase the quantities of ρo DDT in breast milk in this region. In general, the order of quantities of chlorinated compounds in breast milk was as follows: DDTs>PCBs>HCB>HCHs> Dieldrin (30).

In a study carried out by Azeredo et al. (2008) in Theamazon (Brazil), it was indicated that the quantity of DDT in approximately 87% of the collected breast milk samples was higher than the WHO standard. The authors suggested that Theamazon was in the vicinity of Maderia river, so DDT was extensively used as an antimalaria measure because of the high incidence of this disease. However, it has been frequently revealed that the organochlorine pesticides such as DDT had toxic effects on the environment and wildlife and cause contamination of the fishes. On the other hand, the consumption of fish was the main dietary regime in the region. Mueller et al. (2008) determined the level of organochlorine pesticides in collected samples of breast milk in Australia. The levels of DDT and HCH in breast milk were 279 and 21 ng/g, respectively. These compounds were also detected in all samples of breast milk; and based on the obtained results, it was suggested that the levels of organochlorine pesticides in breast milk continued to increase from 1980 to1990 (29).

Discussion

The Factors Influencing the Amount of Chlorinated Pesticides in Breast Milk

Our review on the studies undertaken in the world showed that DDT and its metabolites had the highest levels in breast milk. It can be suggested that high human exposure to these chemical compounds and their extensive usage have likely increased their amount in breast milk (15,17,19,22,25). Nevertheless, it should be mentioned that DDT was the first chlorinated pesticide whose use was forbidden in different countries (17). According to Burke et al. (2003), it was suggested that the level of residue of organochlorine pesticides in breast milk was lower in regions where anti-malaria program had been performed (14).

In a study conducted by Chao et al. (2006), the results indicated that the level of DDT in breast milk has been reduced from 3595 ng/g to 333 ng/g during the two previous decades as a consequence of limited usage of organochlorine pesticides and application of substituted compounds against agricultural pests (15).

Organochlorine Pesticides Residue in Breast Milk

Mueller et al. (2008) concluded that the levels of dieldrin and heptachlor were higher in breast milk in areas where these pesticides had been used for controlling termite than the other areas (29). The measured

quantity of DDT in breast milk was 9362 ng/g in an American country, Brazil (28). They observed that the level of this pesticide in breast milk was very high in this country due to the use of organochlorine pesticides against vectors of malaria.

The majority of the performed studies revealed a positive relation between the age of the mother and the level of pesticides in breast milk, and this may be due to the more accumulation of fat tissues in older women and potentially higher accumulation of organochlorine pesticides in those tissues (14,15,22).

In study of Mishra and Sharma (2011), a statistically significant positive correlation was found between the level of organochlorine pesticides in breast milk and the age of the mother; and it was indicated that the estimated daily intake (EDI) of DDTs and HCHs in the body of children who consumed breast milk were higher than the acceptable daily intake (ADI) because the unacceptable quantities of these compounds could transfer to the body of children through breast milk (19).

In a study by Fujii et al. (2012), the level of endosulfan and chlordane in breast milk in China and southern Korea were correlated with the age of the mother. Also, there was a significant positive relation between the body mass index (BMI) of the mothers and the levels of toxaphen and oxychlordane in breast milk in Japan (20).

Polder et al. (2009) found that the age of mother was also one of the factors influencing the levels of pesticides in breast milk (25).

Moreover, in a study carried out by Azeredo et al. (2008), a direct relation was found between the increased age of the mother and increased level of DDT in breast milk in Brazil (28).

Multiparty has been surveyed in all the performed studies, and the increased levels of pesticides in breast milk of multipar mothers were specified (8-9,19).

Podler et al. (2008) found that the levels of organochlorine pesticides in breast milk of multipar mothers were higher than those of nulipar ones. Moreover, the results indicated that the determined quantities of the studied pesticides have been decreased by 50 to 60% compared to a study conducted in these regions in 1991(24).

Ben Hassine et al. (2012) suggested that the age of mother and her multiparty influenced the level of organochlorine in breast milk; therefore, the levels of these compounds were high in multipar mothers (30).

By the worldwide review of the articles we found that the levels of chlorinated pesticides in breast milk in rural areas were higher than the others. These areas were in the vicinity of farms, so the extensive use of pesticides is likely to have influenced the levels of pesticides in breast milk (14,19).

Subramanian et al. (2007) suggested that several factors could influence the levels of organochlorine pesticides in breast milk in Chennai as follows: The region and the river in the vicinity, high agricultural activities, high incidence of malaria and extensive application of organochlorine pesticides including DDT against agricultural pests and malaria vectors have caused the increment of the levels of DDTs and HCH in breast milk (16).

In a study by Glynn et al. (2011), it was suggested that several factors including health, genetics and life style influenced the levels of chlorinated pesticides in breast milk. The results revealed that regional differences in levels of chlorinated pesticides in breast milk were due to geographical factors and differences between the age and body mass index (BMI) of mothers (26).

The results obtained in some of the studies indicated a direct relation between diet and the levels of pesticides in breast milk. It has been revealed that the residues of chlorinated pesticides in food products could transfer to different tissues after ingesting the contaminated food (14,19).

Podler et al. (2003) suggested that nutritious habits and exposure through pesticides residue in food are likely to cause the enhancement of the levels of these compounds in breast milk (22). Dahmardeh et

al. (2009) indicated that the level of organochlorine pesticides in breast milk of mothers who consumed fish once a weak was significantly lower than those of mothers who consistently consumed it in their diet. These authors proposed that the organochlorine pesticides such as DDT might be leached from the treated farms and finally transferred to rivers and seas (17).

Finally, the results of this review revealed that the amounts of chlorinated pesticides in breast milk in Asian, African and Sought American countries were higher than those of European countries. However, in general, other studies than what carried out in Chenai (India) suggested that the residues of these compounds in breast milk have been decreasing during the recent years. It was also suggested that the levels of these pesticides in breast milk in developed countries such as Australia and Russia were lower than those of developing and African countries and this may be due to the fact that these developed countries banned the use of these pesticides much earlier than other countries.

Mishra and Sharma (2011) suggested that the values of organochlorine pesticides were very higher than those of developed countries (19).

Bergkvist et al. (2012) suggested that illiteracy of the women and use of a large amount of pesticides have resulted in enhancement of the levels of residue of DDTs and their metabolites in Bangladesh (21).

Conclusion

Although at the present time the developing agricultural activities have aimed at increasing agricultural and dairy products, the extensive use of pesticides in plant protection has resulted in environment pollution. Among the different classes of pesticides, the main concern has been directed to the application of organochlorine pesticides due to their bioaccumulative nature and persistence in animal and plant tissues. Obviously, the bioaccumulation of organochlorine pesticides in humans is of high concern, and the conducted studies suggested that breast milk could be a significant biomarker for estimation of these residues in the human body. The organochlorine pesticides are still applied in some developing countries including some regions of Iran, against agricultural pests or vectors of diseases such as malaria. Thus, it seems essential to inform the community about the adverse effects of these chemical compounds. Also, governments should ban the use of such pesticides.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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