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Organochlorine Pesticides Concentrations in Maternal Serum and Their Effects on Umbilical Cord Serum Pesticides Concentrations, Neonatal Birth Weight and Gestational Age

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Abstract: Recently, much attention has been focused on the effects of pesticides on human health. This work was conducted to study the effects of high maternal serum organochlorine pesticides levels on umbilical cord serum pesticides levels, neonatal birth weight and gestational age. The present study was carried out on 123 normal pregnant women from El-Kasr El-Eini Hospital and their newborns at the time of delivery. The age of the mothers ranged from 20 to 29 years. All mothers had moderate socio-economic status. We exclude mothers with poor obstetric history, multiple gestation, hypertension, preeclampsia or had acute or chronic illness from this study. The neonates were classified into two groups. The first group consisted of 80 full term (F.T) babies, 41 of them were male (51.2%). The second group were 43 premature (PT) neonates, 21 were male (49%). 18 of the P.T neonates were below or equal to 32 weeks gestational age (G.A) and 25 were more than 32 weeks G.A. The orgnochlorine pesticides levels were determined from the blood serum of all the mothers and from the umbilical cord serum of their neonates. Heptachlor pesticides was found in all the samples of the preterm's mother- neonate dyads. The pesticide found in the highest concentration in maternal and cord serum of preterm neonates was heptachlor 7 mic/L followed by DDT 6 mic /L and heptachlor epoxide 4.4 mic/L. We found a high concentration of serum hepatachlor, endrin, heptachlor epoxide, dieldrin and DDT in the umbilical cord serum of PT neonates and in the serum of their mothers compared to those of full term neonates and the difference was statistically highly significant ($P<0.001$). Also the serum levels of heptachlor and DDT in the umbilical cord of PT ≤ 32 weeks GA were higher than those of PT> 32 weeks GA and this difference was significant $P< 0.001$ and $P< 0.05$ respectively. As regards gender, no significant statistical difference was found in the serum pesticides levels of the umbilical cord between male and female $P> 0.05$. Our results showed a highly significant positive correlation between maternal and umbilical cord serum heptachlor, endrin, heptachlor epoxide, dieldrin and DDT pesticides ($r =1$ and $P< 0.001$) while a negative correlation was found between maternal serum pesticides and gestational age, neonatal birth weight, length and head circumference. Also a negative correlations between umbilical cord serum heptachlor ($r = -0.8$, $P<0.001$), DDT ($r = -0.5$, $P<0.001$) and each of birth weight, length and head circumference were observed and these correlations were statistically significant. Whereas no significant correlation was showed between maternal serum pesticides and maternal age. We need to strengthen our efforts towards prevention of pesticides exposure by the health education and by reducing the spread of pesticides in the environment.

Key words: organochlorine pesticides – umbilical cord serum birth weight, gestational age.

INTRODUCTION

The term "pesticides" refers to chemical substances that are biologically active and interfere with the normal biological processes of living organisms deemed to be pests whether these are noxious plants or weeds, insects, mould or fungi. Pesticides can be broadly classified according to their intended target pest (i.e. herbicide for weeds, insecticide for insects, fungicides for plant diseases and fungi Bosma *et al.,* (2000). There are many sources of exposures to pesticides. The three routes of exposure are oral ingestion, dermal absorption and inhalation. Pesticides can be tracked into home on clothing and in vehicles, exposing family members as well. Pesticides used in pet flea collars, in treatments for scabies and lice and for home infestations of wasps, cockroaches, ants, agricultural pesticides used on farms and greenhouses were ingested by food products.

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Pesticides used domestically or in agriculture run off into ground and surface water exposing entire populations. Generally the higher the dose, the greater the potential for effects (Chun and Kang, 2005). The organochlorine insecticides may be divided into four distinct groups including DDT (dichlorodiphenyl trichloroethane), cyclodienes (aldrin, endrin, heptachlor, dieldrin, chlordane, endosulfan, chlordecone), hexachlorocyclohexane (lindane) and related compounds. Because they are so lipid soluble, these compounds are stored in fatty tissues and repeated small exposures may result in accumulation and eventual clinical toxicity Ellenhorn *et al.,* (1997). Free radicals play an important role in the toxicity of pesticides and environmental chemicals. Pesticides such as DDT and lindane may induce oxidative stress, leading to generation of free radicals, the scavenging enzyme system and lipid peroxidation. Oxidative stress may cause chronic and permanent damage Etemadi *et al.,* (2002). Specific lawn and garden pesticides mainly insecticides have been associated with negative effects on the central or peripheral nervous systems of animals and humans Baldi *et al.,* (2001). Evidence suggests that exposure to some pesticides such as dieldrin, rotenone and paraquat interacting with genetic and other factors, may increase the susceptibility to parkinson's disease Eskenazi *et al.,* (1999). Steeland *et al.,* (2007) reported that exposed subjects to chlorpyrifos for termite treatment suffered from symptoms such as fatigue, reduced muscle strength, memory problems and mood disturbances. The neurotoxicity of chlorpyrifos occurs some time during the long process of neurological development (from in utero to adolescence) and can result in developmental neurotoxicity and changes in cognition and behavior (Rice and Barone, 2000). Organochlorine pesticides have been associated with endocrine disrupting ability by interfering with the rate of synthesis or metabolic breakdown of hormones Go *et al.,*(1999); European Commission, (2000). Organophosphates disrupt both autonomic and parasympathetic control of airways and may influence the occurrence and severity of asthma, respiratory diseases and flu like illness in children (Eskenazi *et al.,* 1999). Pesticides can alter human immune system function even under relatively low-dose exposure including changes in lymphocytes numbers, hypersensitivity and the presence of auto-antibodies (Colosio *et al.,* 1999). Pesticides can affect the liver in the form of zonal hepatocellular alterations, inflammatory reactions, intrahepatic cholestasis, hepatic necrosis or even hepatic cancer. The various organelles of the liver cell can be affected i.e. plasma membrane, endoplasmic reticulum, mitochondria and nucleus. Concerning the kidney, exposure to pesticides can lead to acute or chronic renal failure with impact on the glomerular tubules and renal vasculature Emara, (1989); Omran *et al.,* (1993). Amr *et al.,* (1993) reported an increase in the incidence of bone marrow aplasia due to organophosphate and organochlorine pesticides. Several studies investigated the association between pesticide exposure and the risk of brain, breast, lung, kidney, pancreatic cancers and non hodgkin's lymphoma (Efir *et al.,* 2003; Buzio *et al.,* 2002; Hu and White, 2002). These effects were seen most consistently for longer duration of exposure and were found in the cases of children whose parents were occupationally exposed to pesticides Carsor, (2002). Persons exposed to pesticides may be manifested by a significant increase in the total chromosomal aberrations in the form of breaks, isobreaks, gaps and deletions (Amr *et al.,* 1994). The chronic effect of pesticides have been positively associated with certain reproductive and developmental manifested effects such as the increased incidence of mutagenicity, teratogenicity, embryotoxicity, infertility reduced sperm count, early pregnant loss, spontaneous abortion, fetal death, certain birth defects and altered growth (Garcia, 1998; Pryor *et al.,* 2000).

The aim of this work is to study the effects of maternal serum organochlorine pesticides levels on umbilical cord serum pesticides levels, neonatal birth weight and gestational age.

Subjects and Methods:

This work is a cross section study included 123 pregnant women and their newborns. Mothers were completely free from any diseases and apparently normal. Their age ranged from 20 to 29 years. All mothers had moderate socio-economic status. Mothers with history of diabetes mellitus, hypertension, preeclampsia or had acute or chronic illness were excluded from the study.

Multiple gestation and poor obstetric factors such as uterine malformation, placenta previa or incompetent cervix were also excluded from this work. The newborns were classified into two groups. The first group consisted of 80 full term babies. The second group consisted of 43 premature newborns their birth occurs through the end of the last day of the thirty-seventh week (259^{th} day) following onset of the last menstrual period (Klaus, 1993; Guidelines, 1992). 18 of the preterm babies were below or equal to 32 weeks gestational age.

This study was carried out in the period from March 2006 to February 2007. The mothers were selected from El Kasr El Eini Hospital after taking a consent of joining this work from the director of the hospital. All mothers were subjected to demographic data which include: age, last menstrual period, occupation of the parents.

Newborn information was obtained: Gestational age was confirmed using the modified Dubowitz examination Ballard, (1991) gender, birth weight, length and head circumference for each newborns were recorded. All measurements were performed three times by the same investigator and the mean was taken.

Five millimeters of blood were collected from each mother and from the umbilical cord of her newborn the blood was centrifuged and the organochlorine pesticide residues in the blood serum were determined according to the method of Dale *et al.,* (1966) as follows:

1- Blood serum sample (about 2 ml) was mixed thoroughly and transferred to a 15 ml round bottom culture tube.
2- 6 ml hexane was added, tightly stoppering of the culture tube with a foil, then the tube was placed on rotator.
3- Rotator speed was setted at 50 rpm and rotated for two hours.
4- Transferred 5 ml of hexane extract and evaporated in water bath at 40°C
5- The tube was allowed to cool (3-5 min) and then foil was placed on its hold in place firmly.
6 The sample now is ready for pesticide residues detection.

Aliquots of 1-2µl of extracted blood serum samples were injected into a Hewlett Packard gas chromatography model 5890 equipped with Ni^{63} electron capture detector (ECD), fitted with HP-101 capillary column (cross linked methyl silicon Gum), 30 mx 0.25 mm x 0.25 µm film thickness. The colum oven temperature was programmed from 160°C to 220°C at a rate of 3°C /min and held for 25 min. Injection and detector temperature were 220°C and 300°C respectively.

Standards of Pesticide:

Pesticide standards of lindane, heptachlor, heptachlor epoxide, dieldrin, endrin, p.p. DDT (1,1,1-tri-chloro-2,2 bis (p-chlorophenyl, ethane), O.p-DDT (1-(o-chloro-phenyl)-1-(p-chloro-phenyl)-2,2,2-tri-chloroethane), p.p-DDD (1,1-di-chloro-2,2 bis (p-chlorophenyl) ethane, O.pDDD (1-(o-chlorophenyl)-1- (p-chlorophenyl)-2,2-dichloroethane, and p.p-DDE (1,1-dichloro-2,2-bis (P-chlorophenyl) ethylene were purchased from Chem.-Service, Inc. (West chester, PA).

Statistical Analysis:

Data was analyzed using SPSS win statistical package version 12. Numerical data were expressed as median and range. Qualitative data were expressed as frequency and percentage. Chi-square test was used to examine the relation between qualitative variables. For quantitative data, comparison between two groups was done using Mann- Whitney test. Wilcoxon signed –rank test was used to compare two related variables. Relation between different numerical variables was tested using Spearman correlation probability (p-value) less than 0.05 was considered significant and less than 0.001 considered as highly significant.

RESULTS AND DISCUSSION

Table (1-a) shows the demographic criteria of mother-neonate dyads. The age of the mothers ranged from (20 to 29 years) with median of 24 years in both F.T and P.T with no statistical difference (P-value 0.36). From the 80 F.T newborn 41 were male (51.2%) and from the 43 P.T 21 were male (48.8%) Table (1-b). The mean gestational age (G.A) of the F.T babies was 40 weeks and that of P.T was 32.4 weeks. The G.A of preterm ranged from (28-35 weeks). The mean ± SD of the weight of F.T neonates was 3183 ± 200 gm with a range of (2800-3600 gm). The weight of P.T neonates ranged from (850-2350 gm) with mean ± SD (1560 ± 383 gm). The mean length of F.T babies was 49.6 ± 0.6 cm SD and the mean length ± SD of P.T neonates was 42.9 ± 3.1 cm. The mean head circumference of F.T neonates was 34.8 ± 0.4 cm S.D and that of P.T neonates was 30 ± 2.1 cm S.D (Table 1-a).

Table (2) shows the organochlorine pesticides levels in maternal serum of F.T and PT neonates. The mean ± SD of the heptachlor pesticide level of the mother's serum of F.T newborn was 0.038 ± 0.08 mic/L and that of P.T's mothers was 2.67 ± 1.87 mic/L the range of heptachlor in the serum of maternal P.T babies was (0.32 – 7.10 mic/L). The mean serum level of endrin ± SD in F.T's mothers was 0.003± 0.01 mic/L and that of P.T's mothers was 0.22±0.51 mic/L. The mean serum level ± SD of Dieldrin in F.T's mothers was 0.002 ± 0.01 mic/L and that of P.T's mothers was 0.304 ± 0.75 mic/L. The mean DDT serum level in F.T's mothers was 0.001 mic/L while in P.T's mothers it was 2.76 ± 1.2 mic/L, there was a high statistical significant difference in all serum pesticides levels between F.T's mothers and P.T's mothers (P<0.001).

Table (3) shows the organochlorine pesticides levels in umbilical cord serum of F.T and P.T neonates. The mean serum level ± SD of heptachlor in F.T umbilical cord was 0.03 ± 0.07 mic/L, the range was (0.00-0.23

mic/L) while in P.T babies the mean of heptachlor was 2.58 ± 1.84 mic/L, the range was (0.27-6.95 mic/L). the mean serum level ± SD of dieldrin in the F.T's umbilical cord was 0.002 ± 0.008 mic/L, the range was (0.00-0.05 mic/L) while in P.T neonates the mean ± SD was 0.28 ± 0.72 mic/L, the range was (0.00-3.18 mic/L). The mean serum level ± SD a DDT in F.T's umbilical cord was 0.001 ± 0.004 mic/L, the range was (0.00-0.024 mic/L) while in P.T neonates the mean ± S.D was 2.715 ± 1.17 mic/L, the range was (0.00-6.15 mic/L). The difference of umbilical cord serum pesticides levels between F.T and P.T is highly significant ($P<0.001$).

The comparative study of serum pesticides levels in mothers of P.T ≤ 32 weeks G.A and mothers of P.T > 32 weeks G.A was shown in table (4). The mean serum heptachlor in the mothers of P.T ≤ 32 weeks G.A was 3.83 ± 1.99 mic/L S.D while the mean serum level of heptachlor in the mothers of P.T > 32 weeks G.A ± S.D was 1.83 ± 1.26 mic/L. The mean serum DDT in the mothers of P.T ≤ 32 weeks G.A was 1.32 mic/L ± 1.66 mic/L S.D. The mean serum DDT in the mothers of P.T > 32 weeks G.A ± SD was 0.37 ± 0.58 mic/L and this difference was statistically significant.

Table (5) shows the comparative study of anthropoemetric parameters (birth weight, length, head circumference) and the umbilical cord serum pesticides levels between PT ≤ 32 weeks G.A and P.T > 32 weeks G.A. There were a statistically significant differences in all anthropoemetric parameters $P < 0.001$ and also in umbilical cord serum heptachlor, dieldrin and DDT between PT ≤ 32 weeks G.A and those of P.T > 32 weeks G.A.

Table (6) shows that there was no statistical significant difference of the umbilical cord serum pesticides levels between male and female neonates $P > 0.05$.

Table (7) shows the correlation coefficients between maternal serum pesticides levels and gestational age, neonatal birth weight and other parameters.

There were a significant negative correlation between maternal serum heptachlor ($r = -0.89$), DDT ($r = -0.59$) and gestational age, also a significant negative correlation between maternal serum heptachlor ($r= -0.89$), DDT ($r=0.54$) and neonatal birth weight.

Table (7) shows also that there was no significant correlation between maternal age and serum pesticide levels.

Table (8) shows a highly positive correlation between maternal serum pesticides and umbilical cord serum pesticides $r = 1.00$ and $P < 0.001$. Also a negative correlation is shown in table (8) between umbilical cord serum organochlorine pesticide levels and anthropoemetric parameters (weight, length and head circumference) of the neonate babies. Figures from (1 – 4) showed the correlation between maternal and umbilical cord serum pesticides and gestational age and birth weight.

Fig. (1): Correlation between maternal serum DDT pesticide and gestational age (weeks).
Fig. (2): Correlation between umbilical cord serum heptachlor pesticide and gestational age.
Fig. (3): Correlation between maternal serum heptachlor pesticide and birth weight.
Fig. (4): Correlation between umbilical cord serum DDT pesticide and neonatal birth weight.

Discussion:

A preterm neonate's birth occurs through the end of the last day of the thirty-seventh week (259^{th} day) following onset of the last menstrual period Klaus, (1993); Guidelines, (1992). Approximately 9% of all United States birth are premature and almost 2% are less than 32 weeks' gestation Cochran, (1997). In Egypt the incidence of prematurity is much higher[27]. The etiology of prematurity is unknown in most cases Cochran, (1997).

As a consequence of environmental exposure, organochlorine pesticides accumulate in lipid rich tissues such as maternal adipose tissue and partition to maternal blood serum and umbilical cord blood serum Waliszewski *et al.,* 2000; Waliszewski *et al.,* 2001.

Prior to world war II, the pesticides that we use now did not yet exist. After world war II certain pesticides are used for protection of public health as disinfectant for medical facilities and control of carriers of disease such as mosquitoes and rodents. However, the abuse of chemicals in pest control may contribute to both health and environmental problems Acquavella *et al.,* (1998). It has been reported by WHO Experts Committee in the Safe use of Pesticides that there were as many as 500.000 pesticide poisoning cases annually with a mortality rate of 1%. In developing countries the hot climatic conditions and the general lack of education make pesticide use more dangerous to the applicators than in developed countries WHO, (1990).

In Egypt, the use of pesticides approximately doubled every 10 years, and about 670.000 metric tons have been injected into the environment since Amr *et al.,* (1952).

In the present study we found the presence of several classes of parent organochlorine pesticides and their metabolites in the maternal and umbilical cord blood serum. Heptachlor was found in the serum of all the samples of the preterm's mother - neonate dyads (100%). The pesticide found in the highest concentration in maternal and cord serum of preterm neonates was heptachlor (7 mic/L) followed by DDT (6 mic/L) and heptachlor epoxide (4.4 mic/L). Our data was consistent with the study done by Carrion *et al.,* (2005). However Bjerregaard and Hansen (2000)[34] found that 1,1 dichloro-2,2-bis (P-chlorophenyl ethylene) (P,P'-DDE) and hexachlorobenzene were the highest concentrations in maternal and cord serum, their levels were 4.8 mic/L and 1.2 mic/L respectively. Also Kanja *et al.,* (1992) found that the main contaminants in all his samples were P, P' DDE (100%) and O, P' DDT (59%).

Although pesticide use is widespread, little is known about potential adverse health effects of in utero-exposure. Pesticides may induce oxidative stress[4]. Cord serum antioxidant capacity correlate with gestational age Zidan *et al.,* (2004).

Our results showed a significant positive correlation coefficients between maternal serum heptachlor, endrin, hephachlor epoxide, dieldrin and DDT and umbilical cord serum pesticides ($r = 1$ and $P < 0.001$). These data were similar to the studies done by Whyatt *et al.,* (2003) and Whyatt *et al.,* (2005) who evaluated the effects of prenatal insecticide exposures among urban in New York city of the 571 women enrolled, 85% reported the use of some form of pest control during pregnancy and when they collected blood samples from the mothers and their newborns they found that maternal and newborn blood levels are similar and highly correlated ($r = 0.4 - 0.8$, $P < 0.001$). The statistical evaluation of results and the pairing of samples analyzed indicate that absorbed organochlorine pesticides cross the placental barrier and reach a balanced state between mother and fetus Waliszewski *et al.,* (2000).

As regards organochlorine pesticides levels in the umbilical cord serum of male and female, our results coincided with those of Rhainds *et al.,* (1999) and Guillette, (2002) who found no significant statistical difference of organochlorine pesticide levels between both gender.

In our work we found a high concentrations of heptachlor, endrin heptachlor epoxide, dieldrin and DDT in the umbilical cord serum of preterm neonates and in the serum of their mothers compared to those of full term neonates and the difference was statistically significant ($P < 0.001$). Also the serum levels of heptachlor and DDT in the umbilical cord of preterm ≤ 32 weeks gestational age were higher than those of preterm > 32 weeks gestational age and these differences were statistically significant $P < 0.001$ and $P < 0.05$ respectively. Moreover a negative correlation was found in this study between maternal serum pesticides levels and gestational age. This agrees with the studies done by Perera *et al.,* (2004) and Perera *et al.,* (2005) and Whyatt *et al.,* (2004). Organochlorine pesticides such as DDT may induce oxidative stress, leading to generation of oxygen free radicals, alteration in antioxidants and lipid peroxidation (Etemadi *et al.,* 2002). Maternal oxidant stress and maternal antioxidant capacity are likely to alter the cord blood antioxidant capacity *Zidan et al.,* (2004). found a strong positive correlation between low birth weight infant's cord serum antioxidant levels and gestational age.

Table 1-a: Demographic criteria of mother-neonate dyads.

	No.	Mean	S.D	Median	Minimum	Maximum	P-value
Mother's age							
• F.T	80	23.9	2.3	24.00	20.00	29.00	0.367
• P.T	43	24.4	2.76	24.00	20.00	29.00	
Gestational age							
• F.T	80	40.00	0.00	40.00	40.00	40.00	< 0.001
• P.T	43	32.44	2.22	34.00	28.00	35.00	
Weight							
• F.T	80	3183.10	200.5	3200.0	2800.00	3600.00	< 0.001
• P.T	43	1560.47	383.83	1650.00	850.00	2350.00	
Length:							
• F.T	80	49.6	0.6	50.0	48.00	50.00	< 0.001
• P.T	43	42.97	3.11	44.00	37.00	47.50	
Head Circumference							
• F.T.	80	34.8	0.4	35.0	34.00	35.00	< 0.001
• P.T	43	30.01	2.09	31.00	26.00	32.50	

F.T = Full Term P.T =Preterm S.D= Standard Deviation
P<0.001 = Highly Significant P < 0.05 = Significant

Table 1-b: Gender:

	Frequency	Percent
Male		
• F.T	41	51.2
• P.T	21	48.8
Female		
• F.T	39	48.8
• P.T	22	51.2
Total		
• F.T	80	100.0
• P.T	43	100.0

Table 2: Organochlorine (OC) pesticides levels in maternal serum of full term (F.T) and preterm (P.T) neonate babies.

Pesticides	Mean	S.D	Median	Minimum	Maximum	P-value
Heptachlor						
• F.T's mothers	0.038	0.080	0.000	0.000	0.267	<0.001
• P.T's mothers	2.671	1.875	2.562	0.325	7.102	H.S
Endrin						
• F.T's mothers	0.003	0.014	0.000	0.000	0.083	<0.001
• P.T's mothers	0.223	0.516	0.000	0.000	2.312	H.S
Heptachlor epoxide						
• F.T's mothers	0.000	0.000	0.000	0.000	0.000	<0.001
• P.T's mothers	0.116	0.687	0.000	0.000	4.491	H.S
Dieldrin:						
• F.T's mothers	0.002	0.010	0.000	0.000	0.062	<0.001
• P.T's mothers	0.304	0.753	0.000	0.000	3.241	H.S
O.PDDD						
• F.T's mothers	0.001	0.005	0.000	0.000	0.034	<0.001
• P.T's mothers	0.383	0.716	0.000	0.000	3.104	H.S
P. PDDE						
• F.T's mothers	0.000	0.004	0.000	0.000	0.036	<0.001
• P.T's mothers	0.353	0.702	0.000	0.000	3.242	H.S
O.PDDT						
• F.T's mothers	0.000	0.000	0.000	0.000	0.000	< 0.05
• P.T's mothers	0.030	0.152	0.000	0.000	0.939	S
DDT						
• F.T's mothers	0.001	0.006	0.000	0.000	0.036	< 0.001
• P.T's mothers	2.766	1.237	0.000	0.000	6.35	H.S
No. of detected pesticides						
• F.T's mothers	0.5	0.51	1	0.000	1.000	< 0.05
• P.T's mothers	4	1.97	4	1.000	7.000	S

Table 3: Organochlorine pesticides levels in umbilical cord serum of F.T and P.T neonates.

Pesticides	Mean	S.D	Median	Minimum	Maximum	P-value
Heptachlor						
• F.T	0.033	0.072	0.000	0.000	0.236	<0.001
• P.T	2.589	1.845	2.471	0.275	6.957	H.S
Endrin						
• F.T	0.002	0.010	0.000	0.000	0.061	<0.001
• P.T	0.208	0.497	0.000	0.000	2.269	H.S
Heptachlor epoxide						
• F.T	0.000	0.000	0.000	0.000	0.000	<0.001
• P.T	0.112	0.676	0.000	0.000	4.421	H.S
Dieldrin:						
• F.T	0.002	0.008	0.000	0.000	0.051	<0.001
• P.T	0.285	0.727	0.000	0.000	3.186	H.S
O.PDDD						
• F.T	0.000	0.003	0.000	0.000	0.022	<0.001
• P.T	0.346	0.653	0.000	0.000	2.967	H.S
P. PDDE						
• F.T	0.000	0.003	0.000	0.000	0.024	<0.001
• P.T	0.334	0.679	0.000	0.000	3.186	H.S
O.PDDT						
• F.T	0.000	0.000	0.000	0.000	0.000	< 0.05
• P.T	0.027	0.138	0.000	0.000	0.859	S
DDT						
• F.T	0.001	0.004	0.000	0.000	0.024	< 0.001
• P.T	2.715	1.172	0.000	0.000	6.153	H.S
No. of detected pesticides						
• F.T	0.50	0.90	1	0.000	1.000	< 0.05
• P.T	4.00	1.93	4	1.000	7.000	S

Table 4: Comparative study of serum pesticides levels in mothers of P.T ≤ 32 weeks gestational age and mothers of PT > 32 weeks GA.

Pesticides	Valid no.	Mean	S.D	Median	Minimum	Maximum	P-value
Heptachlor							
• Mothers of P.T ≤ 32 wks	18	3.832	1.998	3.612	0.325	7.102	<0.001
• Mothers of PT > 32 wks	25	1.835	1.260	1.743	0.412	4.324	H.S
Endrin							
• Mothers of P.T ≤ 32 wks	18	0.260	0.492	0.000	0.000	1.594	0.528
• Mothers of PT > 32 wks	25	0.196	0.541	0.000	0.000	2.312	N.S
Heptachlor Epoxide							
• Mothers of P.T ≤ 32 wks	18	0.249	1.059	0.000	0.000	4.491	0.787
• Mothers of PT > 32 wks	25	0.019	0.096	0.000	0.000	0.481	N.S
Dieldrin:							
• Mothers of P.T ≤ 32 wks	18	0.654	1.065	0.000	0.000	3.241	0.022
• Mothers of PT > 32 wks	25	0.053	0.174	0.000	0.000	0.801	S
O.PDDD							
• Mothers of P.T ≤ 32 wks	18	0.648	0.924	0.204	0.000	3.104	0.027
• Mothers of PT > 32 wks	25	0.192	0.450	0.000	0.000	1.941	S
P. PDDE							
• Mothers of P.T ≤ 32 wks	18	0.617	0.922	0.000	0.000	3.242	0.053
• Mothers of PT > 32 wks	25	0.163	0.411	0.000	0.000	1.766	S
O.PDDT							
• Mothers of P.T ≤ 32 wks	18	0.052	0.221	0.000	0.000	0.939	0.787
• Mothers of PT > 32 wks	25	0.015	0.073	0.000	0.000	0.364	N.S
DDT							
• Mothers of P.T ≤ 32 wks	18	1.320	1.660	0.970	0.000	6.350	0.028
• Mothers of PT > 32 wks	25	0.370	0.58	0.000	0.000	1.940	S
No. of detected pesticides							
• Mothers of P.T ≤ 32 wks	18	3.780	1.66	4.000	1.000	7.000	< 0.049
• Mothers of PT > 32 wks	25	1.840	1.40	1.000	1.000	4.000	S

Table 5: Comparative study of anthropoemetric parameters, serum pesticides levels in P.T ≤ 32 weeks gestational age and those > 32 weeks GA.

Pesticides	Valid no.	Mean	S.D	Median	Minimum	Maximum	P-value
Weight							
• P.T ≤ 32 wks	18	1163.89	166.98	1200.00	850.00	1450.00	0.001
• PT > 32 wks	25	1846.00	187.59	1800.00	1600.00	2350.00	H.S
Length							
• P.T ≤ 32 wks	18	39.72	1.44	40.00	37.00	42.00	0.001
• PT > 32 wks	25	45.30	1.39	45.50	41.00	47.50	H.S
Head circumference							
• P.T ≤ 32 wks	18	27.78	1.14	27.75	26.00	29.50	0.001
• PT > 32 wks	25	31.62	0.53	32.00	30.50	32.50	H.S
Heptachlor:							
• P.T ≤ 32 wks	18	3.734	1.943	3.588	0.275	6.957	0.001
• PT > 32 wks	25	1.764	1.261	1.697	0.348	4.258	H.S
Endrin:							
• P.T ≤ 32 wks	18	0.237	0.460	0.000	0.000	1.514	0.528
• PT > 32 wks	25	0.186	0.530	0.000	0.000	2.269	N.S
Heptachlor epoxide:							
• P.T ≤ 32 wks	18	0.246	1.042	0.000	0.000	4.421	0.787
• PT > 32 wks	25	0.017	0.083	0.000	0.000	0.414	N.S
Dieldrin:							
• P.T ≤ 32 wks	18	0.620	1.034	0.000	0.000	3.186	0.022
• PT > 32 wks	25	0.44	0.154	0.000	0.000	0.719	S
O.PDDD							
• P.T ≤ 32 wks	18	0.583	0.831	0.172	0.000	2.967	0.025
• PT > 32 wks	25	0.177	0.429	0.000	0.000	1.872	S
P. PDDE							
• P.T ≤ 32 wks	18	0.589	0.899	0.000	0.000	3.186	0.053
• PT > 32 wks	25	0.150	0.387	0.000	0.000	1.697	S
O. PDDT							
• P.T ≤ 32 wks	18	0.048	0.202	0.000	0.000	0.859	0.787
• PT > 32 wks	25	0.012	0.060	0.000	0.000	0.302	N.S
DDT							
• P.T ≤ 32 wks	18	1.190	1.598	0.705	0.000	6.153	0.035
• PT > 32 wks	25	0.372	0.551	0.000	0.000	1.872	S
No. of detected pesticides							
• P.T ≤ 32 wks	18	3.780	1.66	4.000	1.000	7.000	<0.049
• PT > 32 wks	25	1.840	1.40	1.000	1.000	4.000	S

Table 6: Statistical difference between umbilical cord serum pesticide levels in male and female neonates

	Heptachlor	Endrin	Heptachlor Epoxide	Dieldrin	O.PDDD	PP. DDE	O. PDDTDDT
P-value	1.0716	0.450	1.00	0.178	0.401	0.742	0.143
NS	NS	NS	NS	NS	NS	NS	0.989

NSN.S = Non Significant

Table 7: Correlation coefficients between maternal serum pesticides levels and gestational age, neonatal birth weight and other parameters.

Pesticides	Gestational age	Weight	Length	Head circumference	Maternal age
Heptachlor					
• r	-0.894**	-0.895**	-0.843**	-0.856**	0.020
• P	0.000	0.000	0.000	0.000	0.824
Endrin					
• r	-0.332	-0.345	-0.298	-0.322	0.158
• P	0.000	0.000	0.001	0.000	0.080
Heptachlor epoxide					
• r	-0.197	-0.186	-0.200	-0.194	0.139
• P	0.029	0.039	0.026	0.032	0.125
Dieldrin					
• r	-0.377	-0.362	-0.399	-0.415	0.168
• P	0.000	0.000	0.000	0.000	0.063
O.PDDD					
• r	-0.539**	-0.481**	-0.513**	-0.488**	0.131
• P	0.000	0.000	0.000	0.000	0.150
P. PDDE					
• r	-0.494**	-0.447**	-0.465**	-0.491**	0.161
• P	0.000	0.000	0.000	0.000	0.075
O. PDDT					
• r	-0.183	-0.171	-0.190	-0.179	0.053
• P	0.043	0.059	0.035	0.047	0.561
DDT					
• r	-0.591**	-0.541**	-0.565**	-0.562**	0.132
• P	0.000	0.000	0.000	0.000	0.146

= Negative correlation
** P < 0.001 = Highly significant
* P < 0.05 = Significant
P > 0.05 = Non significant

Table 8: Correlation coefficients between umbilical cord serum pesticides levels and maternal serum pesticides levels and other parameters.

	Maternal serum pesticides	Gestational age	Weight	Length	Head circumference
Umbilical cord serum pesticides					
Heptachlor					
• r	0.999**	-0.894**	-0.894**	-0.844**	-0.857**
• P	0.000	0.000	0.000	0.000	0.000
Endrin					
• r	1.000**	-0.332	-0.345	-0.298	-0.322
• P	0.000	0.000	0.001	0.001	0.000
Heptachlor epoxide					
• r	1.000**	-0.197	-0.186	-0.200	-0.194
• P	0.000	0.029	0.039	0.026	0.032
Dieldrin					
• r	1.000**	-0.377	-0.362	-0.399	-0.415
• P	0.000	0.000	0.000	0.000	0.000
O.PDDD					
• r	1.000**	-0.539**	-0.481**	-0.513**	-0.488**
• P	0.000	0.000	0.000	0.000	0.000
P. PDDE					
• r	1.000**	-0.494**	-0.447**	-0.465**	-0.491**
• P	0.000	0.000	0.000	0.000	0.000
O. PDDT					
• r	1.000**	-0.183	-0.171	-0.190	-0.179
• P	0.000	0.043	0.059	0.035	0.047
DDT					
• r	0.951**	-0.578**	-0.526**	-0.555**	-0.546**
• P	0.000	0.000	0.000	0.000	0.000

= Negative correlation
** P < 0.001 = Highly significant
* P < 0.05 = Significant
P > 0.05 = Non significant

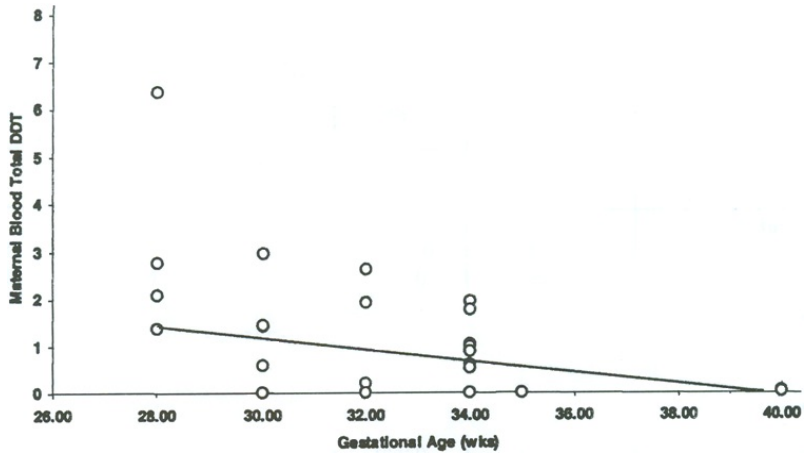

Fig. 1: Correlation between maternal serum DDT pesticide and gestational age (weeks).

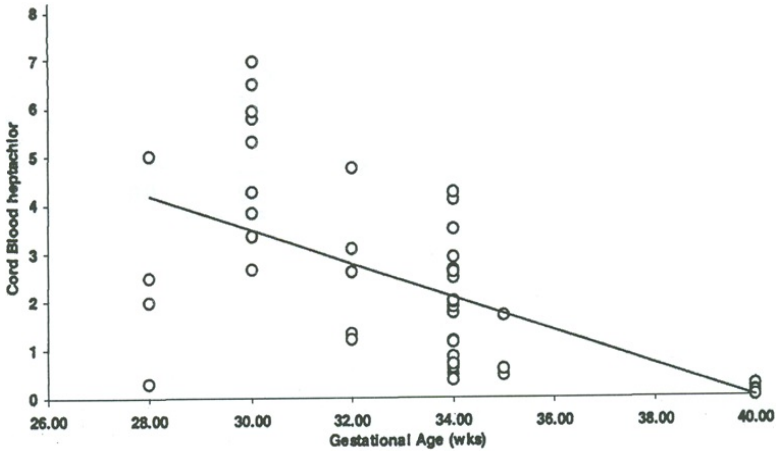

Fig. 2: Correlation between umbilical cord serum heptachlor pesticide and gestational age.

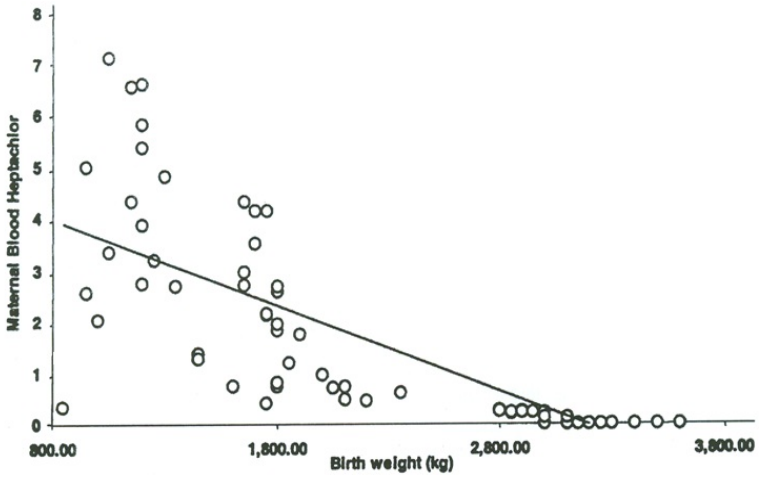

Fig. 3: Correlation between maternal serum heptachlor pesticide and birth weight.

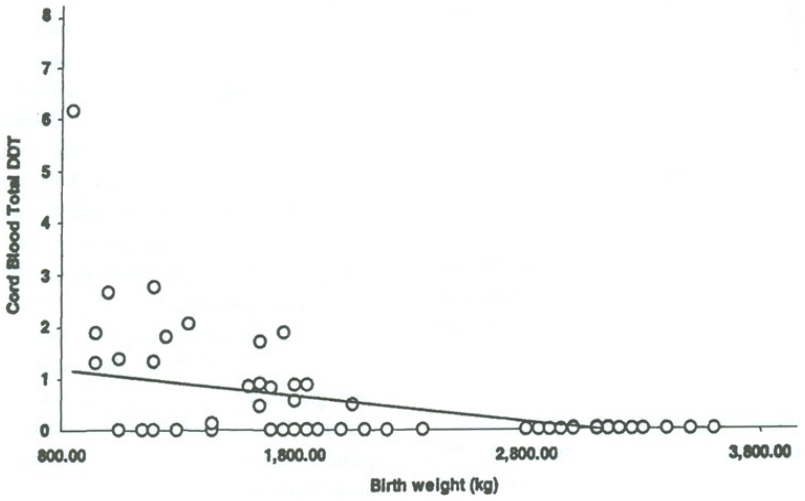

Fig. 4: Correlation between umbilical cord serum DDT pesticide and neonatal birth weight.

Another aspect of this study was the significant negative correlation between maternal serum heptachlor ($r = -0.8$, $P < 0.001$), DDT ($r = -0.5$ $P < 0.001$) and neonatal birth weight, length and head circumference, also the combined exposure to many pesticides affect fetal growth. These results were in agreement with the results of Perera *et al.,* (2005) and Fukata *et al.,* (2005) who reported that increased serum pesticides levels were associated with decreased birth weight and / or length and head circumference $P < 0.05$ and that combined exposure had a significant multiplicative effect on birth weight and head circumference. Siddiqui *et al.,* (2003) concluded that exposure of pregnant women to organochlorine pesticides may increase the risk of intra-uterine growth retardation.

In the present investigation no correlation was found between maternal serum pesticide and maternal age. On the contrary Bjerregaard and Hansen, (2000). reported that the concentrations of organochlorines increased with maternal age.

Conclusion and Recommendation:

In conclusion, pesticides are by definition toxic and biocidal. They are contaminants to our environment and have been found in air, soil, animal and human tissue. The wide spread utilization of pesticides open a big discussion concerning their effect on the human health. Until now a satisfactory investigation has not been performed and results are conflicting.

From the present study we stress upon the importance of health education, the development of an adequate surveillance and reporting system, including data on incidence and severity of acute episodic and chronic exposure to pesticides to establish a comprehensive data base on human exposure and the consequence there of.

Rhainds *et al.,* (1999) underline the role of public health authorities in the evaluation of biological levels of environmental contaminants among pregnant mothers and their newborns for the assessment of risk of adverse health effects.

The results of this study showed that organochlorine pesticides can cross the placenta and there was direct relationship between pesticides levels in mother blood serum and cord blood serum. Our study can be repeated on a larger scale including urban and rural areas to verify the exact role of maternal exposure to pesticides on neonatal birth weight and premature delivery.

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