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Organochlorine Pesticides in Cord Blood: A Threat to the Safety of Prenates

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Abstract: Persistent organic pollutants (POPs) are a group of chemicals which are very resistant to natural breakdown processes and are therefore extremely stable and long-lived. POPs are not only persistent in the environment but many are also highly toxic and get bioaccumulated in the tissues of animals and humans. Most of them do not occur in nature but are synthetic chemicals released as a result of anthropogenic activities. Vast amounts of POPs have been released into the environment and due to long distance transport on air currents, POPs have become ubiquitous pollutants and now represent a global contamination problem. Organochlorine pesticides (OCPs) belong to the category of POPs and are extremely and widely persistent and toxic compounds. OCPs are a group of compounds of great chemical stability, low aqueous solubility and high persistence whose presence in the environment is a clear indication of pesticide pollution. Human body burden of OCPs resulting from the universal presence of these contaminants in the environment is an issue of public health concern because they have been linked with the pathogenesis of different diseases. A number of OCPs used in different national programmes in India, seem to be accessible to human beings through different routes of exposure, with digestive tract being the main. After the absorption, OCPs are circulated in the blood and then distributed to different organs and tissues where they get accumulated in accordance to the fat content of the tissues. Cord blood aiding as a circulatory connection between mother and baby can serve as a carrier for lipophilic xenobiotics, including OCPs. There are many reports from India and all over the world giving an idea about the concentration of detectable OCPs in the cord blood of a woman, but no such report is available from Pink City of India, Jaipur. A study was, therefore conducted in the Jaipur, Pink city of India and capital of Rajasthan to assess the OCPs residues in the cord blood of women, using gas liquid chromatography. The results revealed that human cord blood, stores certain detectable chlorinated hydrocarbon pesticides including isomers of HCH, metabolites of DDT and heptachlor and Aldrin. In the cord blood, a-HCH, Aldrin and DDE were detected quite frequently whereas DDD was detected only in quite a few samples. Concentration of total DDT and total HCH were found to be 75.4 and 142.1 ppb respectively. The data is further stratified with respect to dietary habits, age, different habits of pesticide use, weight and parity. The OCPs residues present in the cord blood primarily can be considered as an indication of the transfer of these chemicals from maternal to fetal circulation across the placenta which may pose various problems of the wellbeing of prenates. Secondly, their presence in the cord blood signposts the pesticide burden in the women, which in turn is a risk to human health.

Key Words: Cord Blood, Organochlorine, Contamination, Residues, Gas Chromatograph, Prenates

INTRODUCTION

Persistent organic pollutants (POPs) encompass many different and varied groups of man-made chemicals. Some POPs have been listed by national and international organizations as being chemicals of prodigious concern. For instance, the United Nations Environment Program (UNEP) has listed certain POPs, such as organochlorines pesticides (OCPs), as being chemicals of great concern. OCPs are substances/compounds containing chemically combined chlorine and carbon. This is a huge group of chemicals that includes many POPs. The UNEP list comprises 12 organochlorines – known as the dirty dozen. These are: the chlorinated dioxins (PCDDs) and chlorinated dibenzofurans (PCDFs). The term pesticide is used to indicate any substance, preparation or organism used for destroying pests. Synthetic pesticides have been used since in the early to mid-twentieth century. The modern history of pesticides dates back to World War II when for the first time the insecticidal properties of DDT were recognized. DDT was first introduced on a large scale to fight fleas, lice,

flies and mosquitoes and reduce the spread of insect borne diseases such as malaria and yellow fever. Many public health benefits have been realized by the use of pesticides, but their potential impact on the environment is substantial too [1]. OCP are used extensively as insecticides sterilizes, and herbicides. In particular, those used as insecticides are extremely toxic to living bodies. Use of OCPs is banned or is severely restricted in most countries and are of immense concern as they are omnipresent environmental contaminants and are evidently toxic. Whole environment can become contaminated by OCPs once they are released in the environment. For instance, spraying persistent pesticides on the crops can contaminate vegetation and soils, direct discharges from OCPs manufacturing facilities may contaminate rivers and releases of OCPs from the stacks of incinerators and industrial facilities contaminate air. Consequently, OCPs can contaminate local areas close to where they are released. However, some OCPs are volatile/semivolatile and may evaporate from soil or water to air. Subsequently, they may be transported for thousands of kilometers on air currents and contaminate regions remote from their source. These OCPs migrate on air currents from warmer regions of the globe towards colder Polar Regions. Once they reach colder temperatures they condense and are deposited again on the Earth's surface. OCPs may also be transported for long distances by rivers, ocean currents and as contaminants in wildlife. Due to the extensive releases of OCPs and long distance transport they have become global contaminants and even attain high levels in remote regions, such as the arctic. Many OCPs which pollute the environment become incorporated into food webs. They accumulate and persist in the fatty tissues of animals and humans because they are soluble in fats and are not easily broken down in the body. Even low environmental levels of OCPs can lead to high levels in the body tissues of animals and humans. The levels of OCPs in fat increase as one animal eats another, so that the highest levels are found in predator animals at the top of food webs, such as polar bears, seals, toothed whales, birds of prey and humans, this process is described as biomagnification. But in developing countries or third world countries such as India, because of the cost benefit ratio organochlorines are still, the major pesticides used in agriculture and public health sector.

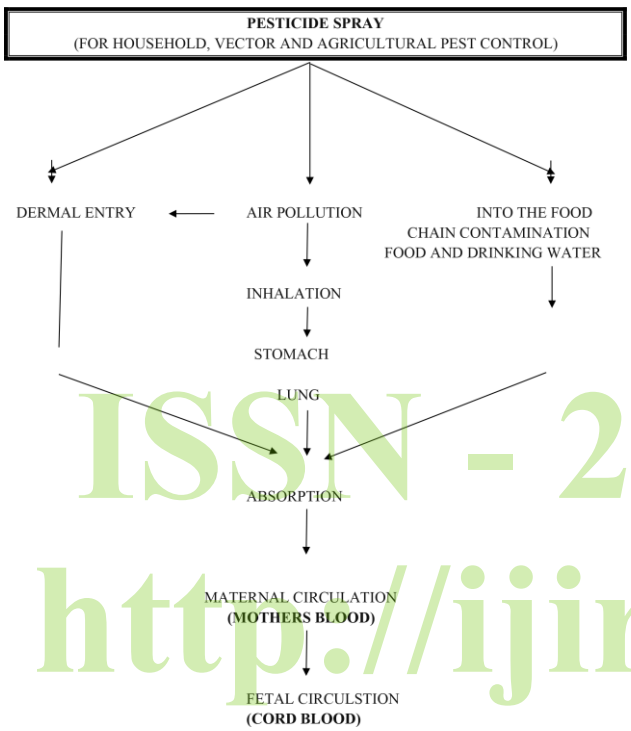
At least 70% of the pesticides handled by the Indian farmer have been declared “excessively toxic” by world health organization. Unfortunately, pesticides are big money often banned in their country of origin stocks are dumped on eager to purchase developing nations. It is a known fact that one quarter of all pesticides exported by the United State are not registered for use in the US. They include cancelled or suspended pesticides because they may cause cancer or otherwise endanger human or the environment. The problems would further aggravate in the coming year, as many pesticides, particularly the chlorinated hydrocarbons directly affect the fetuses and neonates as they get transferred through placenta, cord blood, and mother milk respectively. This has been confirmed in all the mammalian species that have been examined including humans [2], [3].

Furthermore, startling studies have indicated that we have largely over looked the darker side of these chemicals as OCPs are reported to be carcinogenic [4], [5] mutagenic [5],[6] teratogenic [6],[7] immunosuppressive [8],[9] create endocrine dysfunction such as hypothyroidism or high estrogenic activity [10],[11] disturb reproductive processes [12],[13] growth depressants [14],[15] induces several psychogenic and neurogenic abnormalities in adult stages [16],[17], and are associated with abortions, premature deliveries, still births and infants with low birth weights [18]-[21]. OCPs have been in use in India nearly for a half century now. Even after having clear cut evidence suggesting that these chemicals have the ability to eliminate entire species from the planet, the annual consumption of pesticides in India is about 85,000 tons of which OCPs comprise the bulk [22].Therefore, today OCPs are perhaps the most ubiquitous of the potentially harmful chemicals encountered in the environment and are still widely detected in humans despite the considerable decline in environmental concentrations [23].

OCPs, such as Hexachlorocyclohexane (HCH) and DDT account for two-thirds of the total consumption in India [24] for agriculture and public health purposes respectively. Currently, there are about 165 pesticides registered for use in India, of which 40% are

organochlorines [26]. The consumption pattern of these chemicals in India differs from the rest of the world. Placenta serving as a barrier between mother and baby for large number of endogenous and exogenous substances contains appreciable content of fat and hence can serve as a carrier for lipophilic xenobiotics, including organochlorine pesticides. Placenta and cord blood has already been reported to carry the OCPs as described in a report from Lucknow, India [27]. Since there is no such report from Jaipur, pink city of India and capital of Rajasthan, therefore it was planned to carry out systematic study on placental transfer of pesticides in human beings. In the present study obstetrical material - umbilical cord blood of mother was used for biological monitoring of pesticides which besides indicating quantitative and qualitative trends in residue deposits and distribution in pregnant women of the general population, also gives an assessment of the vulnerability of the progeny to these environmental toxins. Since case histories revealed no accidental or occupational exposure to any of the detected pesticides, subjects were exposed through the food chain and the environment. Possible route of entry is given in **Figure.1.**

FIG: 1 POSSIBLE ROUTE OF ENTRY OF PESTICIDES IN THE BLOOD AND CORD BLOOD OF WOMEN.



MATERIALS AND METHODS

101 pregnant women admitted to Zanana Hospital and Mahila Chikitsalya: attached to the Deptt. of obstetrics & Gynecology. S.M.S. Medical College, Jaipur (India) and two private hospitals "Sanjeevani Hospital" and " Meera Hospital", Bani Park, Jaipur are Included in the present study. In general they had no history of any occupational or accidental exposure to pesticides. However, they were asked to fill up a questionnaire giving information relevant to the pesticide residue accumulation such as age, dietary habits, area of residence, parity, social status, accidental or occupational exposure to pesticides etc. according to WHO methodology [27].

Sample Collection

An umbilical cord blood was collected at the time delivery, by squeezing the cord into heparinized vials and stored at -10 degree Celsius till analyzed, generally within 48 hours.

Extraction of Pesticide from Samples

Pesticides were extracted and separated from samples by liquid partition and column chromatography so that they could be analyzed by Gas Liquid Chromatography (GLC) and Thin Layer Chromatography (TLC) procedures. All reagents and chemicals used were of analytical grade and checked for any pesticide contamination. Specimens of cord blood were extracted and then cleaned by florosil column as per the methodology given by Bush and his coworkers with little modifications according to the prevailing laboratory conditions [28].

Quantitative Estimation

Quantitative estimation of pesticide residues in all the extracts was done by HP 5890 series II gas chromatograph (GC) equipped with Ni 63 Electron capture detector (ECD) coupled to HP 3396A integrator. Glass coiled column (1.43 m x 4 mm L x I.D) was packed with Solid Support, Chromosorb 100/120 mesh size along with the Liquid phase: 1.5% OV -14±1.95% OV-210 .Purified nitrogen (IOLAR-1) gas was used as the carrier gas and a known volume of sample was injected in the column with the help of the 10 µl Hamilton syringe. Different peaks of the samples were identified by comparing their retention times with those of standards. Quantitation of the samples were done by the data obtained from the integrator and

were based on peak areas. Standards were obtained from Environmental Protection agency (EPA) U.S.A.

Recovery Analysis and Confirmation of Pesticide residues

Recovery analysis was done by fortification experiments and the percentage recovery was 95–98%.TLC was used for confirming the identity of the OCPs already detected by the GC. The pesticides for which the GC was standardized and were estimated were Aldrin, isomers of HCH (α, β & γ), metabolites of heptachlor (Heptachlor & Heptachlor epoxide) and DDT (DDE, DDD and DDT).

Statistical Analysis

The calculations are based on biological statistics and values are expressed as mean± standard error (S.E.).The difference in the pesticide residue levels between different groups was analyzed with the help of student t test. Significance between the residue levels of different groups was judged at 5 % and 1% levels

OBSERVATIONS

Table .1: Concentration of OCPs in the Cord Blood of 101 pregnant women (ppb).

S. No.	OCPs	Cord blood Range Mean ± S.E.	Ratio Maternal/Cord Mean
1.	∝-HCH	1.0 -508.0 (n-84) 81.7±11.4	0.95
2.	γ-HCH	1.0-125.0(n=67) 32.4 ±6.66	1.33
3.	β-HCH	1.0-1945.0(n=73) 86.8 ±145.96	0.75
4.	Heptachlor	42.05484.0(n=73) 978.2 ±124.35	1.46
5.	Aldrin	1.0-498.0(n=91) 87.8 ±12.35	1.25
6.	Heptachlor epoxide	4.0-4130.0(n=65) 682.2 ± 107.44	0.98
7.	DDE	ND-208.0(n=85) 43.9 ±5.92	1.48
8.	DDD	ND - 2881.0(n=30) 148.3 ± 93.75	0.49
9.	DDT	ND- 238.0 (n-51) 18.0 ± 4.98	1.81
10.	Σ HCH	1.0-2453.0(n=96) 142.1 ± 28.13	1.00
11.	Σ Heptachlor	15.0-6327.0 (n=90) 214.8±148.95	1.28
12.	Σ DDT	ND - 28810.0(n=95) 75.4± 12.82	1.42

Table.2: Stratification of OCPs residue data in Cord Blood with respect to dietary habit, parity pesticide use, weight categories and age categories. (ppb)

S.No	OCPs detected	Dietary habits		Age Categories		Pesticide use	
		Veg.	Non Veg.	17-24 Years	25-34 Years	Pesticide used	Pesticide not used
		45 Cases Mean ± S.E.	56 Cases Mean ± S.E.	55 Cases Mean ± S.E.	46 Cases Mean ± S.E.	45 Cases Mean ± S.E.	56 Cases Mean ± S.E.
1.	∝-HCH	59.3±11.84 (n=36)	98.5±16.77 (n=48)	69.5±12.57 (n=46)	85.8±16.25 (n=38)	116.4±19.58 (n=40)	50.2±8.97* (n=44)
2.	γ-HCH	24.0±7.22 (n=25)	37.8±9.61 (n=42)	34.6±11.14 (N=36)	29.4±6.10 (N=32)	44.4±12.18 (n=32)	21.9±5.60 (n=35)
3.	β-HCH	47.48±10.76 (n=25)	121.8±67.03 (n=28)	41.3±8.16 (n=30)	149.27±84.53 (n=22)	123.2±62.60 (n=30)	31.3±6.88 (n=22)
4.	Heptachlor	838.5±186.00 n=27)	1059.3±163.43 (n=46)	933.4±201.63 (n=34)	1034.8±158.54 (n=38)	1221.6±167.68 (n=30)	808.4±171.35 (n=43)
5.	Aldrin	67.4±13.91 (n=43)	106.1±19.47 (n=48)	98.0±18.09 (n=48)	77.1±16.80 (n=42)	114.8±21.35 (n=43)	54.1±12.51# (n=48)
6.	Heptachlor epoxide	580.5±167.17 (n=26)	780.6±143.85 (n=37)	581.6±127.02 (n=38)	850.0±189.15 (n=26)	636.5±120.09 (n=31)	728.8±173.27 (n=34)
7.	DDE	38.7±8.97 (n=35)	50.6±8.45 (n=50)	37.9±7.39 (n=43)	54.7±9.69 (n=41)	47.8±8.32 (n=41)	408±8.36 (n=44)
8.	DDD	72.6±25.41 (n=15)	226.1±183.71 (n=15)	52.4±14057 (n=17)	278.4±21.04 (n=13)	15.8±5.32 (n=11)	214.0±138.36 (n=20)
9.	DDT	18.1±9.49 (n=24)	17.9±4.27 (n=27)	32.4±15.42 (n=140	12.4±3.57 (n=21)	13.6±3.08 (n=23)	20.4±8.62 (n=28)
10.	Σ HCH	94.8±18.36 (n=41)	178.6±46.62 (n=55)	129.2±22.23 (n=51)	157.9±54.38 (n=45)	220.6±56.13 (n=45)	75.3±12.53* (n=52)
11.	Σ Heptachlor	929.6±204.36 (n=36)	2000.7±769.70 (n=53)	1164.6±222.37 (n=48)	1204.2±191.14 (n=42)	1391.9±260.42 (n=38)	1078.95013.4 (n=50)
12.	Σ DDT	74.8±19.88 (n=39)	55.3±8.50 (n=56)	56.9±8.72 N=52)	76.2±18.66 (n=42)	59.7±9.44 (n=41)	123.7±96.99 (n=52)

Table-2 Contd:

S. No.	OCPs detected	Weight Categories		Parity	
		45-55 Kg	56-75 Kg	primiparous	multiparous
		56 Cases Mean ± S.E.	45 Cases Mean ± S.E.	30 Cases Mean ± S.E.	71 Cases Mean ± S.E.
1.	∝-HCH	85.3±14.50 (n=48)_	72.2±16.73 (n=36)	89.6±19.60 (n=26)	82.0±13.82 (n=58)
2.	γ-HCH	36.1±10.35 (n=39)	26.7±6.65 (n=28)	26.8±6.42 (n=17)	33.9±8.47 (n=51)
3.	β-HCH	63.4±11.51 (n=27)	113.6±75.21 (n=25)	35.1±6.86 (n=17)	115.8±55.7 (n=34)
4.	Heptachlor	1228.0±219.76 (n=43)	780.4±158.29 (n=30)	1047.3±303.80 (n=18)	955.6±129.37 (n=56)
5.	Aldrin	106.8±17.13 (n=52)	65.7±17.08 (n=39)	89.3±19.40 (n=26)	90.7±15.42 (n=65)
6.	Heptachlor epoxide	783.5±150.54 (n=39)	560.3±145.10 (n=26)	464.7±139.86 (n=21)	862.4±149.28 (n=43)
7.	DDE	45.7±8.08 (n=48)	43.1±8.93 (n=36)	44.2±12.99 (n=24)	47.9±7.20 (n=61)
8.	DDD	201.7±146.32 (n=19)	51.9±8.93 (n=36)	56.9±26.96 (n=11)	201.6±146.16 (n=19)
9.	DDT	21.6±7.84 (n=30)	13.1±4.25 (n=22)	28.6±11.80 (n=20)	12.0±2.42 (n=31)
10.	Σ HCH	148.6±22.14 (n=53)	143.3±56.67 (n=43)	123.0±25.06 (n=28)	151.9±38.87 (n=67)
11.	Σ Heptachlor	1423.2±220.5 (n=51)	922.5±179.18 (n=39)	1024.8±295.55 (n=26)	1334.9±175.05 (n=63)
12.	Σ DDT	119.7±51.80 (n=56)	60.7±10.97 (n=39)	174.03±101.67 (n=28)	64.5±8.67 (n=66)

* Statistically Significant (P<.01)
# Statistically Significant (P<.05)
Σ HCH-total HCH
Σ Heptachlor-Total Heptachlor
Σ DDT-Total DDT
n-no of positive samples
ND-not detected

RESULTS

1. Concentrations of OCPs in the cord blood of women are included in the **Table.1.** In the present findings concentration of Aldrin, total HCH, total heptachlor and total DDT were found to be 87.8, 142.1, 214.8 and 75.4 ppb respectively in the cord blood of women.
2. An attempt has been made to find out the effects of dietary habit, age, parity, weight, habits of pesticide use and weeks of gestation period on the accumulation of OCPs in cord blood **(Table.2).**

- Significantly high concentrations of OCPs were found in the cord blood of

women with non-vegetarian dietary habits.

- A general trend of high residue accumulation in the cord blood of women of higher age group was observed when compared with the women of lower age group. But the difference was statistically non-significant between the two groups.
- Higher accumulation of pesticides was found in the cord blood of the women who has used pesticides in comparison of women who has not used pesticides at all.
- A general trend of high residue accumulation was observed in the cord blood of women of high weight category in comparison of women of low weight category.
- In the present findings, parity also influenced the accumulation of OCPs in the cord blood. On comparing the residue deposits of primiparous and multiparous females no statistically significant difference could be observed between the above two groups. But general trend of high residue levels was observed in the cord blood of multiparous females.

DISCUSSION

It is obvious from the results that human cord blood, stores certain detectable chlorinated hydrocarbon pesticides including isomers of HCH, metabolites of DDT and heptachlor and Aldrin. In the cord blood, a-HCH, Aldrin and DDE were detected quite frequently whereas DDD was detected only in quite a few samples. Concentration of total DDT and total HCH were found to be 75.4 and 142.1 ppb respectively. These values when compared with the reports from different parts of India, such as Lucknow from where Saxena and his colleagues (1981) [29] reported the contamination of cord blood with 50.7 and 93.1 ppb of total DDT and total HCH respectively, it is clear that mean values of total DDT and total HCH are nearly double in our findings. In a report from Delhi (Dureja al., 1991) [30] in which cord blood contamination with 0.04 ppb of Aldrin was reported, when compared with 87.8 ppb contamination of the present finding, it is clear that our value is nearly 90 times higher than the above report. Explanation for the above findings can be that most of the area in Jaipur district is rural and large amounts of pesticides are being used there. Illiteracy and unawareness in Rajasthan state could be another factor attributing to these results.

Besides India, there are many reports from all over the world giving an idea about the contamination of cord blood with organochlorine pesticides. In a report from Florida (Miami), O' Leary and his colleagues (1970) [31] reported contamination of cord blood with 53.5 ppb of DDE. In the present study concentration of DDE came out to be 43.9 ppb which is quite higher than the above reported value. Eckenhausen and his colleagues (1981) [32] reported contamination of cord blood from Netherlands, in which the concentrations of p, p' -DDE, p, p' -DDT and a-HCH were 2.7, 1.0, and 0.6 ppb respectively. In the present study the concentration for the above pesticides came out to be 43.9, 18.0 and 32.4 ppb respectively. It is quite clear from the above discussion that Indian babies have more body burden of organochlorine pesticides than does the Dutch babies. In a report from New York, Bush and his coworkers (1984) [28] figured contamination of cord blood as 1.9 ppb of DDE, which is quite low when compared with the present findings in which the concentration of DDE came out to be 43.9 ppb. Concentration of ß-HCH, Y-HCH, p,p'- DDE and p,p- DDT reported to be 0.78, 1.45, 3.93 and 2.17 ppb in a report from Yugoslavia [33]. The values for the above pesticides in present findings came out to be 86.8, 32.4, 43.9 and 18.0 ppb respectively. These values are quite higher than the above reported values. Skaare and his colleagues (1988) reported contamination of cord blood, with 3.0 ppb of DDE from Oslo, Norway [34]. This value when compared with the present findings of 43.9 ppb of DDE, it is nearly 14 times higher than the above reported value.

The magnitude of transfer of different pesticides to the developing one can be had from the ratio of their concentration in mother's blood and umbilical cord blood as given in Table.1. Maximum transfer of p, p' -DDD whereas minimum for p, p' -DDT could be seen as per their ratio of maternal blood and cord blood. Therefore, the order of transplacental transfer for different pesticide compounds which is:

P'P' -DDD>ß-HCH >α HCH>Heptachlor epoxide > ∑HCH>Aldrin > ∑Heptachlor > α-HCH >∑DDT >Heptachlor>p, p' -DDE >p, p'-DDT

The trend may help to get an estimate of the vulnerability of the progeny for them, and shall be assigned top most significance in view of the low capability of the fetus to detoxify them due to their ill developed microsomal mono-oxygenase system and reported biochemical effects in animal experimentation. Transfer of a compound across the placenta decreases with increasing molecular weight, increasing electrical charge and decreasing lipid solubility [35]. Therefore, the above trend for the transfer across placenta seems to be decided by either of the mentioned factors or by a combination of them. Siddiqui in the year 1982, reported that there is maximum transfer of p, p'-DDD and minimum for Lindane through placenta [26]. Maximum transfer of p, p'-DDD is in accordance with our findings but minimum transfer in our findings came out to be of p, p'-DDT.

The distribution study shows that the preferential accumulation of different pesticides and their metabolites on an average basis is:

α- HCH = Placenta>Cord Blood >Maternal Blood.
γ- HCH =Maternal Blood>Placenta>Cord Blood.
ß-HCH = Placenta>cord Blood>Maternal Blood
Heptachlor = Maternal Blood>Cord Blood>Placenta
Aldrin = Cord Blood>Maternal Blood>Placenta
Heptachlor Epoxide= Placenta>Cord blood>Maternal blood
DDE = Placenta>Maternal blood>Cord blood
DDD = Cord blood>Maternal blood>Placenta
DDT = Placenta>Maternal Blood>Cord blood.
∑HCH = Placenta>Maternal blood>Cord blood
∑Heptachlor = Maternal blood>Cord blood>Placenta
∑DDT = Maternal blood>Placenta>Cord blood.

From the above trend it is obvious that the mother has the highest burden of OCPs and considering steady state conditions, only a partial transfer of such compounds to the fetus takes place. But in few cases, the concentration of OCPs was higher in umbilical cord blood as compared with maternal blood and placenta. A possible explanation for this finding may be that at the time of labour the energy provided by food stuffs may not be sufficient to cope with the demand and therefore, body fats may have been consumed. Since, OCPs are lipophilic in nature and are known to accumulate in fat, it seems possible that they have been made available from the depots along with the mobilization of fat and reaching the fetus at a high concentration. Further, it has been reported that lipid soluble chemicals are expected to diffuse out quickly across the placenta and have no problem in reaching the fetus as well as their final accumulation must be decided by partitioning against the blood of the mother [36]. On the other hand, polar metabolites of insecticide are expected to reach the fetus slowly, but once there, they have a very slow rate of elimination [36]. Another explanation may be that, the placenta is highly selective organ which excludes few substance's, permit many to enter by passive or facilitative diffusion at various rates and in some cases by active transport mechanism increases the concentration in the fetal circulation above that in the maternal circulation [37],[38].

With the help of reported case histories of the subjects, efforts were made to find out the possible impact of age, dietary habit, parity, weight and pesticide use in the field and house hold of the mother on the distribution and accumulation pattern of pesticides in the mother and thereby on the degree of their transfer to the fetus.

(a) Effect of dietary habits on the accumulation of pesticide residues in cord blood.

Dietary habits of the mother was found to play an important role in the body burden of lipophilic pesticide residues. In cord blood a general trend of high residue levels was observed in the women with non-vegetarian habits but no statistical significant difference was observed. The difference in the levels of pesticides in the two groups of women might be because high levels of DDT and BHC residues have been reported in mutton, eggs and chicken [39],[40] which are basically a very common component of the non-vegetarian meals. The results of our findings are in accordance with the results reported by Siddiqui in 1982 from Lucknow [26]. He reported that residue levels of HCH, p,p-' DDD, Aldrin, p,p'-DDE in cord blood were significantly higher in the mothers with non-vegetarian habits.

(b) Effect of age on the accumulation of pesticide residues in cord blood.

Mother's age has also been reported to influence

accumulation of OCPs in her circulating blood and its subsequent transfer to the fetus. Siddiqui in 1982 reported that in umbilical cord blood, Lindane and p, p' DDT showed significant differences for the two different age groups [26]. Therefore, an attempt has also been made to divide the subjects into two different age groups 17-24 and 25-34 and to compare the difference in the residue levels of pesticides. A general trend of high residue accumulation in the cord blood of women of higher age group was observed, when compared with the women of lower age group. But the differences were statistically non-significant between two groups of different ages. The greater accumulation of pesticides in the higher age group women might be due to the fact that a longer life span of mothers may cause a greater accumulation of pesticides in them and subsequently may result in comparatively higher transfer of pesticides to the developing embryo. Alternatively a differential rate of absorption, distribution and detoxification of pesticides in two age groups may be partly responsible for higher accumulation of pesticides in mothers of other group, as the activity of drug metabolizing enzymes of the liver may decrease after a certain period, with subsequent increase in age. In a survey study conducted by Selby and his colleagues in the year 1969 in Louisiana Parish, they concluded that no marked differences were observed among age because the population group sampled was fairly homogenous with similar environmental sources of exposure to the chlorinated hydrocarbon pesticides [41].

(c) Effect of' 'use of pesticides" on the accumulation of pesticides in cord blood.

Another aspect of the study has been considering the use of pesticides by the pregnant women to get rid of pests at household and at agricultural field. Therefore, the subjects were divided into two categories, out of which one group has been using pesticides (non-persistent) for different work at household and at fields while other group was not using Pesticides at all. Higher accumulation of pesticides was found in the cord blood of women, who had used pesticides for various purposes. Significantly higher levels of α-HCH, Aldrin and total HCH were found the in the cord blood.

(d) Effect of "weight factor" on the accumulation of pesticides in cord blood.

An attempt has also been made to find out the influence of weight of the mothers on the accumulation of organochlorine pesticides in her blood and its subsequent transfer to the fetus, since, organochlorine pesticides are lipophilic in nature, and they might accumulate in fat rich tissues of the body in alarming concentrations. Therefore, it was expected that the mothers in the high weight category will have high pesticide residue accumulation in comparison of the women of low weight category. It was observed that women of high weight category have a tendency to accumulate more pesticides in the cord blood than the women falling in the low weight category but the difference between two groups was statistically non-significant.

(e) Effect of parity on the accumulation on pesticides in cord blood.

Parity might also influence the accumulation of OCPs. Therefore, the subjects were divided into two groups primiparous and multiparous, on comparing the residue deposits of these two different groups, no significant difference could be observed. But a general trend of high residue levels could be observed in cord blood of multiparous females in comparison to primiparous.

This can be due to the fact that the multiparous females were of higher age group in comparison of primiparous females. Therefore, age can be a factor which might have resulted in greater accumulation of pesticides in multiparous females in comparison of primiparous females (Siddique, 1982) [26]. But in the present study age factor is not found to effect the accumulation of pesticide residues in the tissues of women. Therefore, findings of the present study suggest that other factors such as, dietary habits, use of pesticides and weight might influence the accumulation of chlorinated hydrocarbons in the cord blood.

The present study directly reflects the national scene of magnitude of pesticide pollution which signifies the distribution and accumulation of non-biodegradable lipophilic pesticides in a pregnant woman on one side and subsequently the vulnerability of the successive generation from its very inception in the womb of the mother on other side. The so called “placental barrier" which separates the maternal compartment from the fetal compartment must be regarded as an epithelial

membrane of lipoid character, i.e. a lipid sieve through which lipophilic non-polar substances are able to penetrate according to their concentration gradient and degree of lipophilicity. A physiological state like pregnancy, no doubt helps mother in fighting against the increasing burden of environmental pollutants like persistent organochlorine pesticides. During the state as evident from the present investigation, the mothers appreciably reduce their body burden of pesticides at the expense of intoxication of their own developing baby in the womb through placental transfer throughout the gestational period. A small fraction of total burden of the body gets reduced when placenta is disposed off after child birth. Starvation stress caused an increase in the fetal concentrations of DDT and its metabolites calls for a strict regulation in time to take meals and a balance between calorific intake and energy requirement of the mother during pregnancy to avoid mobilization of fat depots resulting into mobilization of stored residues [36].

CONCLUSION

It is quite clear from the foregoing discussion, that in all over the world Indian mothers have got the highest body burden of organochlorine pesticides. This is because in the third world countries such as India, because of the cost - benefit ratio OCPs are still the major pesticides used in agriculture and public health sector. This is in accordance with the findings of Dale and his coworkers (1965) that the Indians have got the highest body burden of OCPs [42].

The present study directly reflects the national scene of magnitude of pesticide pollution which signifies the distribution and accumulation of non-biodegradable lipophilic pesticides in pregnant women on one side and subsequently the vulnerability of the successive generation from its very inception in the womb of the mother on other side. The so called “placental barrier" which separates the maternal compartment from the fetal compartment must be regarded as an epithelial membrane of lipoid character, i.e. a lipid sieve through which lipophilic non-polar substances are able to penetrate according to their concentration gradient and degree of lipophilicity. A physiological state like pregnancy, no doubt helps mother in fighting against the increasing burden of environmental pollutants like persistent organochlorine pesticides. During the state as evident from the present investigation, the mothers appreciably reduce their body burden of pesticides at the expense of intoxication of their own developing baby in the womb through cord blood during the gestational period. Starvation stress caused an increase in the cord blood concentrations of DDT and its metabolites, calls for a strict regulation in time to take meals and a balance between calorific intake and energy requirement of the mother during pregnancy to avoid mobilization of fat depots resulting into mobilization of stored residues of OCPs [36].

It can be concluded that the magnitude of pesticide pollution is quite high to contaminate the food and environment and as a result toxicant reach the human body through various sources mainly through the absorption from the gastrointestinal tract via contaminated food chain. From there, they are further circulated in maternal blood, cord blood stored in milk and placental tissue of the women. Since, the pesticides are reported to be carcinogenic, mutagenic, teratogenic, immunosuppressive, induces endocrine dysfunction and high estrogenic activity, disturb the reproductive processes, growth depressants, induces several psychogenic and neurogenic abnormalities in adult stages and are also reported to be associated with abortions, premature deliveries, still births, low birth weight consequences are obvious on the mother and the developing baby. It poses various problems of management of neonatal nutrition and health. It calls for suggestions like special care in nutrition and in the environment of mother throughout the life and especially during pregnancy and lactation. It would be advisable for a woman to avoid the consumption of fatty food stuffs and heavily polluted working environment. In the light of our findings stricter regulations may be discussed and such measures have to be weighed against the benefits of the use of pesticides. Present findings on obstetrico toxicology of pesticides particularly in relation to distribution of pesticidal pollutants in pregnant women may finally lead to a better understanding of the influence of chemicals on fetal development and provide grounds for further studies on placental toxicology as related to pesticide pollution in India. In the end, it must be emphasized that there is a rising protest that pesticides are destroying harmless wild life and endangering the health of man himself. The battle against the harmful insects would be much less costly and more efficient,

and the problem of contamination of the environment by toxic materials would be vastly reduced, if insect activities are controlled by natural means. The use of pest-specific predators; parasites or pathogens; sterilization of insects with the help of radiations; trapping insects using insect attractants like pheromones; use of juvenile hormones or hormone inhibitors may therefore be suggested as alternate ways of pest control.

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