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Serum Concentrations of Organochlorine Compounds During Pregnancy and the Newborn

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The widespread use of organochlorine compounds as insecticides during the past few decades has led to their ubiqitous presence in the environment. The polychlorinated biphenyls (PCBs) were produced for use as coolant and insulator fluids for transformers and capacitors, as heat transfer fluids and as fire retardants for wood products (Baselt 1980); heavy industrial usage has led to widespread contamination of the environment with the PCBs. Organochlorine insecticides (OCIs) and PCBs are highly lipid soluble and are resistent to environmental degradation. In human beings these compounds are stored in adipose tissue and are resistant to metabolism. These substances are present in women and the fetus is exposed during in utero development by transplacental transfer. Exposure of the fetus is related to the maternal body burden. Several studies have reported values of OCIs (Curley and Kimbrough 1969; D'Ercole et al. 1976; Procianoy and Schvartsman 1981; Saxena et al. 1981; Siddiqui et al. 1981) or PCBs (Ando et al. 1985; Fein et al. 1984; Kodama and Ota 1980) in maternal and cord serum. Relatively high serum levels of OCIs (Saxena et al. 1980) and PCBs (Wassermann et al. 1982) have been found in women with premature delivery. Also, DDT and PCB residue levels were higher in California sea lions which gave birth prematurely than in those with full-term pups (De Long et al. 1973). OCIs may disturb the hormonal balance of pregnancy and perhaps precipitate labor. Some DDT analogs are reported to have estrogenic effects and PCBs were also estrogenically active (Bitman and Cecil 1970). Limited data exist on the levels and kinetics of OCIs (Curley and Kimbrough 1969) and PCBs (Kodama and Ota 1980) during pregnancy and in newborns.

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A variety of physiological changes that occur in pregnancy could affect the serum level of OCIs and PCBs. During pregnancy progesterone and estrogen production is increased, water is retained and blood volume increases. The total serum lipid values increase and serum albumin levels decrease. Physiological changes during pregnancy may influence the distribution of OCIs and PCBs and, therefore, their concentrations in body fluids. Serum OCIs are in equilibrium with those in tissues and constitute a good indicator of body burden (Radomski et al. 1971).
The aim of this study was to determine the serum level of OCIs and PCBs in three phases of pregnancy and in the newborn during healthy pregnancy and to examine the relationship among them.

MATERIALS AND METHODS

The study group consisted of fourteen healthy pregnant women, selected at random, who were urban residents attending the prenatal clinic of a major medical center. Eleven volunteers, nonpregnant women of comparable age and socioeconomic status were also selected. All participants had no known occupational or accidental exposure to OCIs or PCBs. HCH and DDT are not used currently in Yugoslavia. Blood was collected from the antecubital vein of pregnant women during regular clinic visits six and three months before the expected date of delivery. Samples of blood were also collected at the time of delivery together with blood from the umbilical cord. Informed consent was obtained from all participants.
PCB's, γ and β HCH(isomers of 1, 2, 3 , 4, 5, 6-hexachlorocyclohexane), p,p'-DDT and its metabolite p,p'-DDE were determined in serum samples by the method of Polishuk et al.(1977). Identification and quantitation of the OCIs and PCB's were accomplished on a Perkin -Elmer gas chromatograph model Sigma 1B with an electron-capture detector and a 2 m glass column, packed with 3% OV-17 on Chromosorb WHP, 80-100 mesh. Lipids were extracted and determined by the method of Folch et al.(1957) as modified by Polishuk et al.(1977). The standards employed were Aroclor 1254 and a mixture of pure OCIs.
By visual inspection of data plots the data did not have an arithmetically normal distribution and fitted a geometric distribution better. The geometric mean and geometric standard deviation were calculated after censoring outlying values. Student's t-test was used for evaluating the statistical difference between means.

RESULTS AND DISCUSSION

Table 1. shows the geometric mean values and range of OCI and PCB concentrations in serum of nonpregnant women, pregnant women in the three phases of pregnancy (three and six months before delivery and at term) and in cord serum. The levels for these chemicals, except γ-HCH were higher in the nonpregnant women as compared with pregnant. The time course of OCI and PCB levels in serum during pregnancy and at delivery is shown in Figure 1. Mean values of concentrations of OCIs and PCBs differ in the three phases of pregnancy (Figure 1), but these differences are not significant. Figure 2 shows that OCI and PCB concentrations in the umbilical cord serum are lower than in maternal serum. The differences are statistically significant, exept for HCH levels.

We attempted to examine the influence of pregnancy on OCI and PCB levels in pregnant women and to determine how much of these compounds transfer to the fetus. The maternal β and γ-HCH, pp-DDE, pp-DDT and PCB serum levels show a remarkable similarity to the levels in nonpregnant women (Figure 1.). This implies little change in the distribution of these compounds during pregnancy, in agreement with the earlier reports for OCI by Curley and Kimbrough (1969) and for DDE by O'Leary et al.(1970). Concentrations in cord serum are statisticaly significantly lower in comparison to the maternal level, which (for DDT) is in agreement with results of D'Ercole (1976) and (for PCBs) with the results of Kodama and Ota(1980). β HCH, γ HCH, pp'-DDE, pp'-DDT and PCBs in cord serum averaged 59%, 67%, 59%, 83% and 55% respectively, of the levels found in the mothers. A significant correlation is observed between maternal and cord serum concentrations of the all compounds studied (corr. coeff.=0.71). Among these newborn were a pair of twins. There was a good correlation (Figure3) between levels of the five compounds studied. This supports the conclusion that the mother and fetus are in equilibrium for lipid--soluble substances that readily traverse the placenta. Low PCB and OCI levels have to be considered in relation to the physiologicaly low lipid content of umbical cord serum. Lipid levels in cord serum were about one third of maternal serum level at delivery: mean levels of total lipids of 2.43mg/l for cord serum and 8.01mg/l for maternal serum. Expressing the concentrations of OCIs and PCBs in μg/g lipids a different picture can be obtained: Mean values in cord serum were statisticaly higher than in mother's serum at delivery for γ HCH($p<0.01$), p,p'-DDE($p<0.01$), p,p'-DDT($p<0.01$) and PCBs($p<0.05$).

Table 1. OCIs and PCBs in maternal and cord serum (μg/l)

OCIs+PCB	Nonpregnant (range) G. mean	Pregn. 3 months (range) G. mean	Pregn. 6 months (range) G. mean	Delivery (range) G. mean	Cord blood (range) G. mean
beta HCH	(1.0-3.5) 1.69	(0.6-2.4) 1.41	(0.8-2.8) 1.28	(1.1-2.8) 1.45	(0.3-1.9) 0.78
gama HCH	(1.2-3.6) 1.77	(0.8-4.2) 1.65	(0.5-3.9) 1.3	(0.9-5.4) 2.72	(0.5-5.7) 1.45
pp-DDE	(6.1-14.4) 9.31	(2.8-12.7) 6.14	(2.6-14.7) 6.61	(2.8-11.7) 7.57	(1.6-9.1) 3.93
pp-DDT	(3.2-9.7) 5.87	(1.5-7.8) 3.59	(1.7-8.8) 3.39	(1.0-8.2) 3.62	(1.1-5.6) 2.17
PCBs	(1.8-3.9) 2.86	(1.0-3.8) 2.02	(1.2-3.8) 1.89	(1.1-4.65) 2.01	(0.6-1.6) 1.01

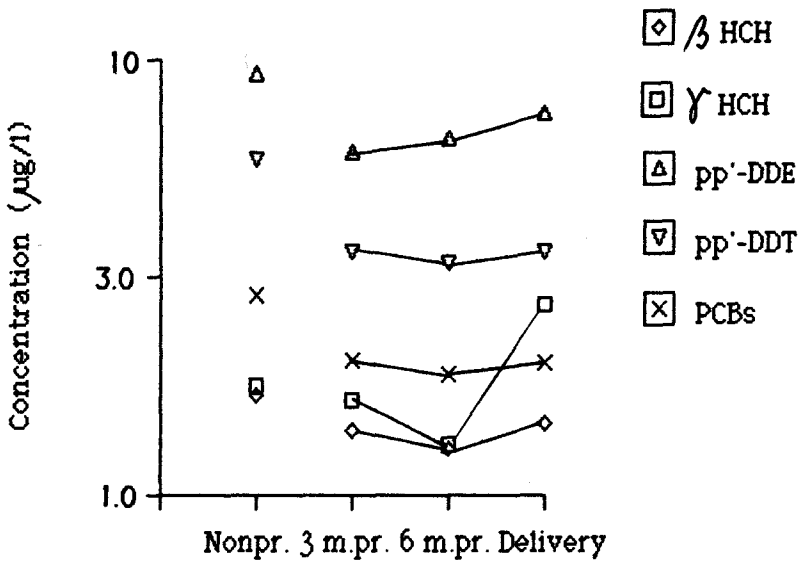

Figure 1. Serum concentrations of OCIs and PCBs in nonpregnant women (Nonpr.) and in pregnant women after three months (3 m. pr.), six months (6 m. pr.) of pregnancy and at delivery. Geometric means of groups on log scale.

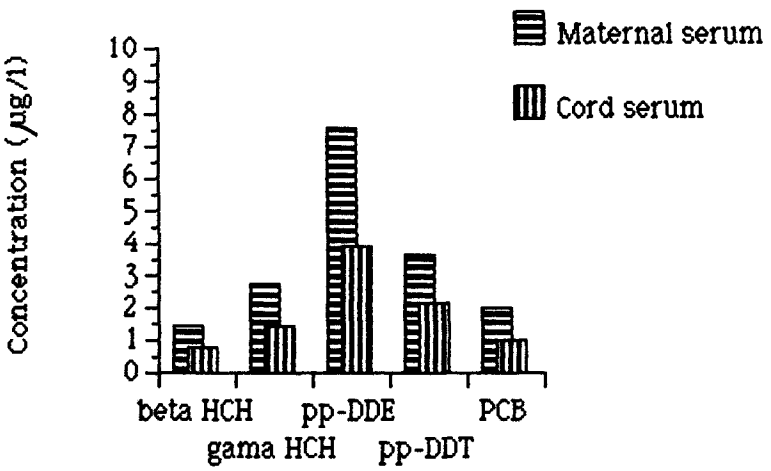

Figure 2. Comparison of the level of OCIs and PCBs. Geometric means of the groups.

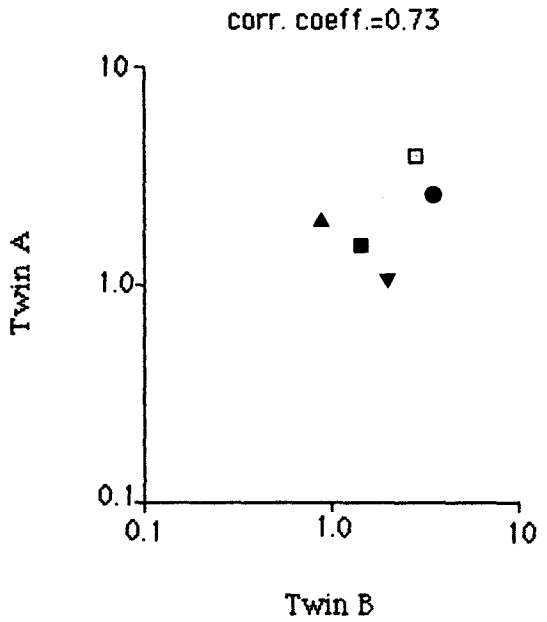

Figure 3. The relationship between levels of βHCH(▲), γHCH(□), pp'-DDE(●), pp'-DDT(▼) and PCBs(■) in the cord serum of twins on log scale.

The low concentrations of OCIs and PCBs in cord serum do not mean that the placenta provides the fetus with some degree of protection from exposure as suggested by D'Ercole(1976) for DDT.
Maternal and cord serum HCH, pp'-DDE, pp'-DDT and PCB mean values in our study subjects are lower than previously reported. Krauthacker et al.(1980) found higher concentrations of p,p'-DDE and p,p'-DDT in maternal and cord serum samples from a continental town of Yugoslavia between 1977 and 1979. Results presented in this work are obtained in an urban area from another part of Yugoslavia. Different year and origin of food consumed by participants could be the reason for the difference. Average OCI and PCB levels reported here are much lower than those reported in studies from Brasil (Procianoy and Schvartsman 1981), India (Saxena et al. 1981; Siddiqui et al. 1981) and Israel (Wassermann et al. 1982). Reported levels in the serum with premature delivery are 15-50 times higher (Saxena et al. 1980 and Wassermann et al. 1982) than concentrations found in Yugoslav

women. The concentration of OCIs and PCBs reported in this paper for maternal and cord serum are similar to those found by O'Leary et al. (1970) and Fein et al.(1984) in USA and Kodama and Ota(1980) in Japan.

The occurence of DDT in serum has been shown to be associated with recent exposure to DDT. The levels of DDE and probably HCH and PCBs, on the other hand, reflect past exposure to OCIs and PCBs. Special care for the nutrition and environment of the mother during pregnancy, as suggested by Sidiqui et al.(1981) and Polishuk et al.(1977) may not be benefical, because it would not change the maternal body burden of OCIs and PCBs or reduce the potential exposure of the fetus.

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REFERENCES

Ando M, Saito H, Wakisaka I (1985) Transfer of polychlorinated biphenyls (PCBs) to newborn infants though the placenta and mothers' milk. Arch Environ Contam Toxicol 14:51-57

Baselt RC (1980) Biological monitoring methods for industrial chemicals. Bomedical Publications, Davis, California

Bitman J, Cecil HC (1970) Estrogenic activity of DDT analogs and polychlorinated biphenyls. J Agr Food Chem 18:1108-1112

Curley A, Kimbrough R (1969) Chlorinated hydrocarbon insecticides in plasma and milk of pregnant and lactating women. Arch Environ Health 18:156-164

De Long RL, Gilmartin WG, Simpson JG (1973) Premature birth in California sea lions: Association with high organochlorine pollutant residue levels. Science 181:1168-1170

D'Ercole JA, Arthur RD, Cain JD, Barrentine BF (1976) Insecticide exposure of mothers and newborns in a rural agricultural area. Pediatrics 57:869-874

Fein GG, Jacobson JL, Jacobson SW, Schwartz PM, Dowler JK (1984) Prenatal exposure to polychlorinated biphenyls: Effects on birth size and gestational age. J Pediatr 105:315-320

Kodama H, Ota H (1980) Transfer of polychlorinated biphenyls to infants from their mothers. Arch Environ Health 35:95-100.

Krauthacker B, Alebic-Kolbah T, Buntic A, Tkalcevic B, Reiner E (1980) DDT residues in samples of human milk, and in mothers' and cord blood serum, in a continental town in Croatia(Yugoslavia). Int Arch Occup Environ Health 46:267-273

Polishuk ZW, Ron M, Wassermann M, Cucos S, Wassermann D, Lemesch C (1977) Pesticides in people. Pestic Monit J 10:121-129

Procianoy RS, Schvartsman S (1981) Blood pestcide concentration in mothers and their newborn infants. Acta Paediatr Scand 70:925-928

Radomski JL, Deichmann Wm B, Rey AA, Merkin T (1971) Human pesticide blood levels as a measure of body burden and pesticide exposure. Toxicol Appl Pharmacol 20:175-185

Saxena MC, Siddiqui MKJ, Bhargava AK, Krishna Murti CR, Kutty D (1981) Placental transfer of pesticides in humans. Arch Toxicol 48:127-134

Saxena MC, Siddiqui MKJ, Bhargava AK, Seth TD, Krishna Murti CR, Kutty D (1980) Role of chlorinated hydrocarbon pesticides in abortion and premature labour. Toxicol 17:323-331

Siddiqui MKJ, Saxena MC, Bhargava AK, Seth TD, Krishna Murti CR, Kutty D (1981) Agrochemicals in the maternal blood , milk, and cord blood: A source of toxicants for prenates and neonates. Environ Res 24:24-32

Wassermann M, Ron M, Bergovici B, Wassermann D, Cucos S, Pines A (1982) Premature delivery and organochlorine compounds: Polychlorinated biphenyls and some organochlorine insecticides. Enviro Res 28:106-112

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