PCBs in adipose tissue, liver, and brain from nine stillborns of varying gestational ages

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Introduction

PCBs enter the fetus via the placenta. In the postnatal period, they are transferred from the nursing mother to her child through breast milk. Exposure to background levels of PCBs is known to have adverse effects on child development. Although relatively large amounts of PCBs are ingested with breast milk, greatest risks have been associated with exposure during the prenatal period. Higher levels of intrauterine exposure were associated with deficits in fetal and postnatal growth, with a less optimal neurological development at the ages of two weeks and 18 months, with a lower score on psychomotor developmental tests up to the age of two years, and with a lower intelligence quotient at 11 years of age.

To our knowledge, there are no data on the PCB body burden of the human fetus at different gestational ages and the distribution of these compounds among fetal organs. We analyzed the PCB contents of adipose tissue, liver, and brain of nine stillborns of varying gestational ages.

Materials and Methods

From March to December 1993, we collected tissue samples of fetuses who died *in utero*. Each eligible stillborn that was presented for obduction to one of the Public Health Laboratories located within a radius of 60 km from Groningen was included in the study. The Groningen region is a semi-urban area in the northeast of The Netherlands. Fetuses had to show no signs of serious chromosomal or congenital malformations. Also, the absence of signs of maceration was a prerequisite for inclusion. From each stillborn we collected 10 grams of subcutaneous white adipose tissue, liver, and brain. The samples were stored at -20°C until analysis. Birthweight, gestational age, presumed cause of death, and the age of the mother were recorded. The study protocol was approved by the local medical ethics committees.

Tissue levels of PCBs (congeners nos. 118, 138, 153, and 180) were determined in the TNO Nutrition and Food Research Institute (Zeist, The Netherlands) by means of gas-liquid chromatography/electron capture detection with two capillary columns of different polarity[1]. The sum of the four PCB congeners (ΣPCB) was calculated. PCBs were expressed on the basis of the extractable tissue fat content (ng/g fat). P-values of 0.05 or less were considered statistically significant.

Results and Discussion

Nine stillborns were eligible for inclusion. Their median (range) gestational age was 34 (17 - 40) weeks, median birthweight was 2050 (162 - 3225) g, and median maternal age was 30 (18 - 32) years. Three stillborns were considered small for gestational age (≤ 10th percentile). The presumed causes of death were: placental insufficiency, abortion, ventricular bleeding, intrauterine pneumonia, or unknown. No adipose tissue could be obtained from one fetus who died at 17 weeks of gestation and also its congener 180 level in liver was below the detection limit.

The PCB levels in adipose tissue, liver, and brain (in ng/g fat) are presented in table 1. The median (range) ΣPCB liver/adipose tissue ratio was 0.8 (0.4 - 0.9) g/g, and the ΣPCB brain/adipose tissue ratio was 0.2 (0.1 - 0.3) g/g. There were strong relationships between ΣPCB in adipose tissue and liver (Spearman rank correlation coefficient = .98; $p<0.01$). The demonstrated tissue distribution pattern is in agreement with that found in other species[2,3], and is likely to be caused by differences in polarity of lipids in each of the organs. The highly apolar PCBs have a high affinity for the highly apolar fats, notably triglycerides.

Table 1: PCB levels in fetal subcutaneous adipose tissue, liver, and brain*.

Congener†	Adipose tissue (ng/g fat)	Liver (ng/g fat)	Brain (ng/g fat)
PCB 118	20 (11-51)	17 (7-35)	6 (3-22)
PCB 138	64 (30-189)	58 (20-120)	15 (7-31)
PCB 153	106 (37-321)	96 (25-154)	20 (9-43)
PCB 180	51 (9-208)	43 (8-93)	10 (2-30)
ΣPCB	235 (97-768)	198 (67-362)	50 (22-122)
ratio to $\Sigma PCB_{adipose}$	1	0.8 (0.4-0.9)	0.2 (0.1-0.3)

* Data represent median (range); † ΣPCB = sum of PCB 118, PCB 138, PCB 153, and PCB 180; $\Sigma PCB_{adipose}$ = ΣPCB in adipose tissue.

The congeneric distribution patterns of PCBs in subcutaneous adipose tissue, liver and brain (in g/100g) were similar (Table 2).

Table 2: PCB congeneric distribution in fetal subcutaneous adipose tissue, liver, and brain*.

Congener†	Adipose tissue (g/100 g)	Liver (g/100 g)	Brain (g/100 g)
PCB 118	8 (6-21)	9 (3-21)	11 (9-20)
PCB 138	28 (24-31)	29 (24-33)	29 (25-31)
PCB 153	44 (39-47)	43 (37-45)	42 (33-48)
PCB 180	19 (9-27)	21 (13-28)	16 (7-24)
ΣPCB	100	100	100

* Data represent median (range); † ΣPCB = sum of PCB 118, PCB 138, PCB 153 and PCB 180.

For each of the fetal compartments, the correlations between the levels of the PCB congeners 118, 138, 153, and 180, and the ΣPCB on the one hand, and the gestational age were not significant; correlation coefficients varied between 0.22 and 0.47. The independency of PCB levels of the gestational age reflects a rapid equilibration between the fetal and maternal PCB stores. In the last 3 months of gestation an overproportional increase of adipose tissue relative to the total body weight occurs. As the deposited fat is mainly synthesized in the fetus from (PCB-free) precursors such as glucose and lactate, the absence of a dilutional effect supports the hypothesis that PCB-poor fat is rapidly provided with maternal PCBs.

Fetal adipose tissue levels of the PCB congeners 118, 138, 153, and 180, and also ΣPCB fell well within the corresponding ranges of milk levels, and also the fetal adipose tissue congeneric distribution proved to be comparable with that of Dutch human milk (n=93; Table 3)[4]. This supports the hypothesis that PCBs readily cross the placenta.

We conclude that maternal PCBs have a tendency to accumulate notably in fetal tissues that contain high levels of storage lipids (i.e. especially triglycerides). They are easily transferred across the placenta and seem to become equilibrated among the apolar parts of maternal and fetal lipids.

Table 3: Dutch mature human milk*: PCB levels (ng/g fat) and PCB congeneric distribution (g/100 g).

Congener†	PCB levels	
	ng/g fat	g/100 g
PCB 118	34 (12-94)	8 (5-16)
PCB 138	129 (44-314)	30 (22-37)
PCB 153	179 (60-438)	43 (38-51)
PCB 180	74 (7-172)	18 (2-27)
ΣPCB	413 (158-969)	100

* Data represent median (range), and are for 93 24-hour milk samples obtained in the second week after delivery.
† ΣPCB = sum of PCB 118, PCB 138, PCB 153, and PCB 180.

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