BACKGROUND LEVELS OF NON-ORTHO-SUBSTITUTED (COPLANAR) POLYCHLORINATED BIPHENYLS IN HUMAN SERUM OF MISSOURI RESIDENTS

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Introduction

Background levels of coplanar polychlorinated biphenyls (PCBs) in individuals with no occupational or documented exposure to PCBs are discussed in this paper. The purpose is to provide current referent levels of coplanar PCBs in Missouri residents. Coplanar PCBs are considered the most toxic of the congeners because of their TCDD like characteristics.

The results of this study characterize the levels of PCB congeners PCB 77, PCB 81, PCB 126, and PCB 169, in a group of 150 men and women with no documented exposure to PCBs. Serum PCB levels were determined in the largest non-pooled group of people reported with only background exposure to PCBs. Although PCB 77, 126, and 169 have been studied before, PCB 81 has only been characterized recently.

Material and Methods

PCB results are reported from a secondary analysis of data collected as part of an exposure assessment of a hazardous waste incinerator that burned soil and other products contaminated with 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD). The original exposure study evaluated potential exposure to TCDD from an incinerator. Human serum TCDD and PCB levels declined from pre to post incineration and no difference was found between the potentially exposed and non-exposed group. The methods and results of that study have been published previously.[1] Specimens were analyzed by the Centers for Disease Control Division of Environmental Health Laboratory Sciences (DEHLS).[2-9] PCB results were reported on lipid-adjusted bases.[10] PCB values less than the limit of detection were entered as 1.9 ppt (ρg/g), one-half the limit of detection. This study analyzed only the specimens taken prior to incineration in the study and control groups. This paper will develop descriptive profiles of coplanar PCBs across several parameters for community residents with no documented exposures.

Results and Discussion

150 people participated in the study and the participants ranged in age from 18 years to 68 years. 20% of the sample were cigarette smokers, 54% were female, and 95% were White. All except one person had a high school diploma and over 60% had family incomes that exceeded $50,000. On average, participants ate only .87 servings of fish per week. The highest consumption of animal products was for poultry, beef, and cheese.

Figure 1 presents boxplots of the coplanar PCBs. Table 1 presents the geometric mean values compared between age and gender categories. The difference between both age and gender groupings for PCB 169 are statistically significant as is the interaction between age and gender.

Only age resulted in a statistically significant difference for PCB 126. The levels for both congeners increased with age and PCB 169 was higher in males. There were no differences in PCB congeners levels between different education and income levels.

Table 2 shows the correlation coefficients for PCB 126, 169, and consumption of fish, other food items, cigarettes per day, height, and weight. The only significant relation across both PCB 126 and 169 was cigarette smoking but it was negative for PCB 126 and positive for PCB 169. The geometric means for PCB 126 in smokers and non-smokers were 3.84 ppt and 7.38 ppt ($p < .001$) adjusting for age and gender, respectively. For PCB 169 smokers average levels were 15.8 ppt versus 13.4 ppt for non-smokers ($p < .015$), adjusting for age and gender. Most of the measures of food consumption were not statistically significant except for several milk products and beef consumption; these values and the direction of the other food related coefficients except fish were negative, indicating that the more servings of the listed food items, the lower the PCB levels.

This study includes the largest sample of randomly selected individuals evaluated for background levels of coplanar PCB levels reported in the literature. The unit of analysis was the individual, which, unlike pooled samples, allows for the calculation of variability between individuals, stratification across groups of individuals, and correlations between individual PCB levels and factors that might be associated with these levels. The large sample size allowed for precision in the measurement of background PCB levels. Detailed questionnaires were administered to verify any other exposure sources including occupation.

Individual congeners as well as total PCBs have been shown to be related to both age and gender but no regression coefficients have been reported.[11-13] In the present study, age was significantly related to PCB 126 and PCB 169. For every one-year increase in age, both PCB congeners increased by approximately 0.4 ppt. All of the outliers and extreme cases depicted in Figure 1 are in individuals 50 years of age or older. There was no gender difference for PCB 126; however, PCB 169 levels were 3 ppt higher in males than females. This difference was statistically significant after adjusting for age. The interaction between age and gender was significant for PCB 169, although, the pattern of differences is not consistent across age categories.

The PCB levels for the four congeners measured were lower than any reported in the literature. The PCB values that were the closest to the present study were reported in Anderson et al. for Jacksonville, Arkansas in 1991.[14] The total TEQ was 11.3 ppt.[1] Although PCBs 126 and 169 are only two of the dioxin-like congeners, they make up 11% of the total TEQ and most of this was derived from PCB 126.

Although this study randomly selected participants, the population was above national averages for education level and income; therefore, it is not necessarily generalizable to other populations with lower income and educational levels. However, this study did not show any relation between income and education to PCB levels across the strata sampled. Because the participants were from Missouri, it is not clear how generalizable these levels are to other populations.

This study provides referent levels for exposure to coplanar PCBs. The low levels of the rapidly metabolized congeners PCB 77 and 81 indicate minimal levels of current exposure and the higher levels of the slower metabolizing PCB 126 and 169 suggest past exposure in the Missouri residents. Although this study used an extensive questionnaire assessing potential sources of exposure, no positive relations were found between these exposure sources and participants' PCB levels, however, the questions only addressed current exposures and the values measured reflect both past and current exposure. Future studies need to define PCB congener specific half-lives and better measure past exposures. It is important for future health studies to address coplanar PCB exposure because these compounds can make up a large percentage of the TEQ.

Table 1: Comparison of Geometric Means

Age and Gender	N	PCB 126 Mean (SD)	PCB 169 Mean (SD)
18-30 yrs.	13	4.66 (2.20)	8.17 (1.62)
Male	5	6.82 (2.27)	12.6 (1.45)
Female	8	3.71 (2.05)	6.23 (1.39)
31-40 yrs.	57	5.99 (2.59)	11.9 (1.48)
Male	23	6.36 (2.53)	11.5 (1.31)
Female	34	5.81 (2.66)	12.2 (1.58)
41-50 yrs.	50	5.26 (2.77)	14.2 (1.72)
Male	26	4.10 (2.64)	16.8 (1.62)
Female	24	6.96 (2.77)	11.8 (1.73)
51-68 yrs.	30	12.1 (3.10)	22.2 (1.42)
Male	14	12.6 (2.48)	24.1 (1.36)
Female	16	11.6 (3.74)	20.9 (1.48)
Total	150	6.5 (2.83)	13.9 (1.68)
Total Male	68	6.23 (2.72)	15.6 (1.58)
Total Female	82	6.69 (2.94)	12.6 (1.73)
Age sig.[a]		0.003	0.000
Gender sig.		0.752	0.001
Age*Gender sig.		0.211	0.017

[a]significance calculated from analysis of covariance

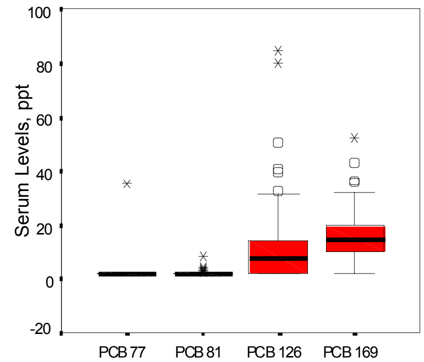

Figure 2: The horizontal lines with the box indicate the medium values, the shaded box represents 50% of the sample, the whiskers indicates the highest and lowest values excluding outliers. Circles indicate outliers and asterisks indicate extreme cases. Most of the values for PCB 77 and 81 were below detection, and the mean values for PCB 126 and 169 were 10.8 (SD 12.3) and 15.7 (SD 7.86) ppt.

Table 2: Partial Correlation Coefficients of the Natural Log of Lipid Adjusted Serum PCBs Levels

	PCB 126		PCB 169	
Variable[a]	Correlation	Significance	Correlation	Significance
Fish Consumption	.085	.303	.070	.399
Servings Cheese	-.155	.061	-.027	.744
Servings Cottage Cheese	-.168	.041	-.107	.194
Servings Cream Cheese	-.047	.572	-.017	.837
Servings Sour Cream	-.088	.288	-.178	.030
Servings of Ice Cream	-.040	.626	-.172	.036
Servings Yogurt	.010	.905	-.032	.699
Servings of Beef	-.192	.019	-.144	.081
Servings of Pork	-.175	.033	.044	.595
Servings of Poultry	-.001	.986	-.006	.941
Number Cigarettes/Day	-.256	.002	.186	.023
Participants Height	-.029	.724	.015	.859
Participants Weight	.132	.112	-.309	.000

[a] Food consumption is reported in servings per week.

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