Rats Exposed Subchronically by Inhalation to an Urban PCB Congener Mixture Show Minimal Toxicity

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INTRODUCTION

Our previous Aroclor 1242 vapor studies have demonstrated the importance of the inhalation route for body burdens of semi-volatile PCBs in laboratory animals. However, there is still a lack of information on the long-term health effects. Also, risks posed by the complex exposure mixtures in the urban environment may not be characterized accurately from single-Aroclor based study. The recent development of the Chicago Air Mixture (CAM), a synthetic mixture resembling the average PCB profile in the Chicago airshed, allows us to conduct an environmentally relevant subchronic inhalation study.

METHODS

Generation of PCB Atmosphere. Aroclor 1242 and Aroclor 1254 were well mixed at 65:35 ratio to prepare the CAM. Vapor-phase PCBs from the CAM at 25 °C were diluted into a moving airflow and fed to a nose-only exposure chamber. Chamber outflow was sampled to establish PCB concentrations.

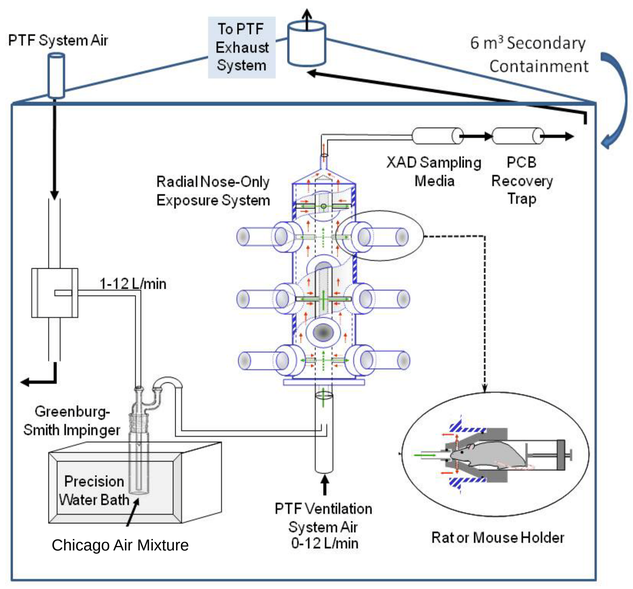


Figure 1. Diagram of the nose-only PCB inhalation exposure system in a secondary containment structure.

Animal Treatment. Female Sprague-Dawley rats were exposed to either the generated PCB atmosphere (n=12) or filtered lab air (n=8) 1.6 hr/day for 4 weeks. Animals were evaluated for signs of toxicity and assessment of PCB body burden.

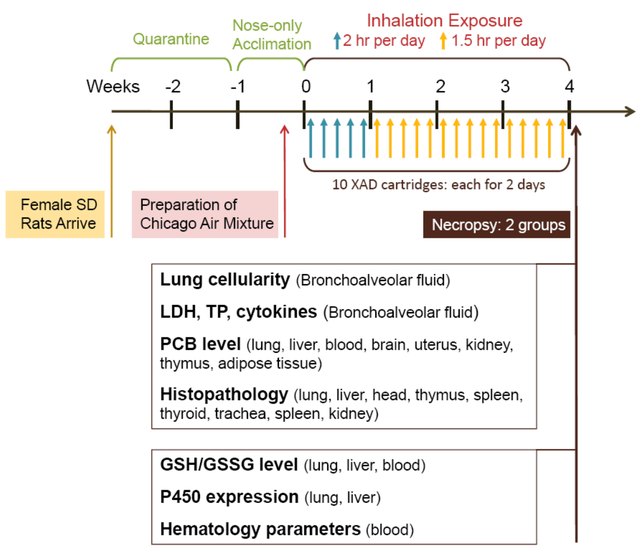


Figure 2. Scheme of the exposure experimental design.

Tissue and XAD Extraction. PCBs were extracted using pressurized liquid extraction. Each sample set was accompanied by a method blank, a tissue blank, and an ongoing precision and recovery (OPR) spike sample. Each sample value was corrected by surrogate recovery. The extracted solutions then went through concentration and cleanup steps before GC/MS/MS determination. Lipid content in tissue was determined gravimetrically.

PCB Analysis. XAD extracts and concentrated tissue extracts were spiked with internal standard. Congeners were analyzed using GC/MS/MS modified from EPA method 1668A.

CONCLUSION

- **High consistency** in low-dose generation of PCB vapor mixture.
- Inhalation contributed to the **body burden** of mono- to hexachlorobiphenyls.
- A distinct **profile of accumulated congeners** in tissue: only ~25 congener detected compared to >110 in the vapor.
- **Minimal toxicity** observed.

RESULTS

The CAM Vapor Generation

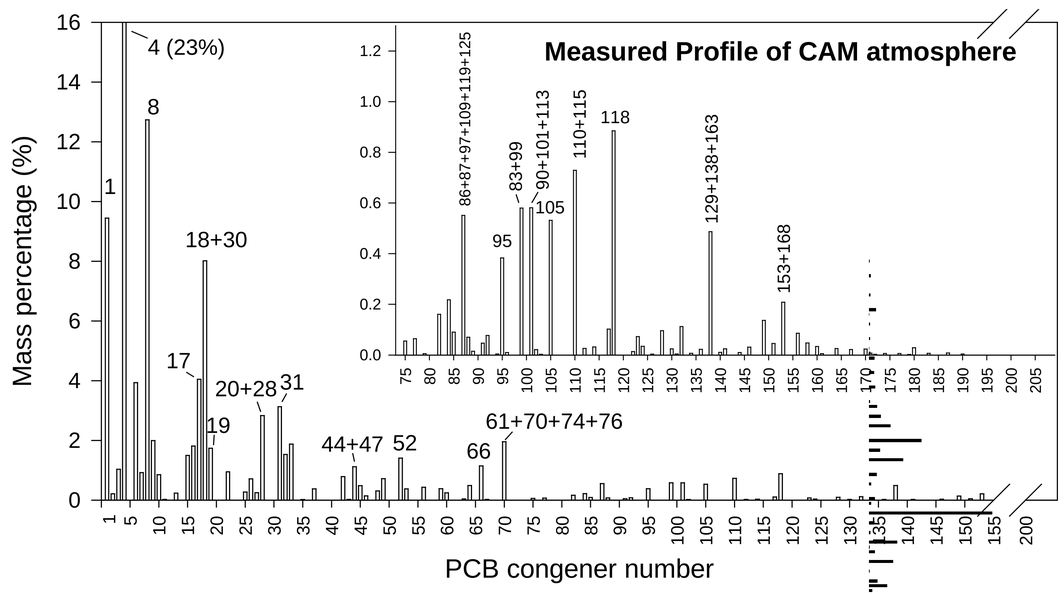


Figure 3. Average distribution profile of all congeners during 4 week exposure in generated CAM vapor, with inset plot showing congeners from PCB 75 to PCB 209.

TABLE1. Total PCB concentration generated during exposure.

day	∑PCBs mg/m³
1-2	0.43
3-4	0.49
5-6	0.54
7-8	0.54
9-10	0.52
11-12	0.57
13-14	0.56
15-16	0.57
17-18	0.51
19-20	0.50
average	0.52±0.01
total dosage	145 µg/rat

Tissue Uptake of PCBs

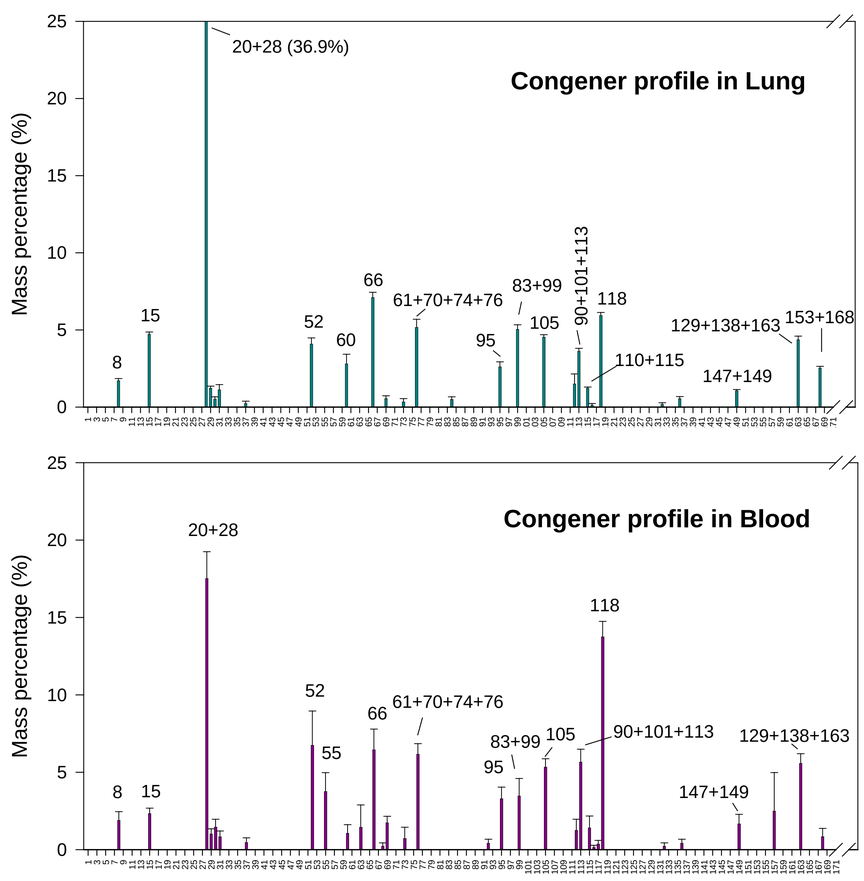


TABLE 2. Mean ± standard error of total PCB levels (ng/g tissue weight) in lung and blood from rats after subchronic inhalation exposure.

Tissue	4-week Exposure $n = 6$	Sham $n = 4$	Sentinels $n = 2$
Lung	67.19 ± 4.14****	7.46 ± 0.98	6.85
Blood	12.88 ± 1.38***	2.30 ± 1.29	2.65

Levels in the 4-week exposed group were significantly greater than control group, ***$p < 0.001$, ****$p < 0.0001$ (t-test for unequal variances).

Figure 4. Average distribution profile of all congeners in lung (A) and blood (B) from exposed animals after 4 week inhalation exposure to the CAM vapor.

Biological Responses

TABLE 3. Red blood cell (RBC) counts, hemoglobin (HGB) and hematocrit (HCT) in blood from rats after subchronic inhalation exposure.

Group	RBC (10^6/µL)	HGB (g/dL)	HCT (%)
PCB	8.82 ± 0.10	16.58 ± 0.19	62.03 ± 0.53****
Control	8.56 ± 0.13	15.97 ± 0.24	48.85 ± 0.59

Levels in the 4-week exposed group were significantly greater than control group, ****$p < 0.0001$ (t-test for unequal variances).

Figure 5. Total glutathione level (A), glutathione disulfide (GSSG) level (B) and percentage of GSSG in total glutathione amount (C) in PCB vapor exposed rat liver, lung and blood. Values are expressed as mean ± standard error.

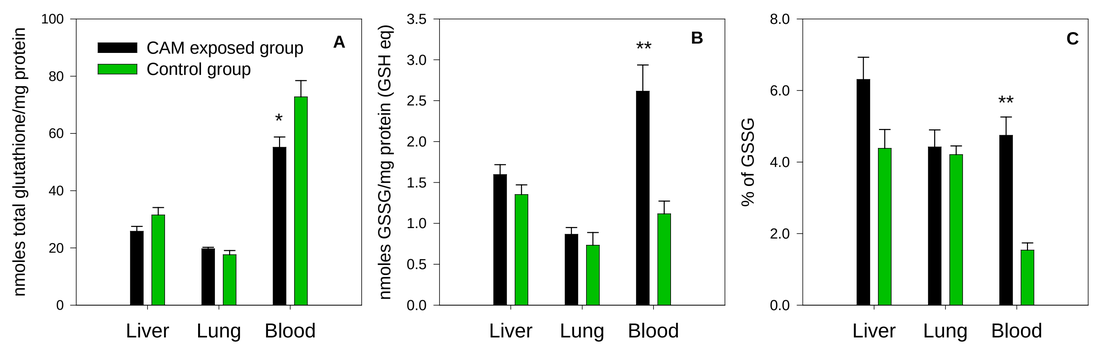
No Toxicity in :

Rat Weight Gain

Pulmonary Immune Response (Inflammatory cell enumeration, total protein, LDH activity)

CYP Activities in Lung and Liver

Histologic change in various tissue.



*Significantly different from control group, $p < 0.05$; **Significantly different from control group, $p < 0.01$.

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