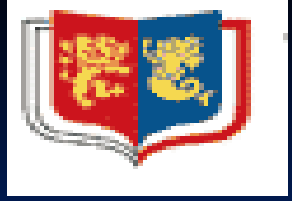

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Polychlorinated biphenyls (PCBs) and Polybrominated Diphenyl Ethers (PBDEs) in Indoor Environments: Levels and Implications

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PCB and PBDE applications in indoor environments

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PCB:

- Additive to concrete
- Caulking grout
- Paints
- Permanently elastic sealants
- Flame retardant coatings of acoustic ceiling tiles
- In small capacitors

PBDE:

As flame-retardant additives in different resins, polymers, and substrates used in:

- In wires, cables, textiles, polyurethane foam, carpets and upholstery used in household and business furnishings and cars
- Electronic and electrical equipment such as computers, TV sets, and household appliances

Key questions and Study aims

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1. Are PCB levels declining in indoor ambient air?
2. PBDE body burden of ca 5% of Swedish individuals far exceed those of rest of population - diet does not appear to be the cause. Could these observations be related to indoor environments?
3. How important is the role of contaminated indoor air as a source of outdoor air concentrations

The study aims were:

1. To build up a data set on airborne concentrations in a wide range of indoor microenvironments
2. To investigate:
    1. Seasonal and intra-building variation in concentrations of PCBs and PBDEs
    2. Relative contribution of inhalation exposure to total human intakes

Monitoring locations

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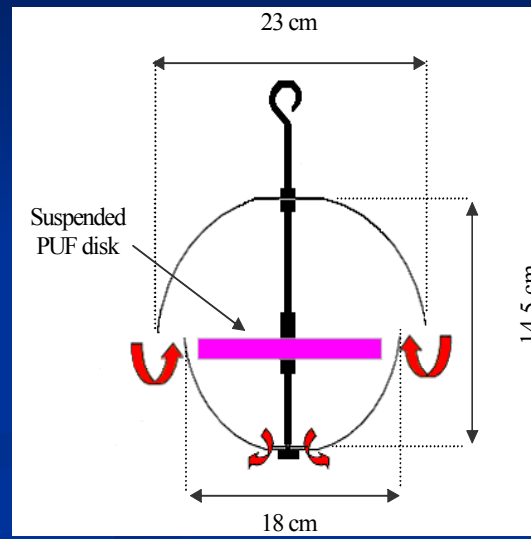
- Fully sheltered PUF disk passive samplers were used in 86 sampling locations:
  - Homes 29
  - Offices 29
  - Private cars 25
  - Public indoor microenvironments 3



- 7 sites were monitored once a month for 12 months
- Similar medium term sampling was conducted in two separate rooms within the same building for 2 homes and 1 office building

Sample preparation, analysis, and QA/QC measures)

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Soxhlet extraction

(HPLC grade Hexane for 8 h)

Purification

Acid wash (98% H_2So_4), Extraction with Dimethyl Sulfoxide and back extraction in Hexane, and Florisil chromatography

Analysis

GC/MS in EI+

DB5 MS column (60 m)

Quality control measures

Recovery of sampling and internal standards

reproducibility of sampling and analytical procedure

Summary of ∑PCB (sum of 63 congeners) and ∑PBDE (sum of 10 congeners) concentrations (ng/m^3) in different indoor environments

	PBDE (ng m^{-3})				PCB (ng m^{-3})			
	Office	Home	Public indoor	Car	Office	Home	Public indoor	Car
Min	0.01	0.00	0.03	0.01	1	0.5	1	0.4
Average	0.17	0.05	0.11	0.71	18	3	31	1
Sd	0.28	0.06	0.07	1.87	27	3	44	1
GeoMean	0.08	0.03	0.09	0.08	8	2	9	1
Median	0.07	0.02	0.14	0.04	6	2	10	1
95th %ile	0.64	0.18	0.16	4.23	88	9	74	3
Max	1.42	0.25	0.16	8.18	102	10	82	6

Congener based passive sampling rates were used to estimate indoor air concentrations of PCBs and PBDEs

Average ∑PCB and ∑PBDE concentrations in different indoor microenvironments

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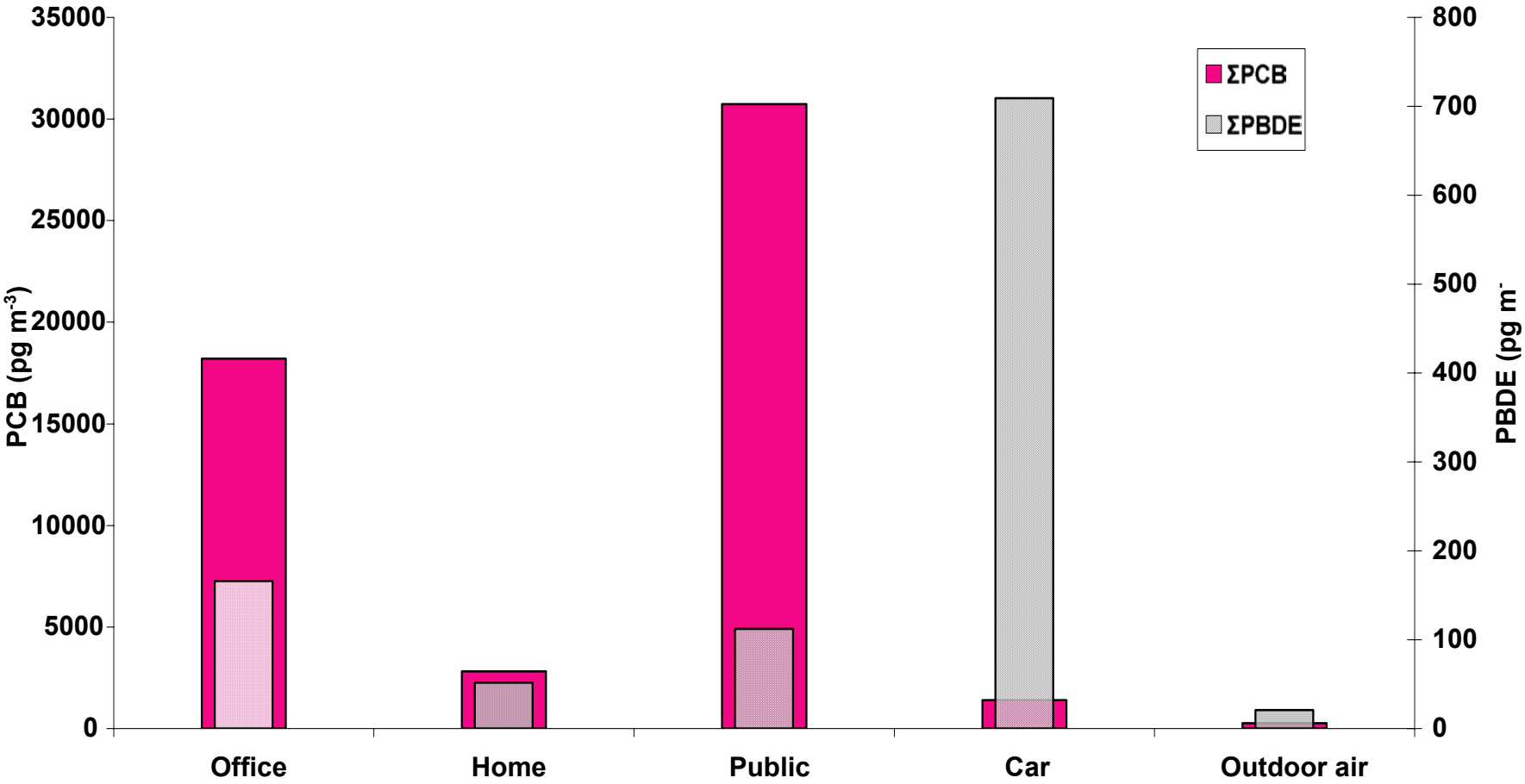

Average PCB concentrations (ng m^{-3}) found in this study and previous Birmingham study

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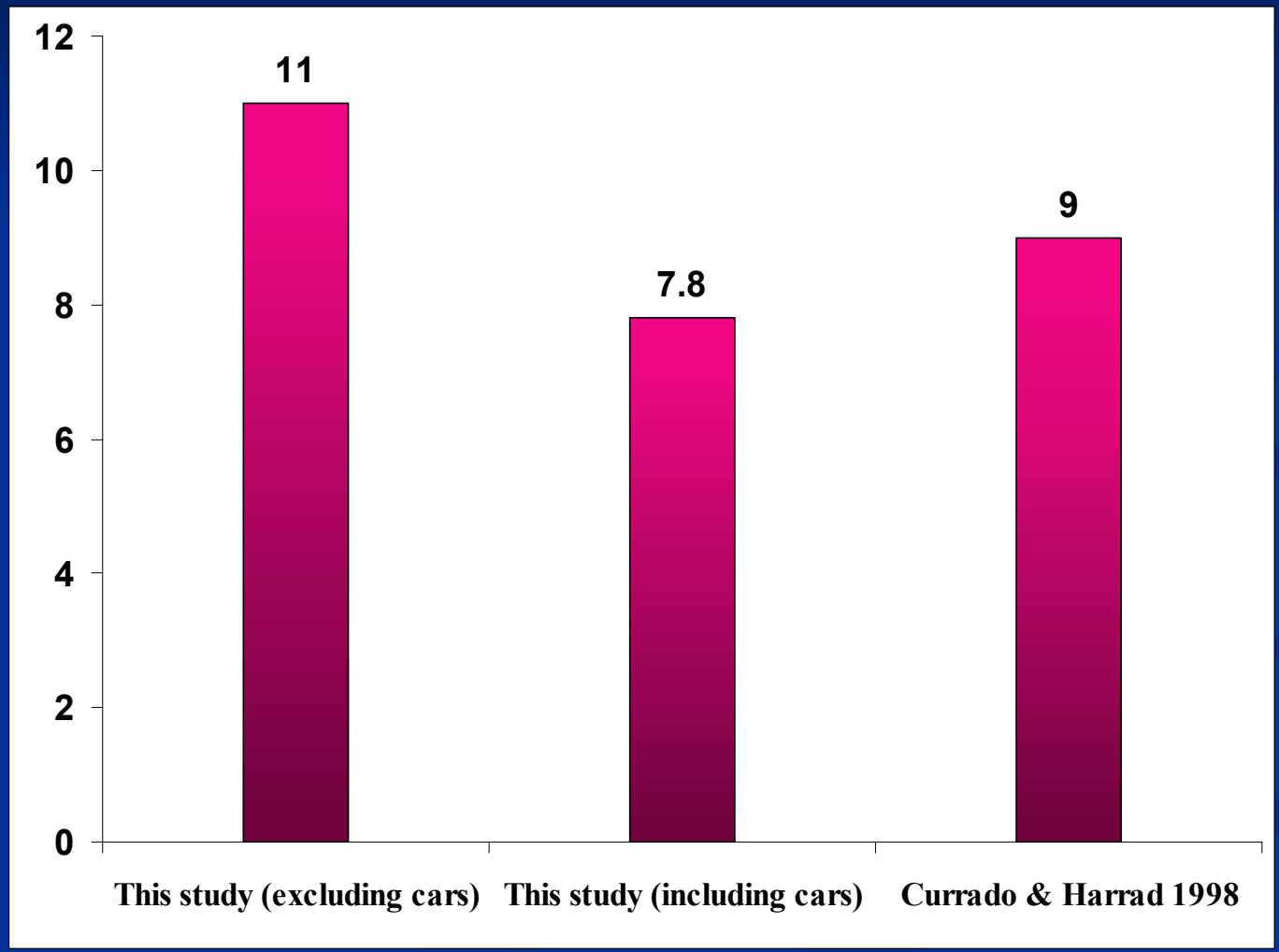

Average PBDE concentrations (pg m^{-3}) found in this study and elsewhere

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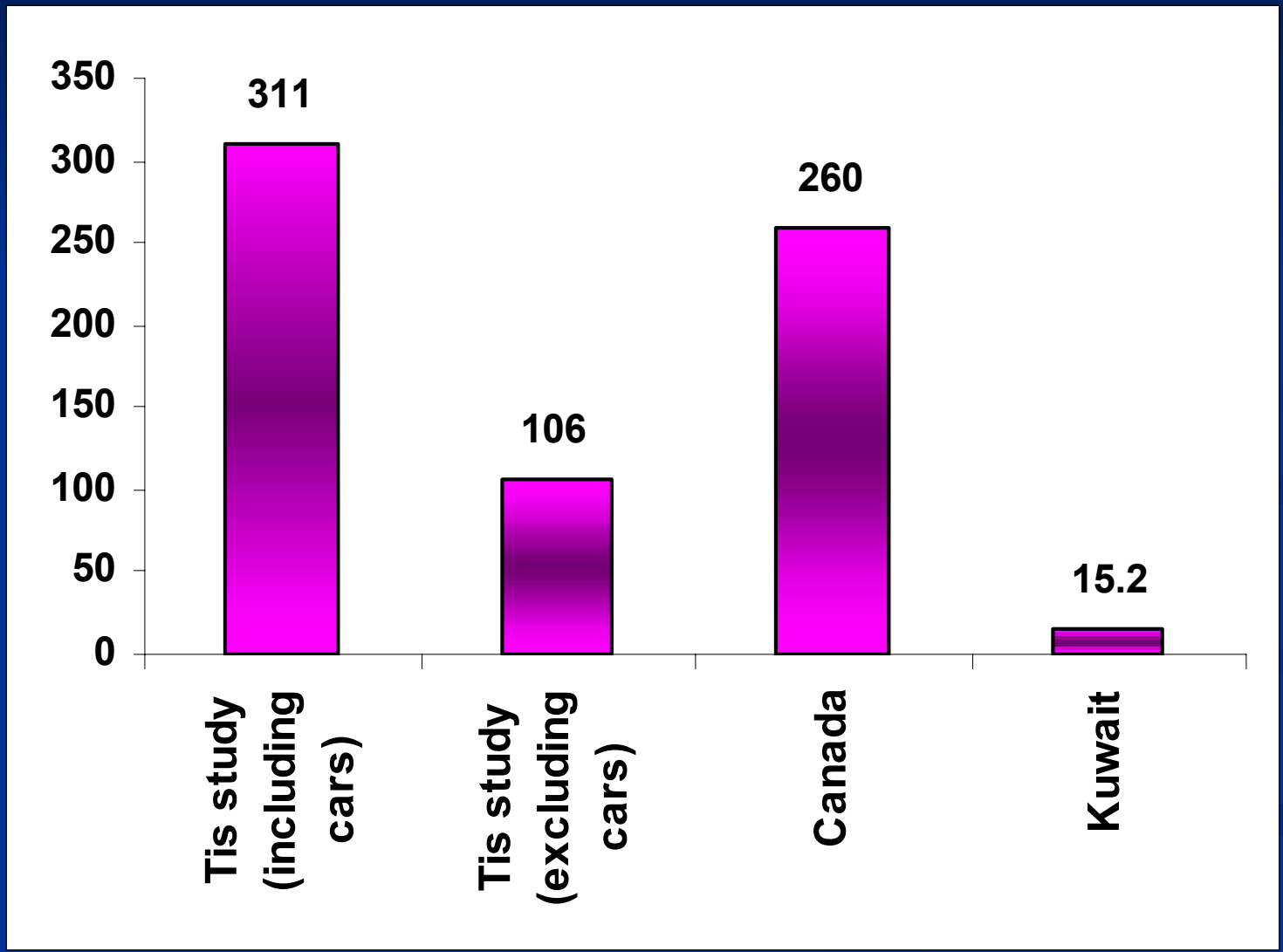

Within-building variation of ∑PCB concentrations in indoor microenvironments

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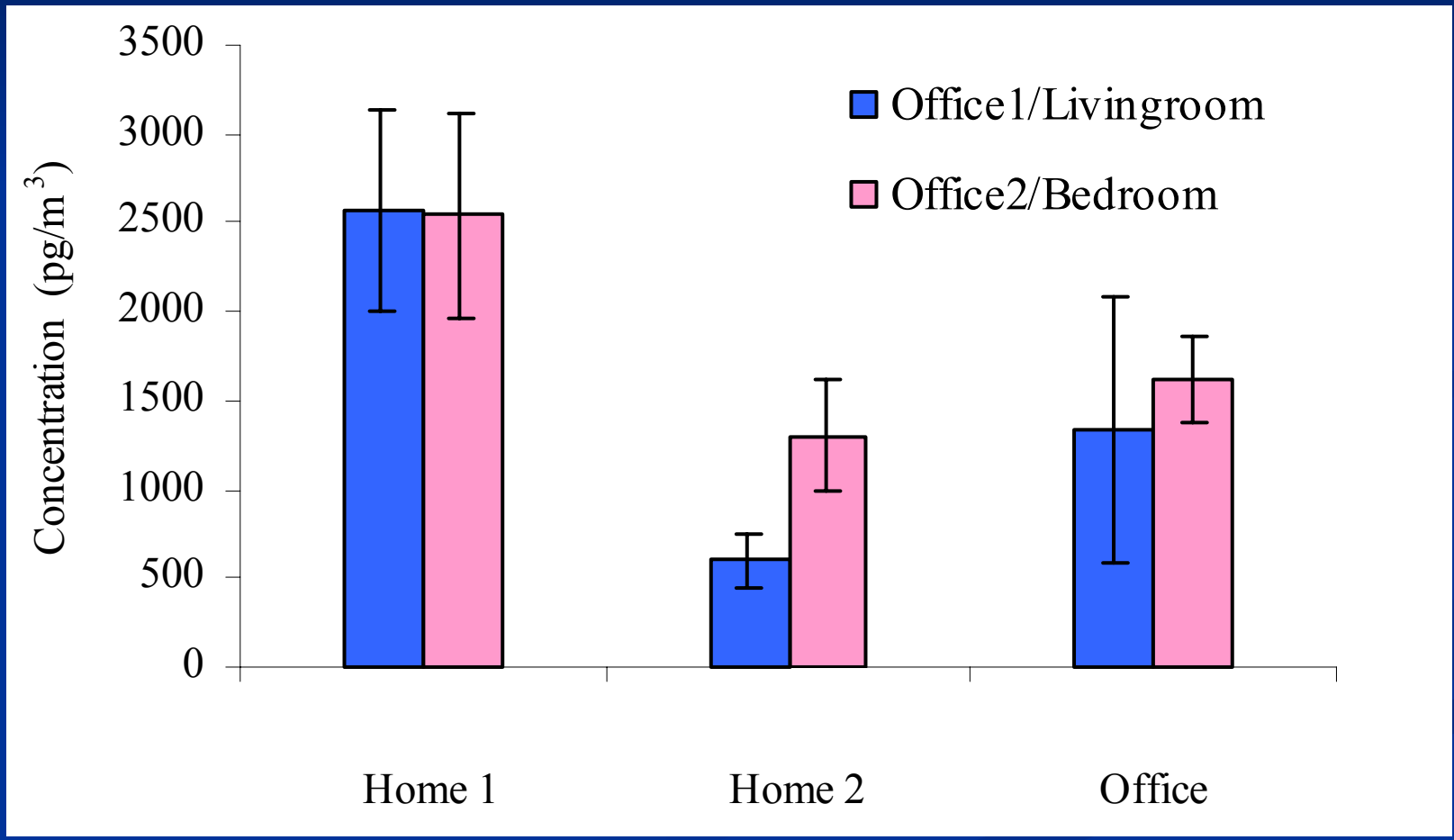

Within-building variation of ∑PBDE concentrations in indoor microenvironments

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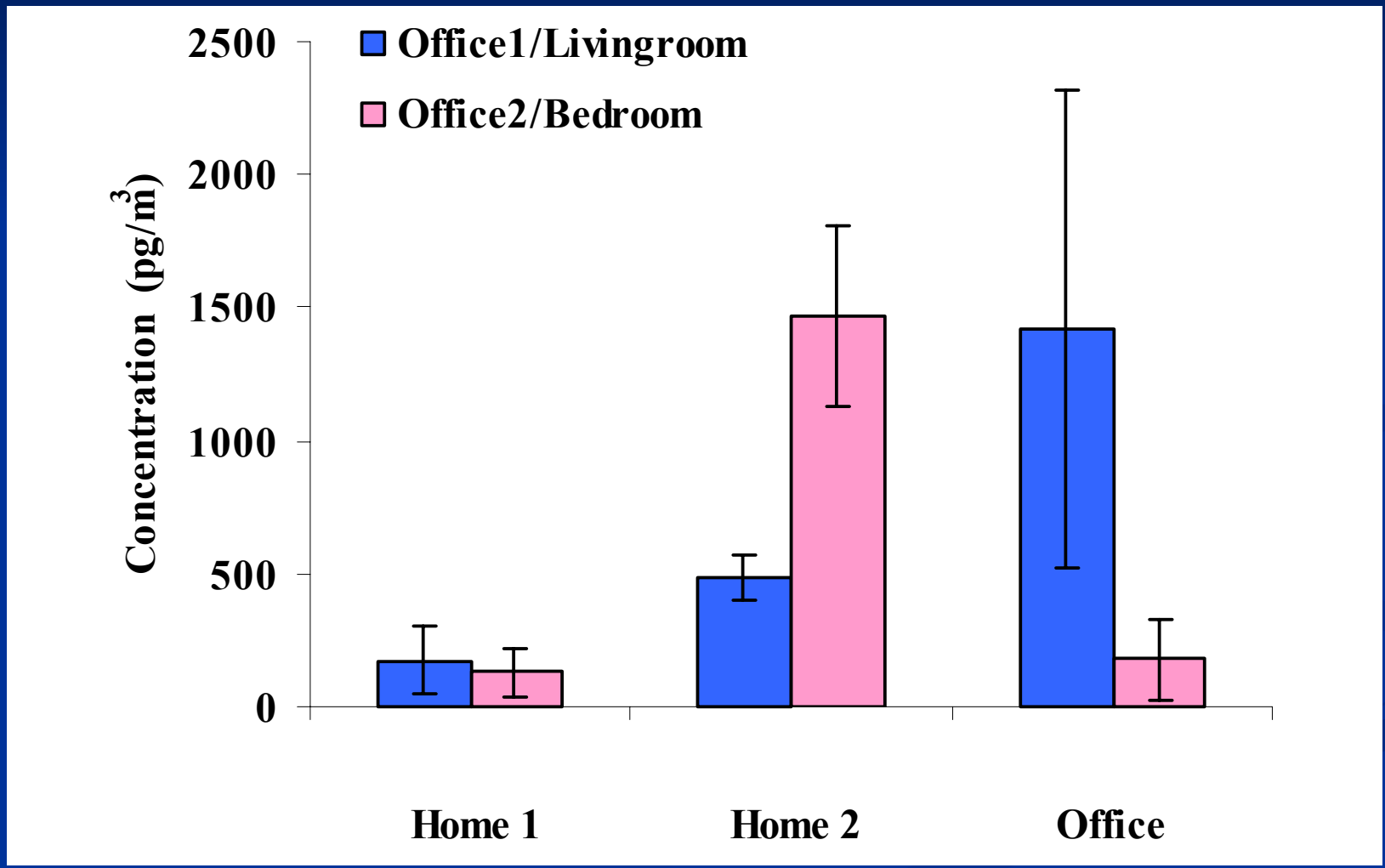

Monthly variation in PCB concentrations in Home 1 (an example of influence of room usage pattern)

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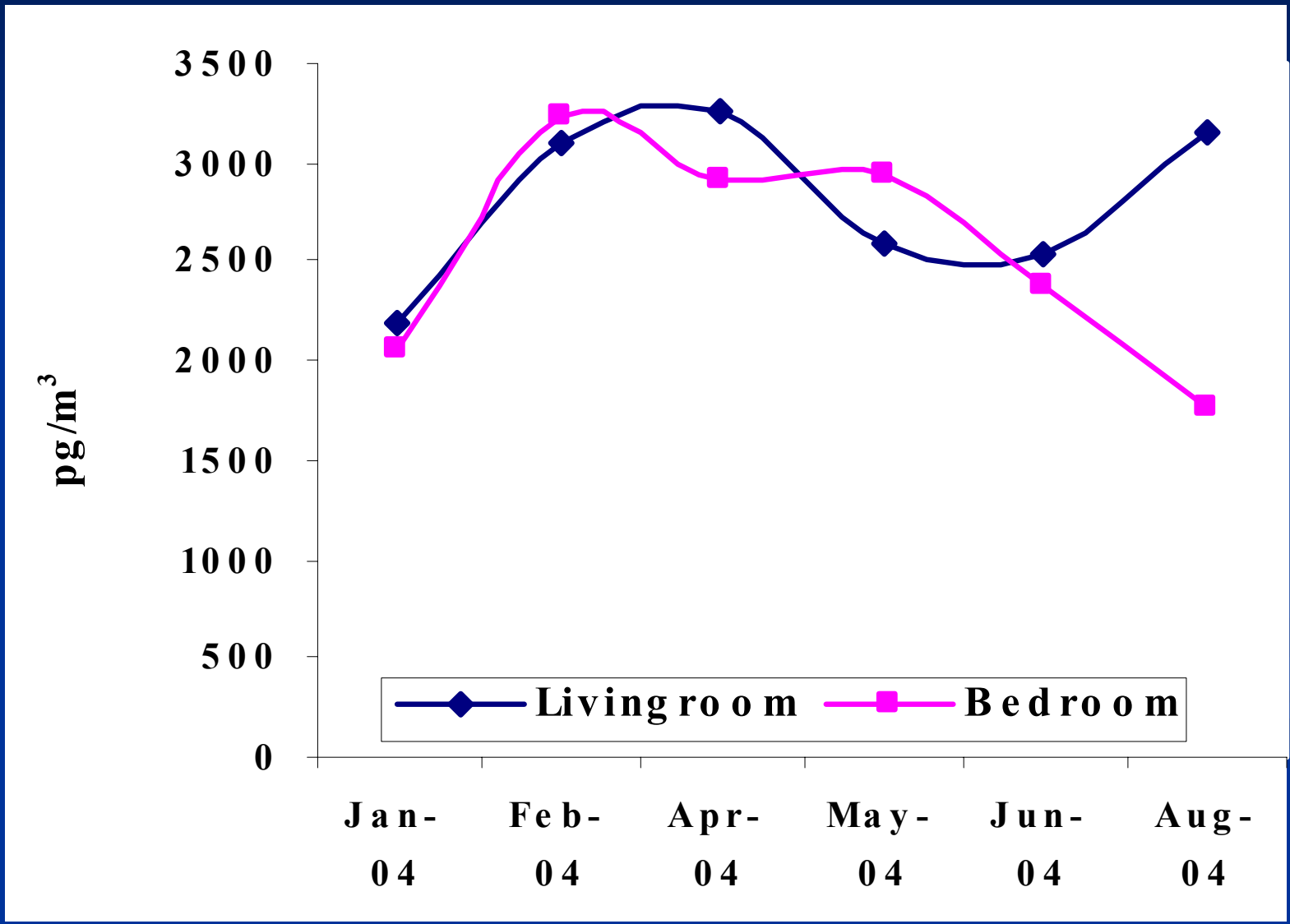

Monthly variation in PCB and PBDE concentrations (pg/m^3) in Office 2 (an example of influence of room content on PBDE levels)

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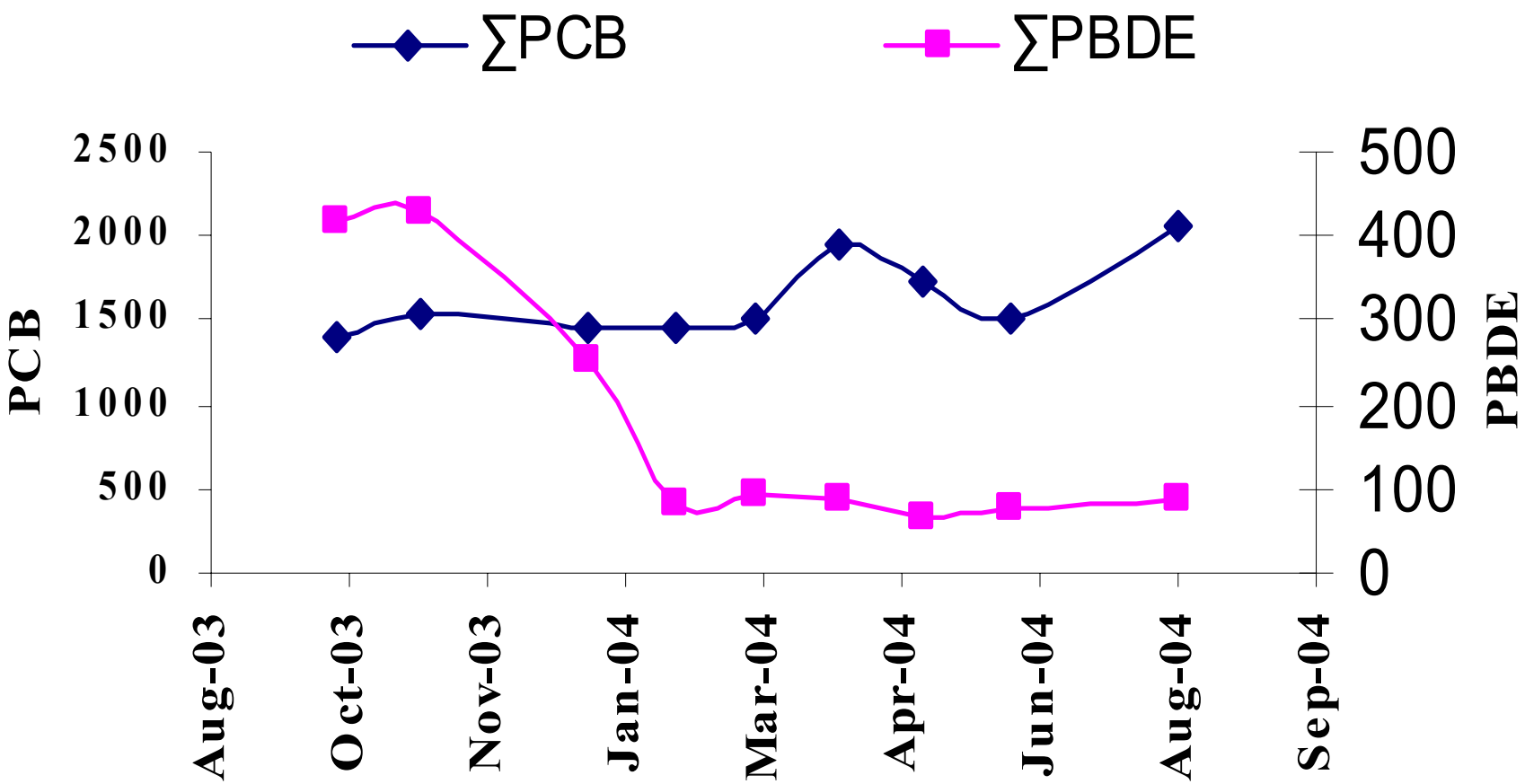

Seasonal variation in concentrations of PCBs in indoor and outdoor air

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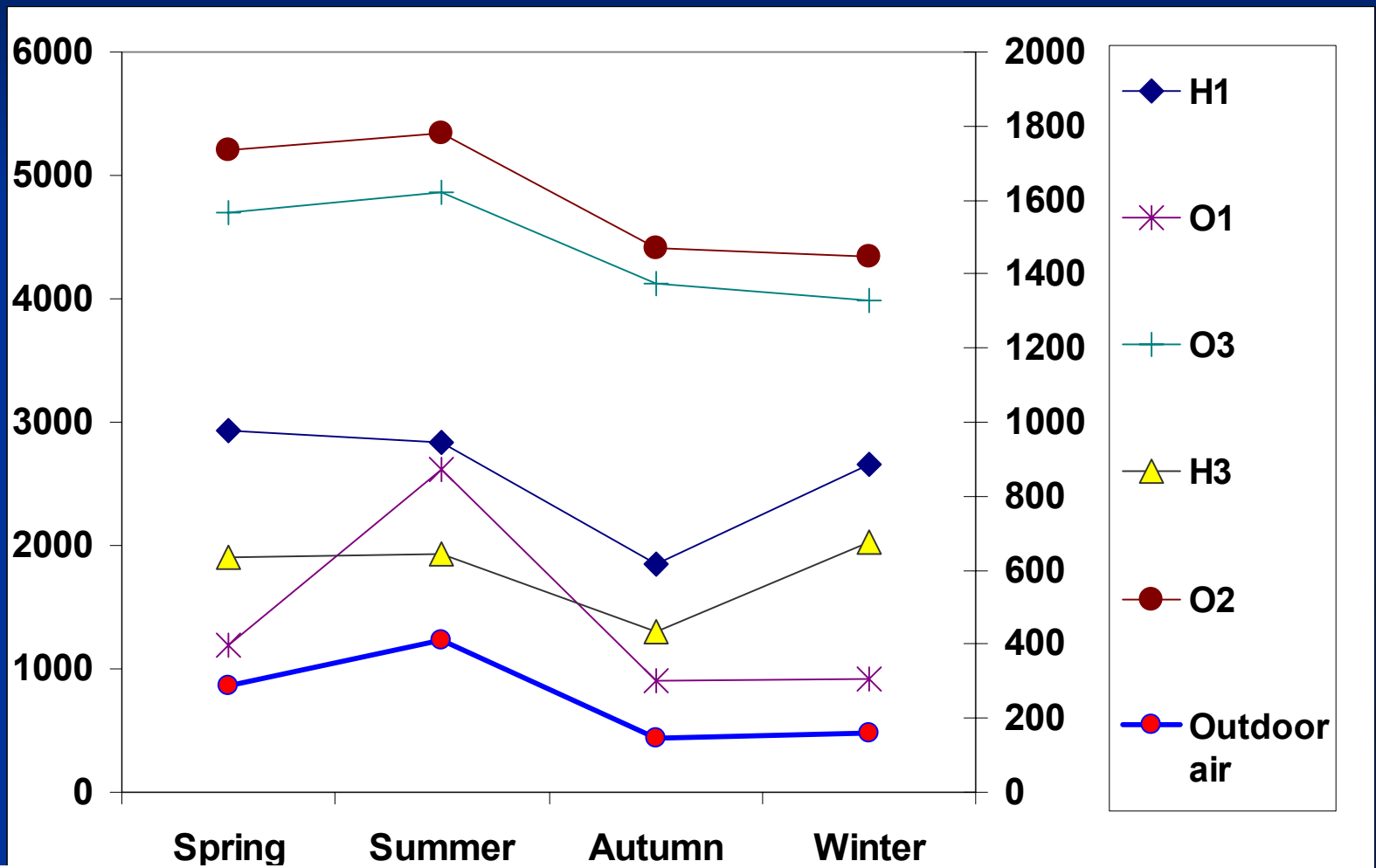

Outdoor air data is from Mao 2000

Daily adult exposure to PCB and PBDE via Inhalation (ng person^{-1})

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$$\sum \text{Exposure} = [(C_H F_H) + (C_O F_O) + (C_P F_P) + (C_C F_C) + (C_{OA} F_{OA})]\ R_R$$

Homes = 63.8 %
Offices = 22.3%
public indoor environments = 5.1%
Transportations = 4.1%
Outdoor = 4.4%
R_R= 20 m^3

	ΣPBDE		ΣPCB	
	Lower bound	Upper bound	Lower bound	Upper bound
Min	0.1	0.3	12	12
Percentile 25	0.4	0.5	37	37
Median	0.8	0.9	60	60
GeoMean	0.9	1	71	71
Average	2.1	2.2	150	150
Percentile 75	1.8	1.9	186	186
Percentile 90	5	5	344	345
Percentile 95	8.8	8.9	587	587
Max	16.3	16.4	666	666

Relative contribution of inhalation exposure to total exposure of PCB and PBDE

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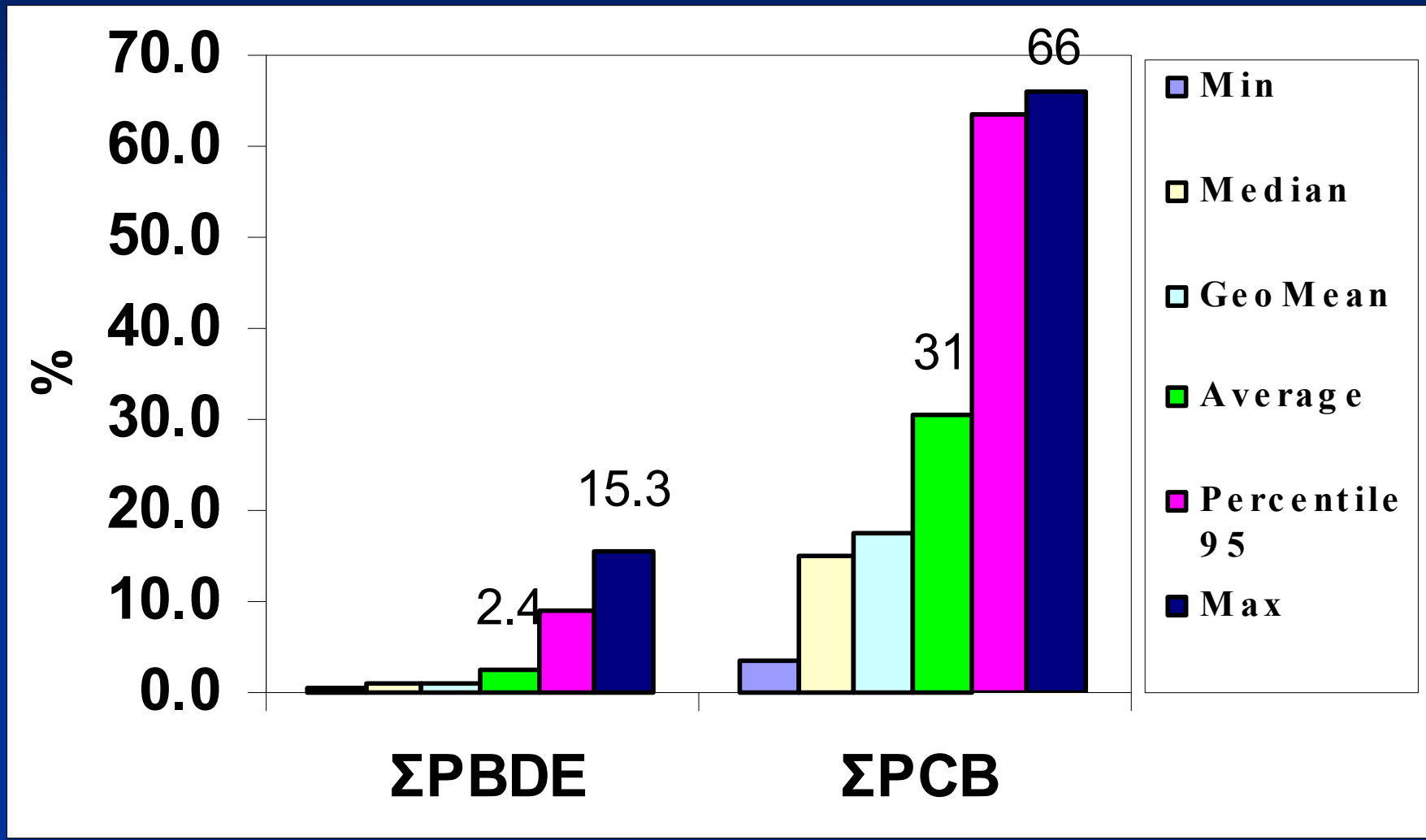

Relative contribution of inhalation exposure to total exposure in 95th percentile of general population

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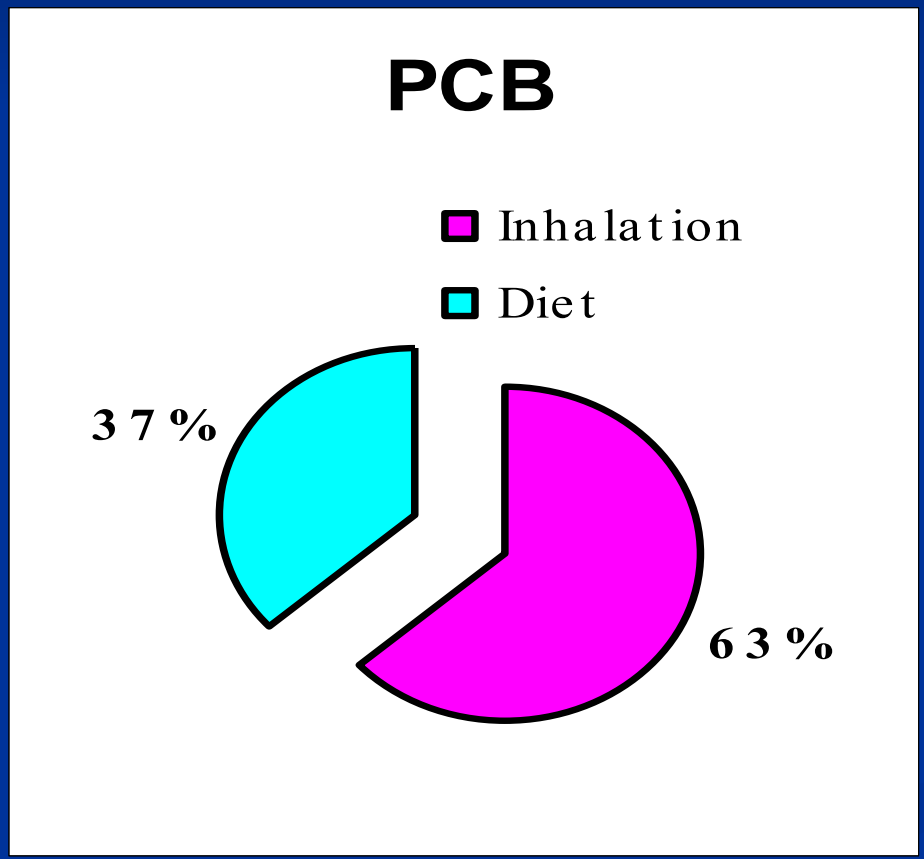

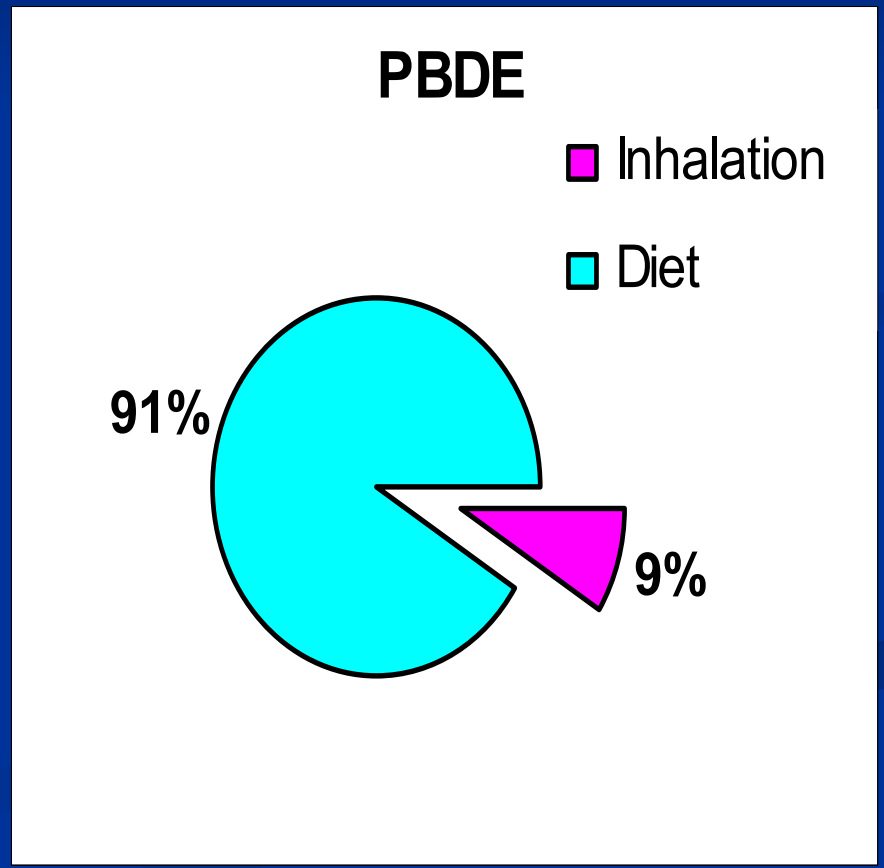

Conclusions

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- PCB and PBDE levels in indoors are much higher than outdoor air concentrations
- PCB and PBDE concentrations in indoor air show significant seasonality, which matches closely that of outdoor air; supporting hypothesis that indoor air is a significant source of PCBs and PBDEs to outdoor air
- No significant decline in PCB concentrations in indoor air is evident since previous (1997) study in West Midlands
- Indoor environments constitute an important vector of human exposure for PCBs and PBDEs in some locations for some people


Q and A