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Indoor environment and human exposure to BFRs

You are not just what you eat ☺

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Outline

- Introduction to exposure assessment
- Design of our study
- Considerations - dust and air sampling
- Our preliminary results
- Results from other studies
- Take home messages

Risk assessment

- Hazard identification
- Dose-response determination
- Exposure assessment
- Risk characterisation

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Exposure assessment

Internal dose

- Measure chemicals in biological matrices such as blood, breast milk, urine (biomonitoring)
- Combine with knowledge on distribution in the body
- Calculate body burden (total amount in the body)

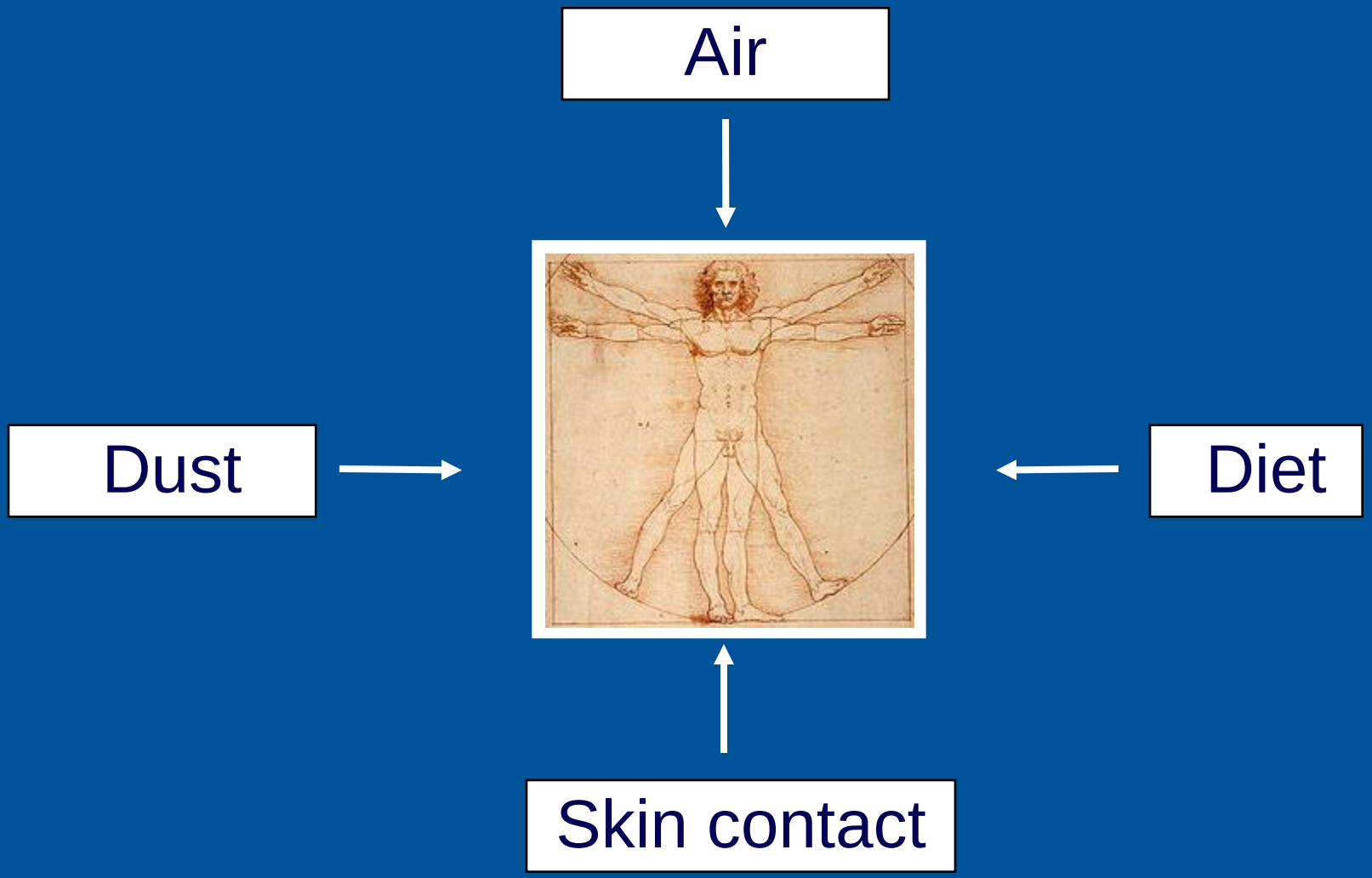
- Integrated exposure over time
- Take individual differences into consideration (e.g. age and gender)

External dose

- Measuring concentrations in delivering media, e.g. food and dust
- Combine with exposure factors (e.g. food consumption or inhalation rate)
- Calculate total intake

- Compare different exposure pathways
- Important for selecting appropriate actions

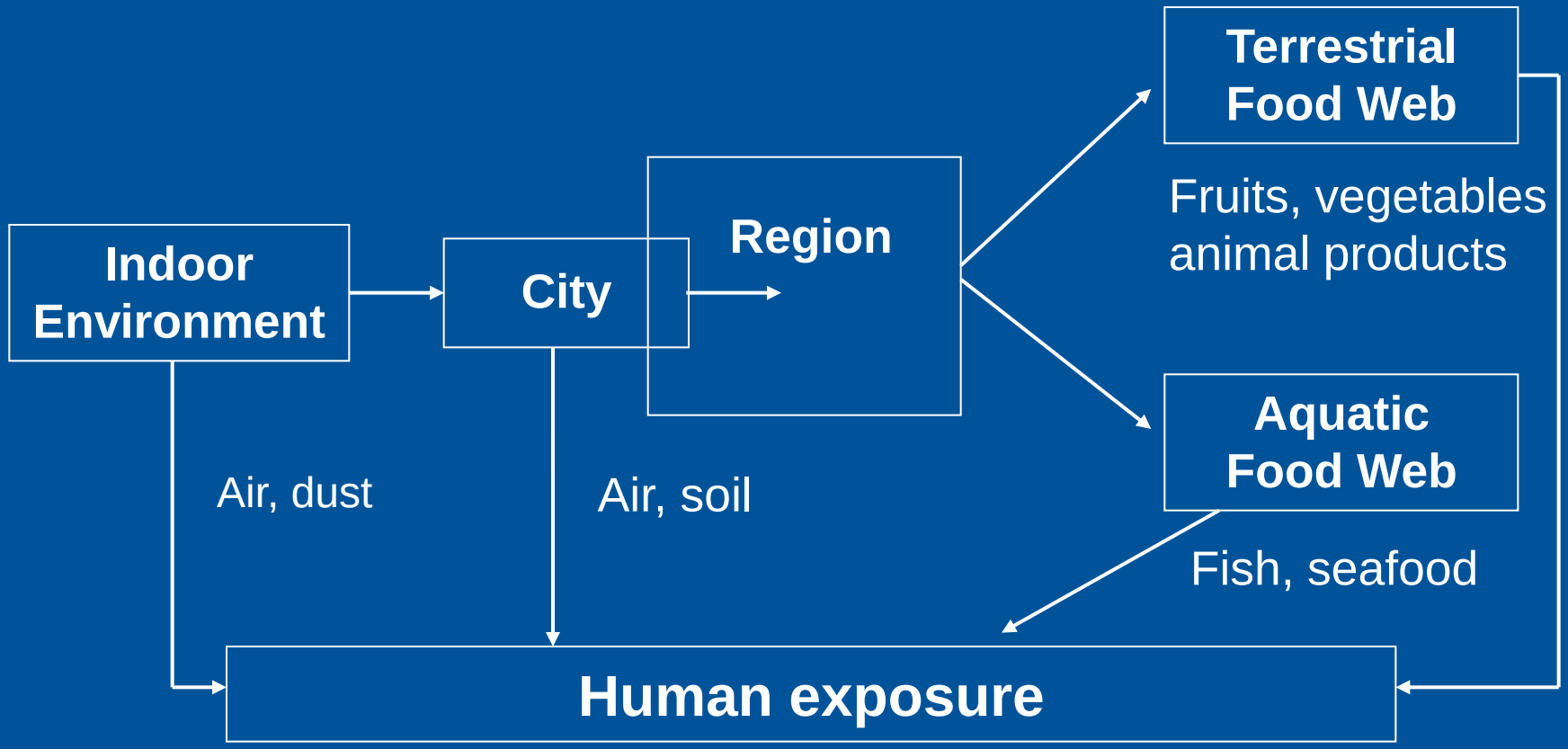
Exposure assessment



Why focus on the indoor environment?

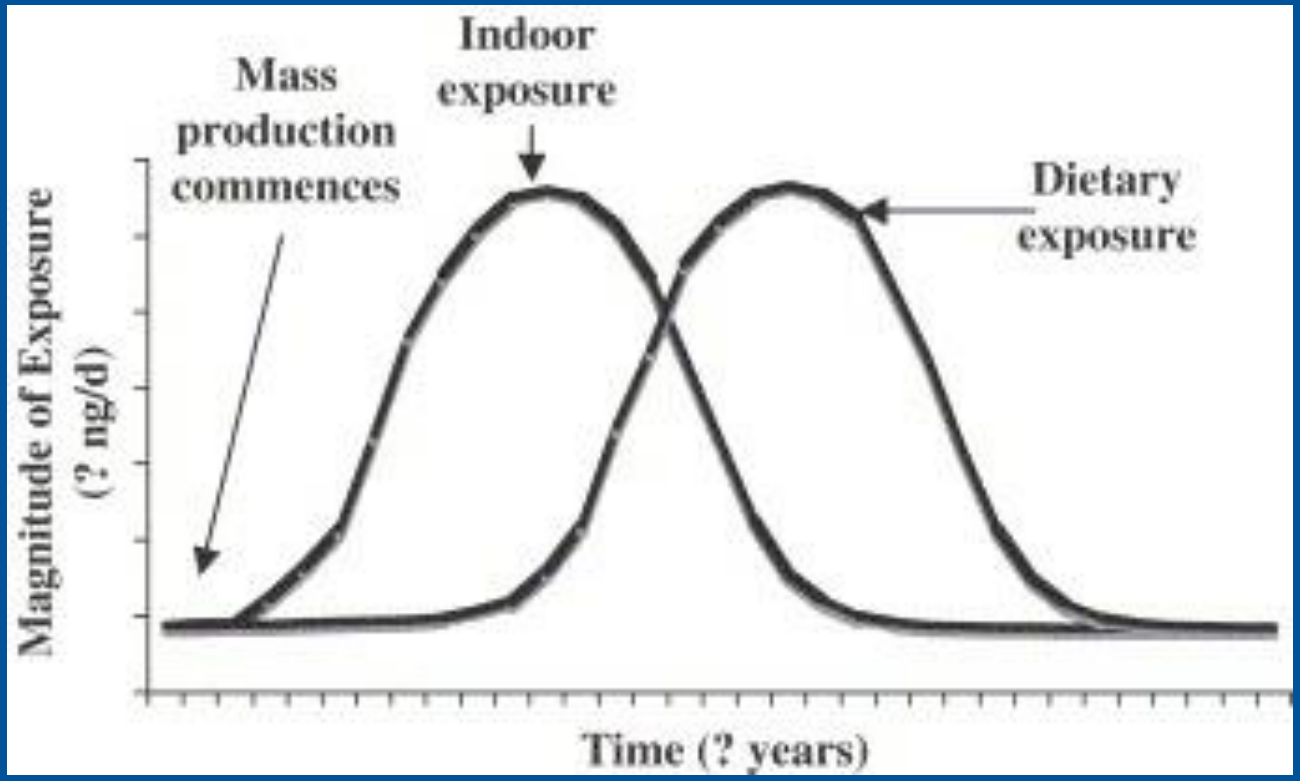
- For traditional POPs consumption of food is main exposure route
- Concentrations of PBDEs higher in serum from the US than from Europe
- PBDE concentrations in food from US similar to that from Europe
- PBDEs have been used in large quantities indoors

Conceptual model of sources, pathways and exposure to POPs



From S. Harrad (ed.) POPs, 2010

Exposure to POPs



Harrad and Diamond. Atmospheric Environment, 40, (2006), 1187-1188

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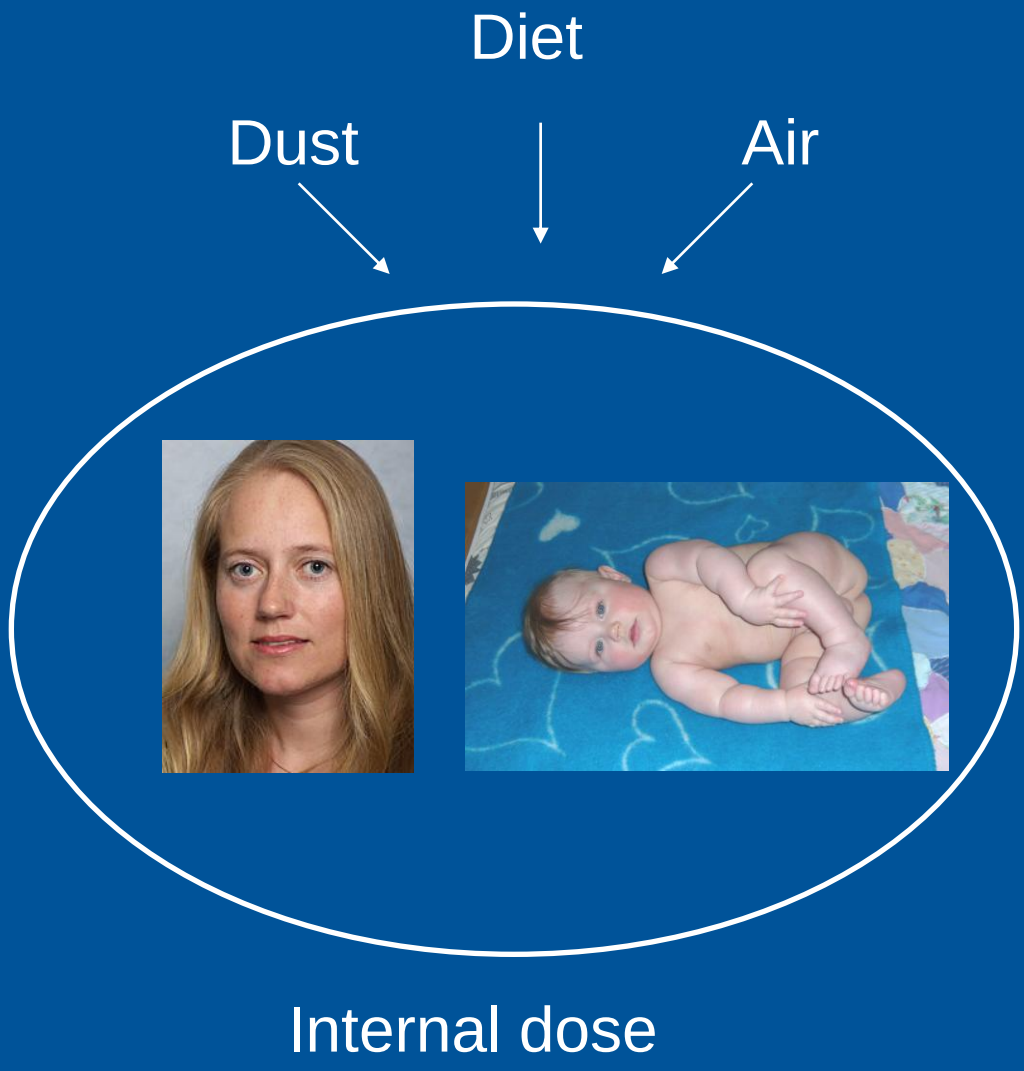
Principal objective

To characterise different human exposure pathways of BFRs and PFCs by comparing estimates of exposure from diet, indoor air and house dust with biomarkers of exposure



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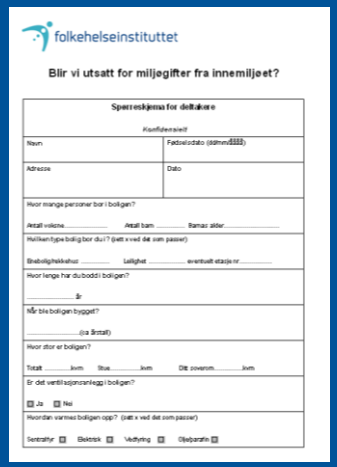
The BROFLEX study

questionnaire


folkehelseinstituttet

Blir vi utsatt for miljøgifter fra innemiljøet?

Spørreskjema for deltakere

Konfidensielt

Navn | Fødselsdato (ddmmåååå)

Adresse | Dato

Hvor mange personer bor i boligen?

Antall voksne..... Antall barn..... Barnas alder.....

Hvilken type bolig bor du i? (sett x ved det som passer)

Eneboligfrittliggende hus ..... Leilighet ..... eventuelt etasje nr.....

Hvor lenge har du bodd i boligen?

..... år

Når ble boligen bygget?

.....(ca årstall)

Hvor stor er boligen?

Totalt .....kvm Stua.....kvm Ditt soverom.....kvm

Er det vanntil sjøsnanlegg i boligen?

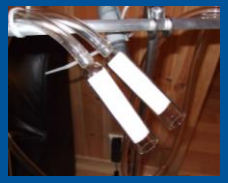
☐ Ja ☐ Nei

Hvordan varmes boligen opp? (sett x ved det som passer)

Sentralfyr ☐ Elektrisk ☐ Vedfyring ☐ Oljebasert ☐

dust

air



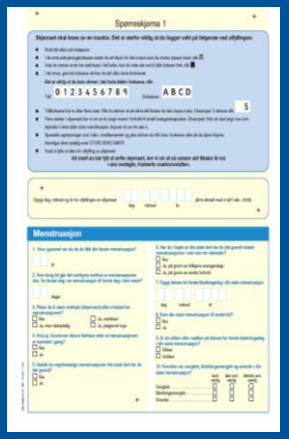
XRF measurements

blood

n = 41

beverages

questionnaire


Spørreskjema 1

Menstruasjon

food

breast milk

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XRF measurements

- Measuring elements by x-ray fluorescence
- Br found in electronics – probably BFRs
- Previous studies have not found associations between dust concentrations and number of e.g. electronics
- Associations between XFR results and PBDE concentrations dust in had previously been found*
- Screening to see if some living rooms are likely to have more BFRs in the indoor environment than others

** Allen et al. Environ. Sci. Technol. 42, (2008), 4222-4228*

XRF results

ppm Br	Number of measurements
< 1000	269
1000 - 10000	69
>100000	66

> 200 000

	ppm Br
Charger to portable CD player	200000
DVD player	210000
TV	250000
Radio	260000
DVD player	260000
Fiberoptic coupling-box	260000
TV	290000

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Dust sampling

- What type of dust is most relevant for human exposure?

Vacuum cleaner bags

- Integrated exposure over time
- Easy
- Do not know where sample has been collected
- Carry-over

Filter collection

- Short interval
- Resource intensive
- Easier to standardise
  - Floor dust vs settled dust
  - Standardised area?

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Indoor air sampling

Active sampling

- Short interval
- Pumps makes noise
- Collects small particles

Passive sampling

- Integrated exposure over time
- Takes a long time to collect enough air
- Uptake rate
- Collects “only” gas-phase

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Assumptions for estimating intakes

- Dust ingestion rate of 50 mg/day[1]

- Infants of 6 months weighing 7 kg, consuming 700 ml breast milk per day (3.1% fat)

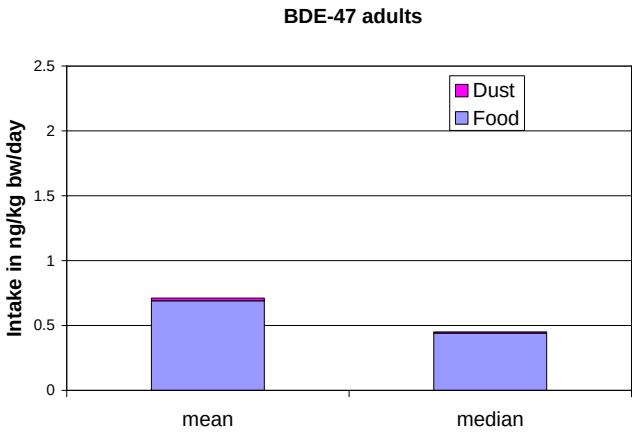
Individual food intakes not yet calculated, values from group of Norwegians exposed to background contaminated food are used[3]

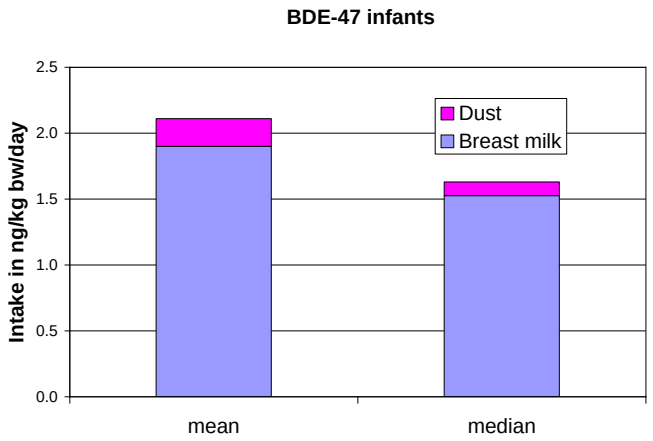
[1]*EPA, 1997.*

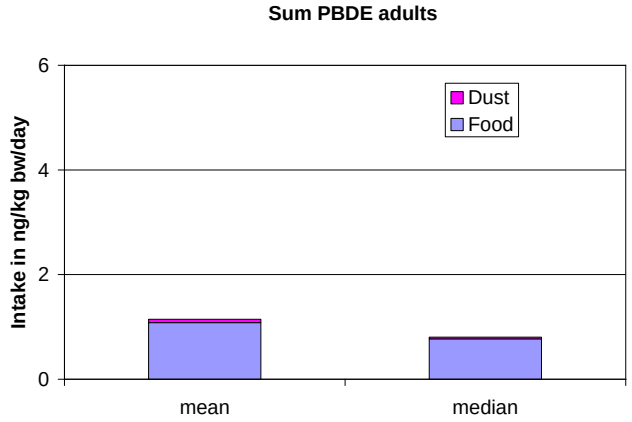
[2]*Egeghy and Lorber. J Expo Sci Environ Epidemiol (2010) 1-19.*

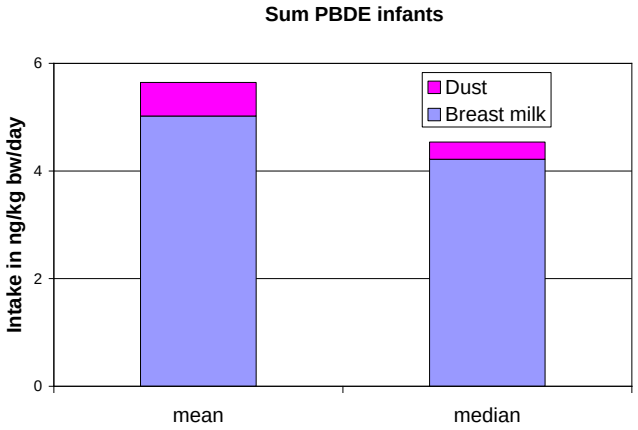
[3]*Knutsen et al. Mol Nutr Food Res, 52 (2008) 217-227.*

Estimated intakes









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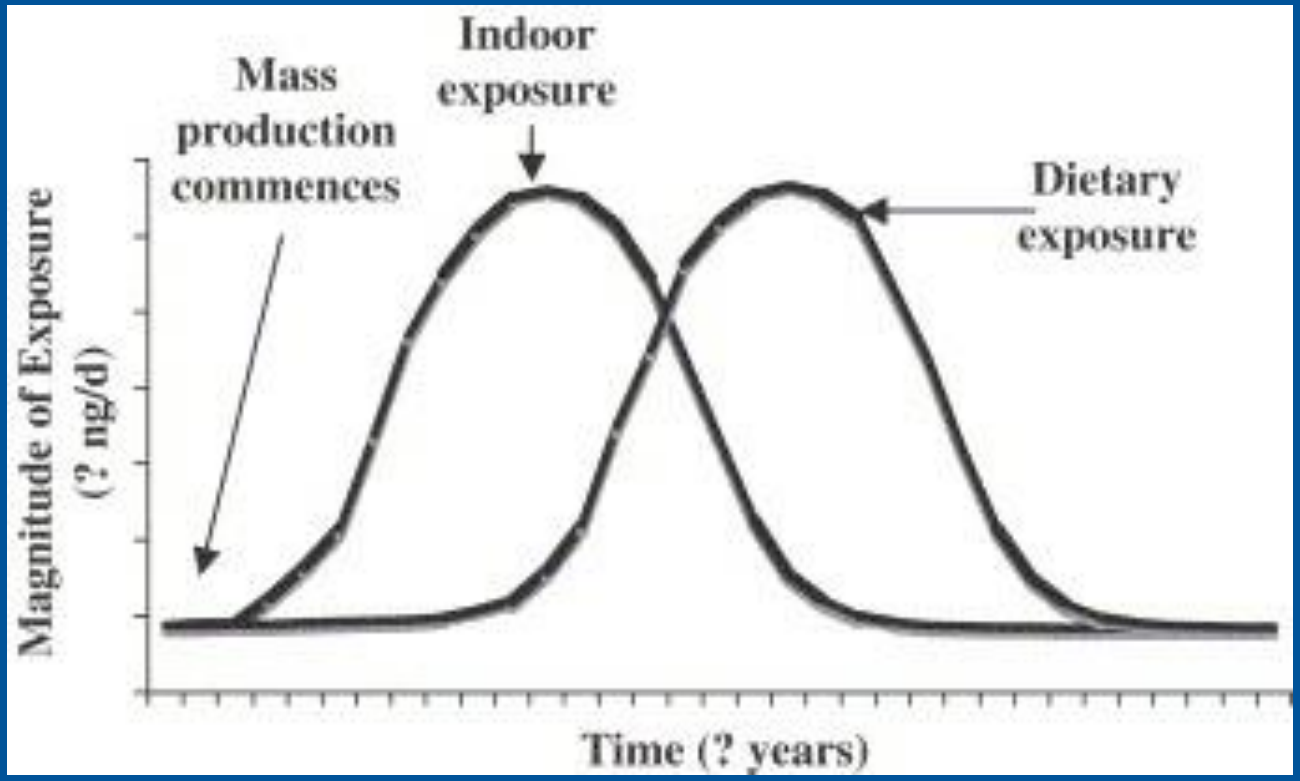
Exposure of Americans

Table 3. Adult exposure intakes for all congeners and pathways, and predicted body burdens compared against measured congener concentrations in blood and milk.

Description	28	47	99	100	138	153	154	183	209	Total	Fraction
I. Exposure Pathway						ng/day					
Water ingestion	<0.01	0.06	0.04	0.01	<0.01	0.01	<0.01	0.01	0.09	0.2	<0.01
Soil/dust ingestion	—[a]	81.3	102.9	39.9	7.9	10.7	6.9	2.9	104.8	357.3	0.66
Soil/dust dermal contact	—	19.5	24.7	9.6	1.9	2.6	1.7	0.7	25.2	85.9	0.16
Inhalation	0.3	2.2	1.0	0.2	—	0.1	0.2	<0.01	1.5	5.5	0.01
Shellfish ingestion	—	13.7	4.6	3.4	—	—	—	—	—	21.7	0.04
Finfish ingestion	0.4	7.0	2.0	1.5	0.01	0.2	0.6	0.02	1.0	12.7	0.02
Beef ingestion	1.0	2.5	2.0	0.3	<0.01	0.3	0.2	0.1	0.2	6.6	0.01
Pork ingestion	—	1.2	1.9	0.2	0.02	0.3	0.2	0.1	0.3	4.2	0.01
Poultry ingestion	0.01	2.1	4.2	1.1	0.1	0.7	0.04	0.1	4.2	12.6	0.02
Other meats	0.2	1.6	2.3	0.4	0.03	0.4	0.1	0.1	1.2	6.3	0.01
Milk ingestion	0.04	5.3	5.3	0.9	0.01	0.7	0.4	0.4	7.0	20.1	0.04
Dairy ingestion	0.01	1.7	1.7	0.3	—	0.2	0.1	0.1	2.2	6.3	0.01
Eggs ingestion	<0.01	0.3	0.7	0.1	<0.01	0.1	0.1	<0.01	0.2	1.5	<0.01
Total	2.0	138.5	153.3	57.9	10.0	16.3	10.5	4.5	147.9	540.9	
Fraction	<0.01	0.26	0.28	0.11	0.02	0.03	0.02	0.01	0.27		

Lorber. J Expo Sci Environ Epidemiol. (2008), 2-19

Exposure to POPs



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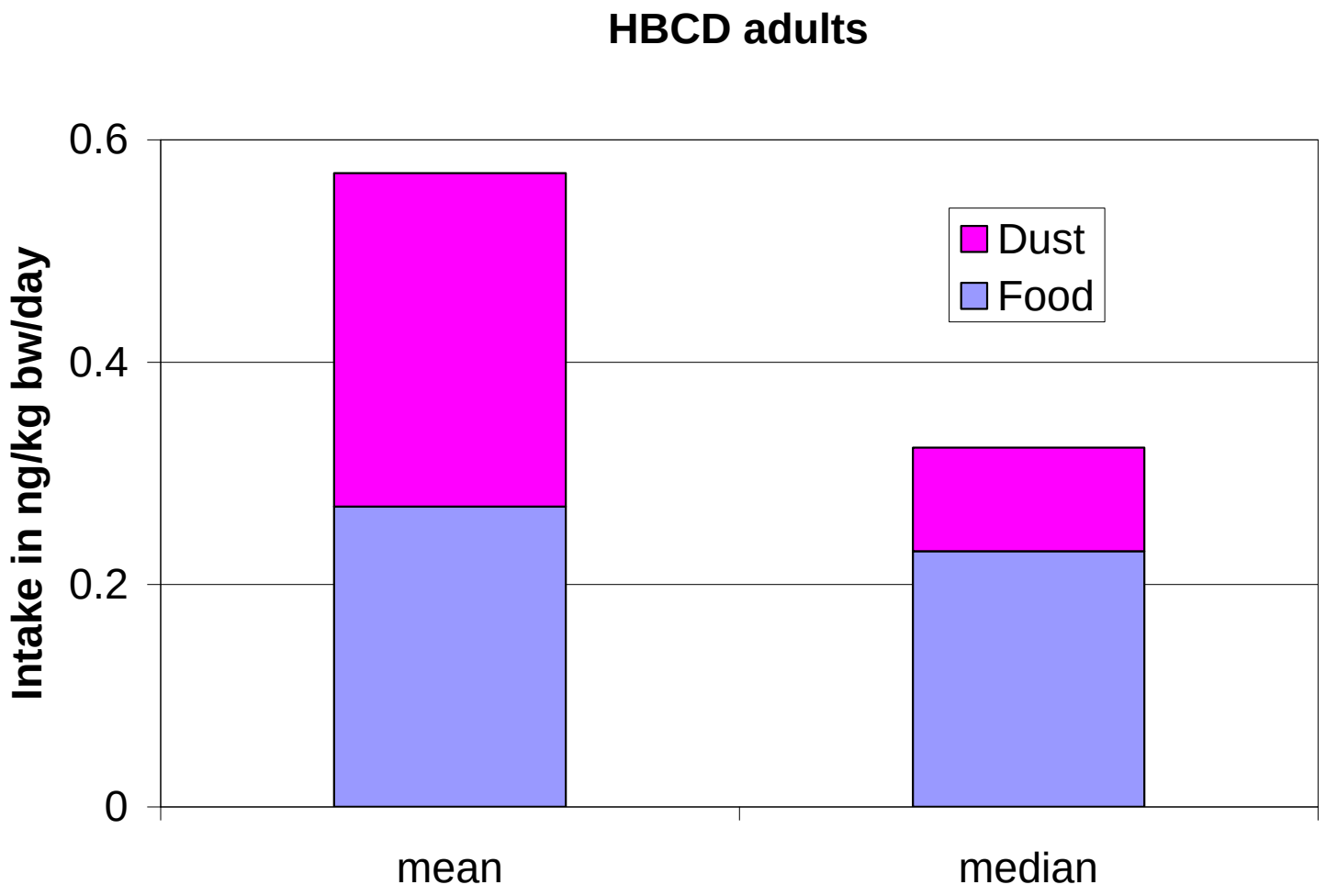
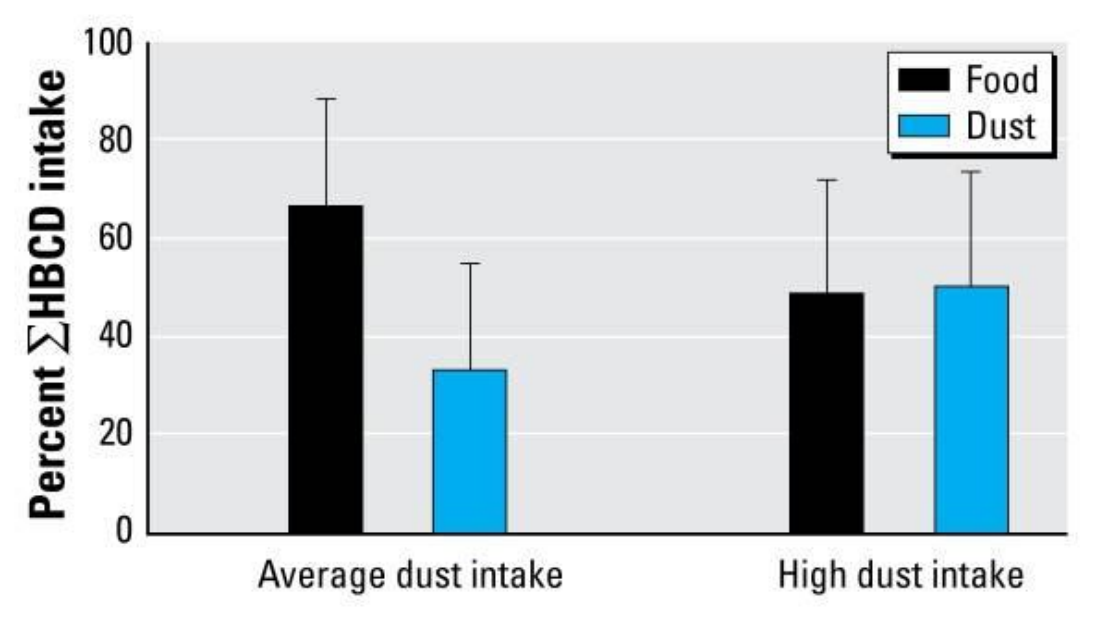

HBCD adults
Intake in ng/kg bw/day
0.6
0.4
0.2
0
Dust
Food
mean
median

Intake of HBCD in adults from Belgium



Roosens et al. Environ Health Perspect. 117,(2009),1707-12

Does intake of HBCD from house dust or diet affect the serum level?

Dust

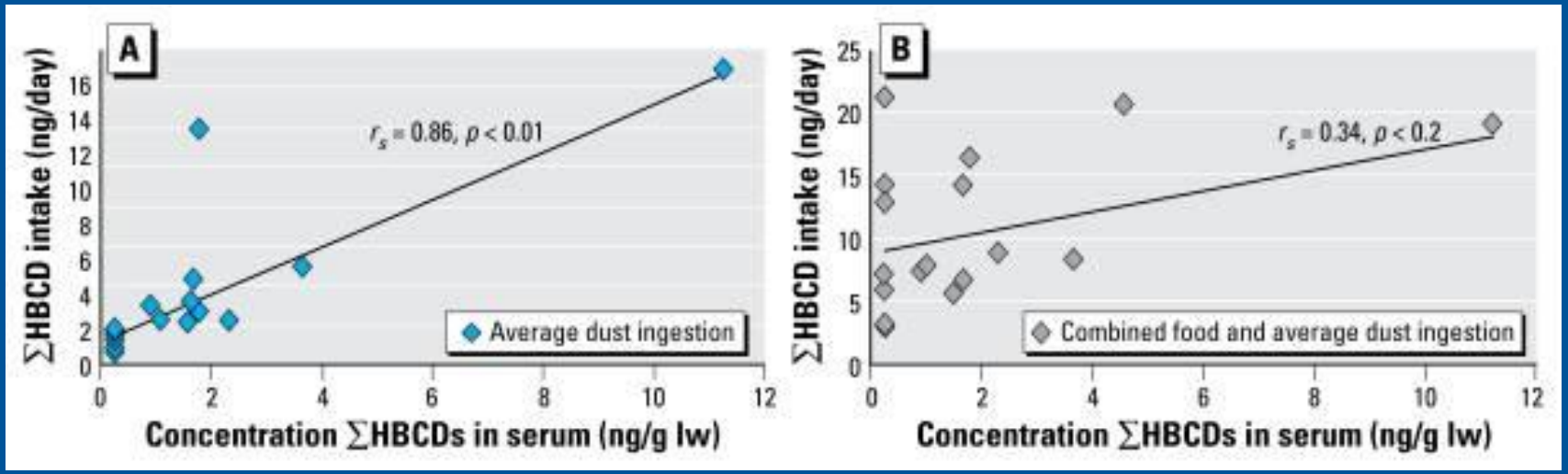
Diet

? ?

Serum

Intake from dust

Intake from dust and diet



Roosens et al. Environ Health Perspect. 117,(2009),1707-12

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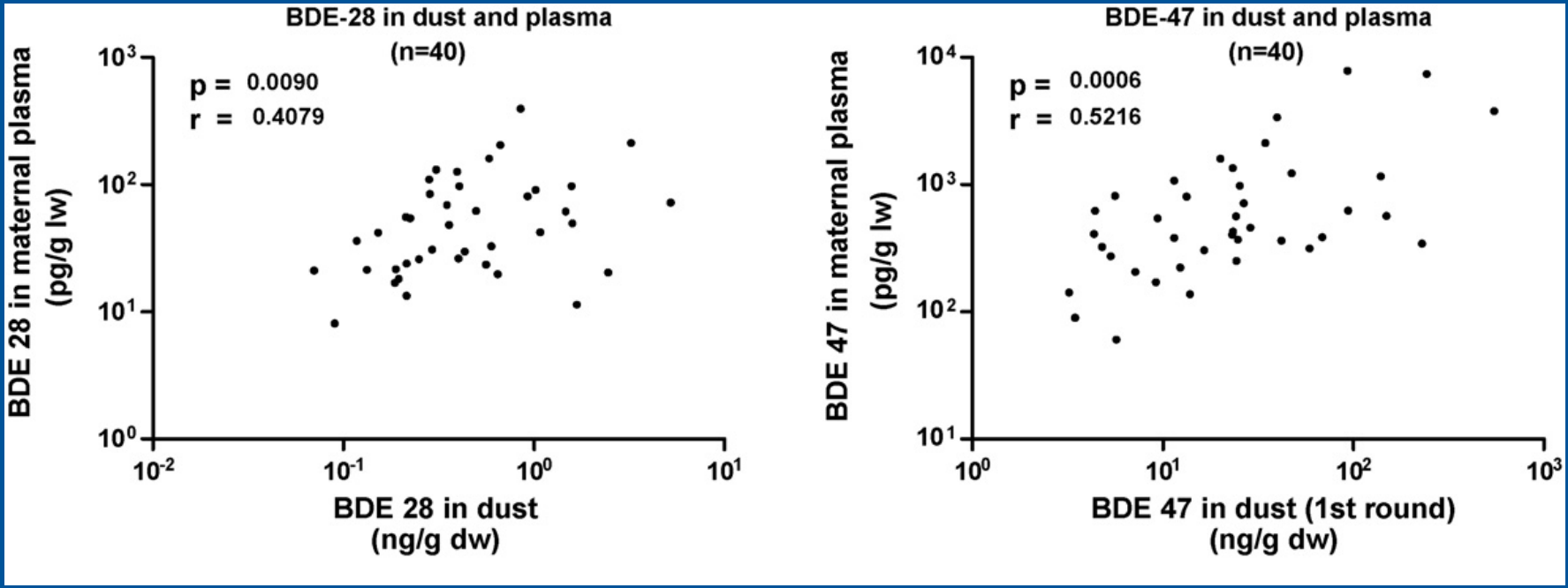
Do the concentrations of PBDEs in house dust affect the plasma level?

Dust → ? → Plasma



Frederiksen et al. Int J Hyg Environ Health. 213, (2010),233-42

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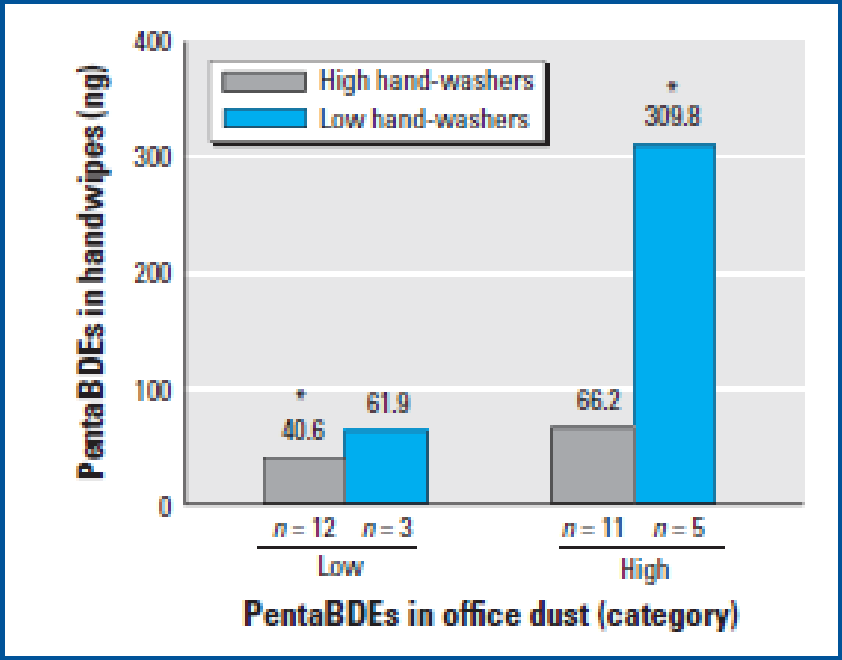
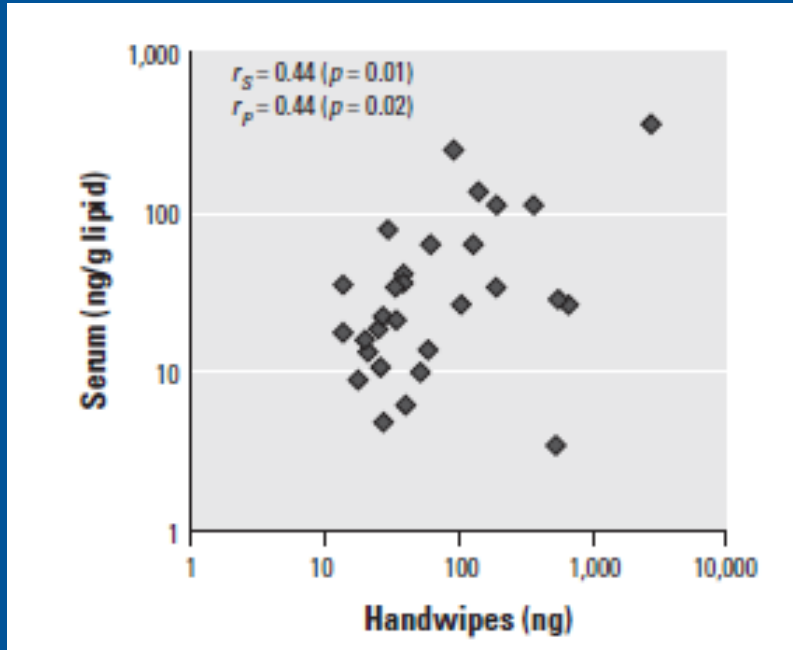
Do the concentrations of PBDEs in the indoor environment affect the serum level?

Dust → ? Handwipes → ? Serum





Watkins et al. Environ Health Perspect.119 (2011),1247-52.

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Take home message nr 1

Knowledge on the importance of different exposure pathways is important for selecting appropriate actions to minimise exposure.

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Take home message nr 2

The indoor environment can be an important exposure pathway for several POPs and especially for those that are

- used in large quantities indoors
- not yet banned or restricted

Take home message nr 3

The relative importance of each exposure pathway might vary a lot between individuals do to

- Variability in conc. in delivering media
- Variability in the exposure factors

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Acknowledgements

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