Norwegian Institute of Public Health

Bisphenols and phthalates in indoor environments

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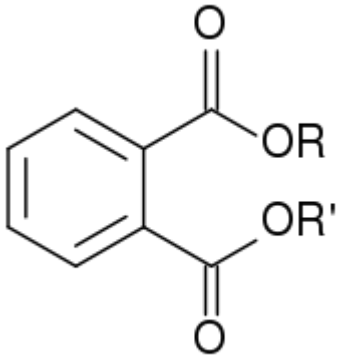
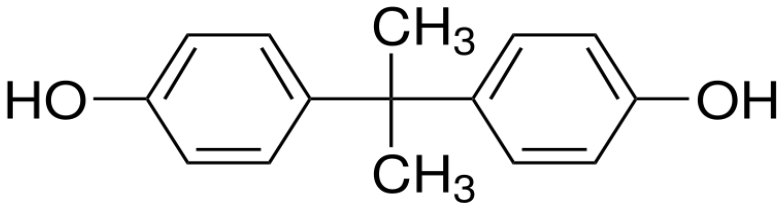
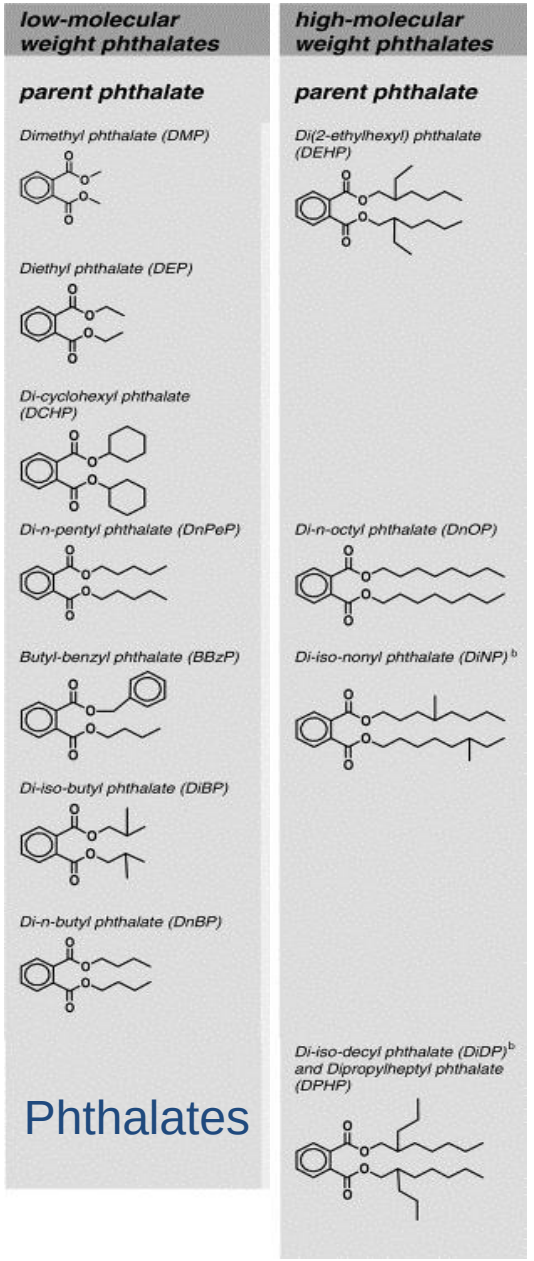


Phthalates

- Man-made chemicals used in plastic production.
- Used for more than 50 years.
- More than 1 million tonnes produced each year.
- Non-persistent environmental pollutants.
- Endocrine disruptors
- Reprotoxic

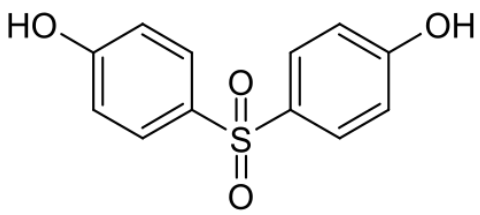


Bisphenol A

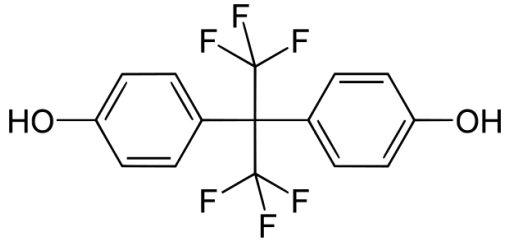


Phthalates

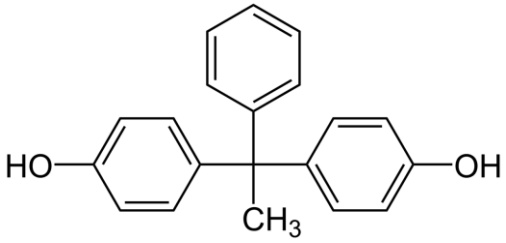
- Other bisphenols
  - Bisphenol (B, E, F, M, P, S, Z, AF, AP, FL)
  - Tetrabromobisphenol A (TBBP A)
  - Bis(2-hydroxyphenyl) methane



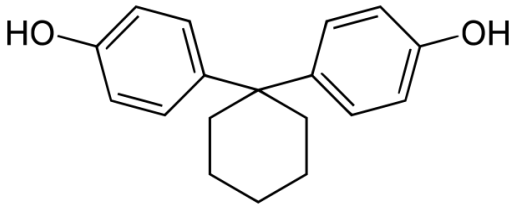
Bisphenol S



Bisphenol AF



Bisphenol AP



Bisphenol Z

Studies in Norway

- Jaakkola et al. and Oie et al. (1999) showed that presence of PVC flooring and significant correlation to bronchial obstruction in children.
- Rakkestad et al. (2007) found different phthalates in particulate matter.
- MoBA study (2009) showing that Norwegian pregnant women have higher exposure of BPA than in Netherland and USA.
- Bertelsen et al. (2012) showing associations between asthma in children and some phthalate metabolites.

We know very little about the levels of these chemicals in Norwegian population…….

EXBISPHA

EXBISPHA: Internal Exposure to Bisphenol A and Phthalates – Sources, pathways and relationship to effects

Assess pathways for human exposure to bisphenol A (BPA) and phthalates

Inhalation

Dermal absorption

Ingestion

Clinical study

48 households with mothers and children (age 6-11 years)

External dose

Air

Wipes

Dust

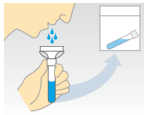
Foods and beverages

Internal dose

Urine

Hair

Blood



Saliva

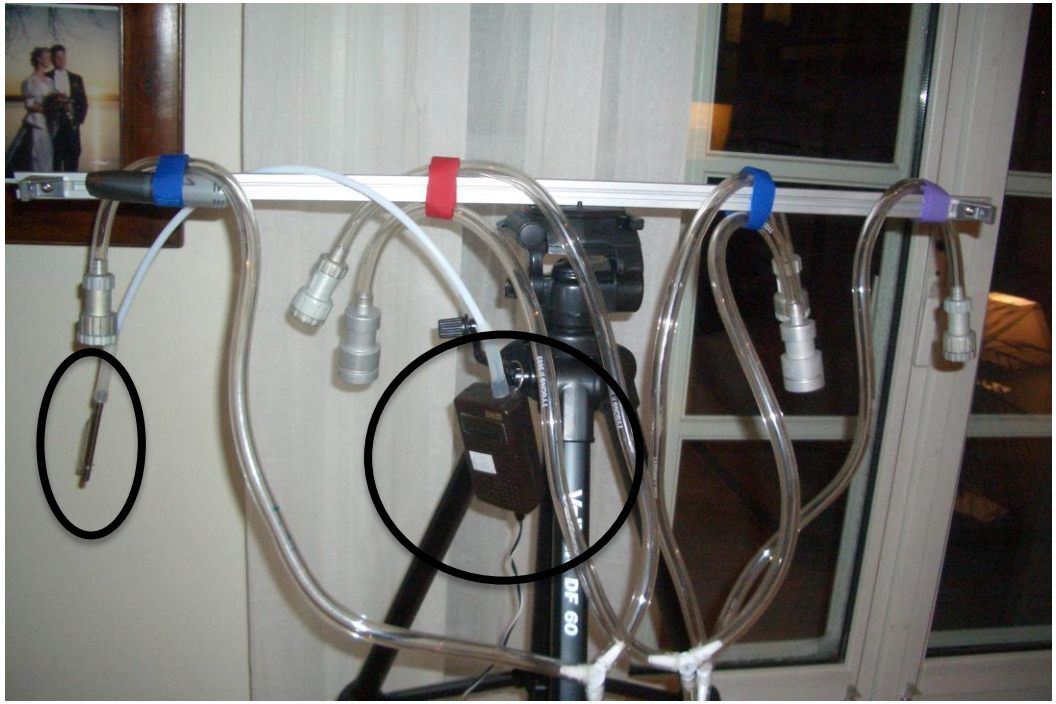
Questionnaires

FFQ. Indoor variables. cosmetics

- Sampling period: January- April/May 2012.
- About 700 different samples are collected.
- Phthalates and Bisphenol A in Norwegian food and beverages.
- Phthalate metabolites in urine samples using liquid chromatography coupled to mass spectrometry (LC-MS-MS).
- Phthalates and Bisphenol A in dust and air samples.

Air samples

- Desorption tubes (Tenax) using pocket pumps
- 70 mL/min, 0.1 m^3 air in one day
- GC-MS/MS
- DMP, DEP, DiBP and DnBP



PM_{10} samples

- Quartz filter (Whatman Q-MA)
- 2.3 m^3/hour, 55 m^3 per day
- LC-HR-TOF
- DMP, DEP, DiBP, DnBP, BBzP, DEHP, DiNP, DiDP and BPA

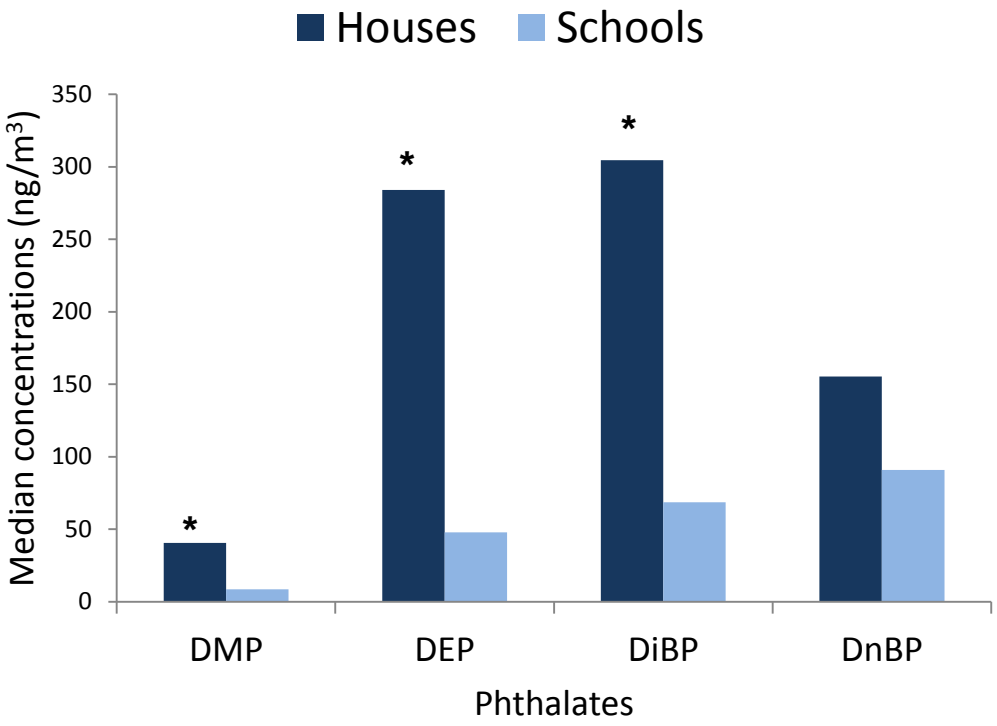
Dust

- Settled dust from elevated surfaces
- LC-HR-TOF
- DMP, DEP, DiBP, DnBP, BBzP, DEHP, DiNP, DiDP and BPA

Dust (windows)

- 28 x 28 cm metal framework
- Metal holder
- Quartz filter
- Up and down and sideways movement
- LC-HR-TOF
- DMP, DEP, DiBP, DnBP, BBzP, DEHP, DiNP, DiDP and BPA

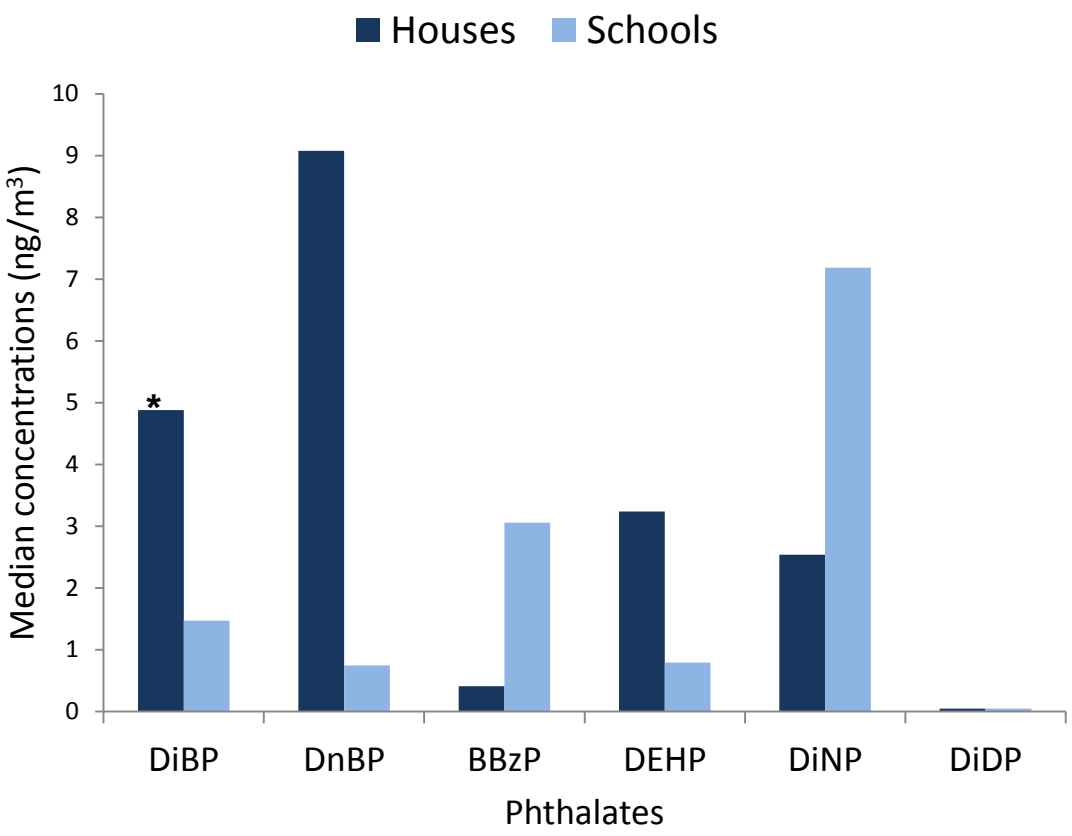
Air



Compounds	Houses	Schools	MW p-value
	ng/m^3		
DMP	40.5	8.44	0.002
DEP	284	47.8	0.004
DiBP	305	68.6	0.002
DnBP	155	90.9	0.236

- 100 % detection frequency both in houses and schools
- Higher concentration in houses.
- Slightly different pattern in houses

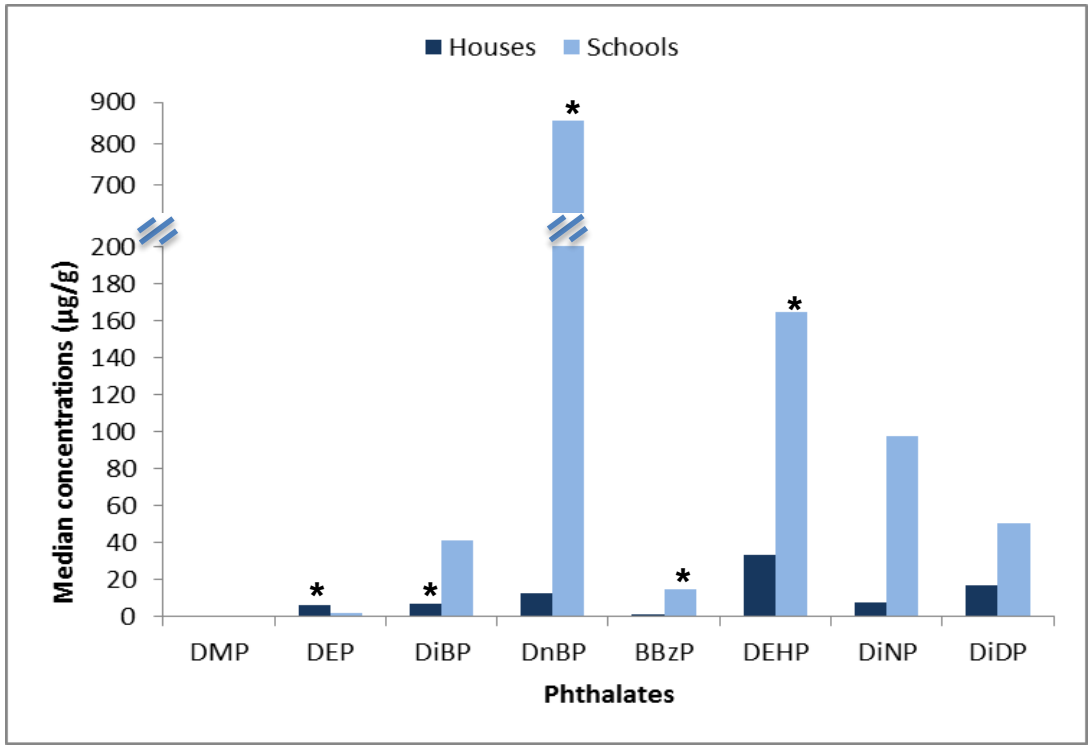
PM_{10}



Compounds	Houses	Schools	MW p-value
	ng/m^3 (detection percent)		
DiBP	4.88 (94)	1.47 (100)	0.007
DnBP	9.08 (83)	0.74 (50)	0.061
BBzP	0.41 (58)	3.06 (100)	0.457
DEHP	3.24 (85)	0.79 (83)	0.271
DiNP	2.54 (71)	7.18 (83)	0.956
DiDP	0.05 (31)	0.05 (33)	0.296

- Different pattern in houses and schools.

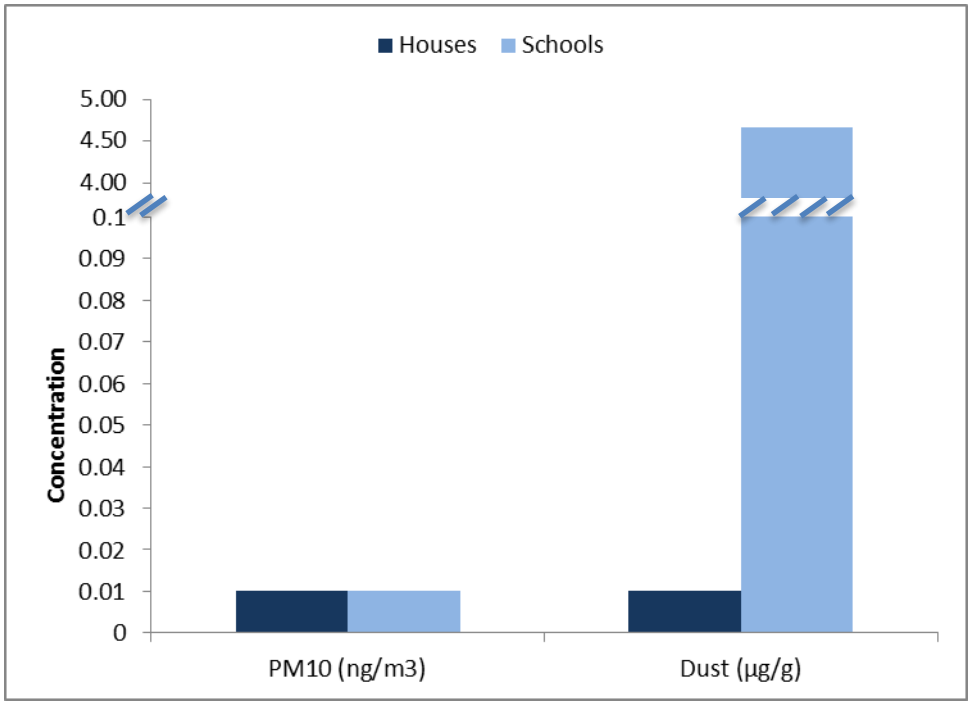
Settled Dust



Compounds	Houses	Schools	MW p-value
	µg/g (detection percent)		
DMP	0.23 (73)	0.07 (83)	0.093
DEP	6.17 (98)	1.81 (83)	0.024
DiBP	6.54 (92)	40.9 (100)	0.001
DnBP	12.9 (73)	855 (100)	0.001
BBzP	0.84 (65)	15.1 (100)	0.001
DEHP	33.6 (88)	165 (100)	0.007
DiNP	7.61 (67)	97.8 (83)	0.178
DiDP	16.9 (71)	50.4 (100)	0.103

- Higher concentrations in the schools.

BPA



	Houses	Schools
PM10 (ng/m^3)	0.01 (38)	0.01 (33)
Dust (µg/g)	0.01 (27)	4.66 (50)

Air, PM_{10} and Dust

- No correlations between air and PM_{10} (DMP, DEP, DiBP and DnBP).
- Significant correlations between PM_{10} and dust for BBzP, DEHP, DiNP, DiDP- only in houses (r = 0.3- 0.4)

Ventilation in schools - air is shifted more often than in houses?

Indoor parameters

Effect

- Size: living room and kitchen
  - ***DnBP dust positively correlated with the size***
- Cleaning (vacuum and washing)
  - ***Vacuum (trends showing more cleaning less concentration for PM_{10} and dust)***
  - ***Washing (not so strong effects as vacuum cleaning)***

No effect

- House type (apartment, small houses, villa)
- Type of building (wood, bricks, concrete, mixed)

Consumer products

Effect

- Stuffed sofa/chairs
  - ***Higher conc. DEHP, DiNP (PM_{10}) and DiDP dust with stuffed sofa***
- Renovation
  - ***Higher conc. DnBP dust in renovated livingroom or kitchen***

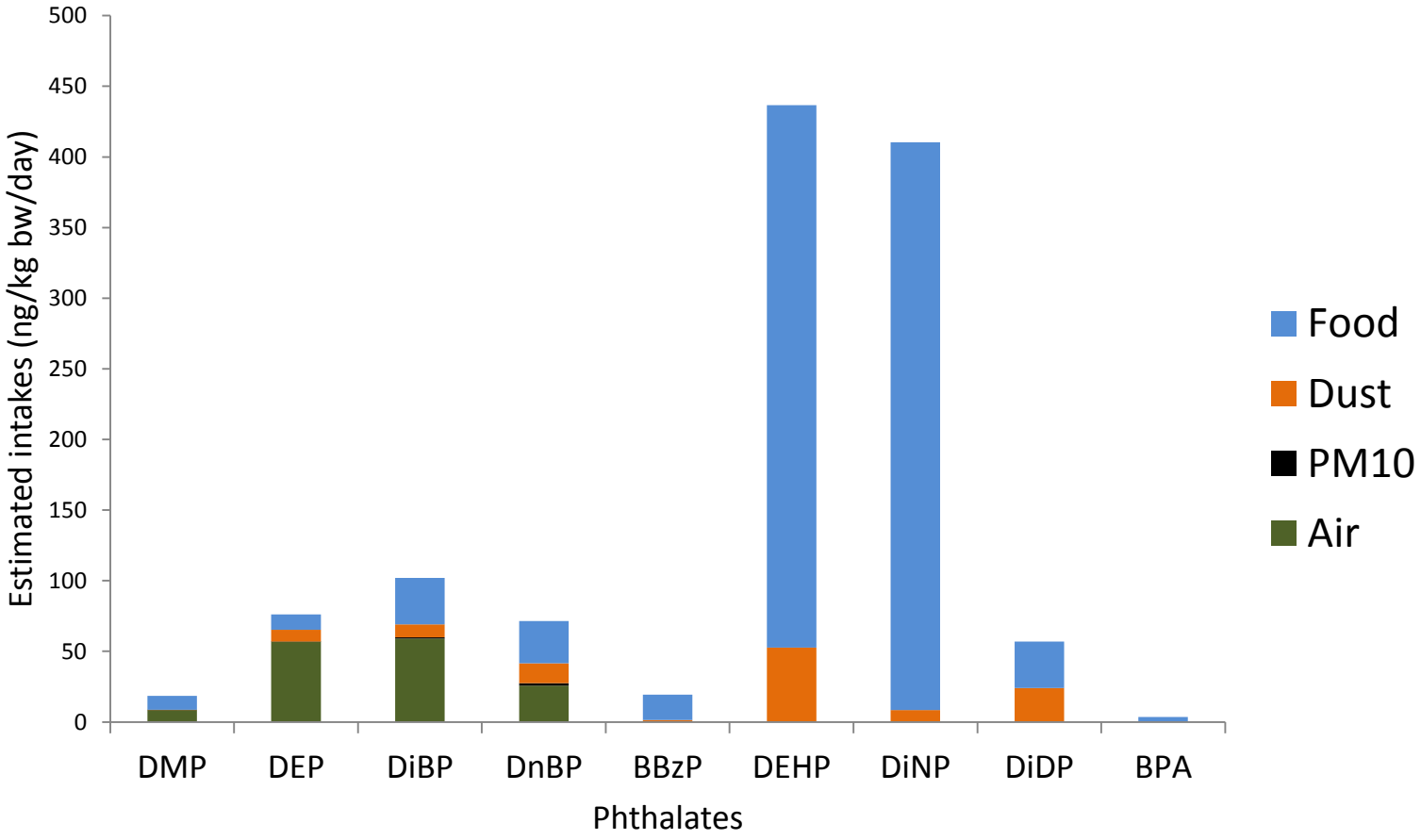
No effect

- Other electrical appliances (TV, mobiles)

Comparison worldwide

- Short chained phthalates in the same range as worldwide.
- Almost similar trend as seen worldwide. *DEP, DnBP and DiBP are dominant in the air, DnBP dominant in PM_{10}, DEHP dominant in the dust samples*
- DEHP is ca 3-10 times lower both in PM_{10} and dust samples compared to other countries.
- Levels of DnBP, BBzP and DEHP in dust and PM_{10} are lower than earlier studies from Norway.
- Little data on BPA in dust and air from other countries, mean but **not** median BPA in dust similar to data available.

Estimated intakes



Conclusions

- For air and PM_{10}, levels are higher in houses compared to classrooms.
- For dust, levels are lower in houses.
- Vacuum cleaning has an effect on the levels of phthalates.

- DEHP levels in Norway are lower than other countries.
- More restricted phthalates have decreased over time in Norway .

- Inhalation- an important source for low molecular phthalates.
- Food ingestion- an important source for high molecular phthalates.

Future plans

- Comparing exposure estimates with biomonitoring data.

- Writing papers.

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    - **Inger Therese Lillegaard**
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    - **Martin Schlabach**
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Thanks for your attention!

QUESTIONS

Collaborators

- Holger Koch. BGFA - Research Institute of Occupational Medicine. Ruhr University Bochum. Germany
- Antonia Calafat. Division of Laboratory Sciences. National Center for Environmental Health. Centers for Disease Control and Prevention (CDC). USA

WHY?

- Endocrine disruptors.
- Functional impairment of development and reproduction.
- Risk of allergy/asthma.
- Risk of diabetes and overweight.
- Phthalates like di-n-butyl phthalate (DnBP), benzyl butyl phthalate (BBP) and diethylhexyl phthalate (DEHP) have been banned in toys and other children products in Europe since 2007.
- BPA is also prohibited for the manufacture of infant feeding bottles in Europe since 2011.

Lyche et al. J Toxicol Environ Health B Crit Rev. 2009.
Martino-Andrade et al. Molecular Nutrition & Food Research. 2010
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Parent compounds	Abbreviation	Urinary metabolites	Abbreviation
Dimethyl phthalate	DMP	-	-
Diethyl phthalate	DEP	Monoethyl phthalate	MEP
Di-iso-butyl phthalate	DiBP	Mono-iso-butyl phthalate	MiBP
Di-n-butyl phthalate	DnBP	Mono-n-butyl phthalate	MnBP
Butyl benzyl phthalate	BBzP	Mono benzyl phthalate	MBzP
Di-2-ethylhexyl phthalate	DEHP	Mono-2-ethylhexyl phthalate	MEHP
		Mono-2-ethyl-5-hydroxyhexyl phthalate	MEHHP
		Mono-2-ethyl-5-oxohexyl phthalate	MEOHP
		Mono-2-ethyl 5-carboxypentyl phthalate	MECPP
Dicyclohexyl phthalate	DCHP	-	-
Di-n-octyl phthalate	DnOP	-	-
		Mono-4-methyl-7-hydroxyoctyl phthalate	OH-MiNP
		Mono-4-methyl-7-oxooctyl phthalate	OXO-MiNP
		Mono-4-methyl-7-carboxyoctyl phthalate	CX-MiNP
Di-iso-decyl phthalate	DiDP	-	-
Bisphenol A	BPA	Bisphenol A	BPA

Study population

Basic characteristics		Mothers	Children
Age (years. mean ± SD)		41.5 ± 4.2	9.4 ± 1.5
Gender (only children)	Boys	na	26
	Girls	na	29
Smoking status (only mothers)	Non-smokers	38	na
	Smokers	9	na
Education (only mothers)	Secondary school	1	na
	Senior Secondary School	9	na
	University/Highschool upto 4 years	9	na
	University/Highschool > 4 years	29	na
Creatinine (g/L. mean ± SD)		8.2 ± 5.2	10.4 ± 3.6
Specific gravity (mean ± SD)		1.015 ± 0.007	1.024 ± 0.005