Phthalates, bisphenols and phosphorus flame retardant exposure in Swedish adolescents and associations with socio-demographic determinants and food consumption

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Introduction

Phthalates, bisphenols and phosphorus flame retardants

> Used in toys, cosmetics, hygiene products, building materials, medical devices, lubricants, food packaging, paints, adhesives, plastic products and PVC

> 8 million metric tons of phthalates alone produced in 2015

Exposure are mainly through food, dermal absorption and inhalation

Associated to a range of detrimental health outcomes

Diabetes

Obesity

Allergy & asthma

Cardiovascular issues

Reproductive health issues

Aim of the study

To investigate the association of suspected toxic substances measured in urine with socio-demographic, food consumption and sampling time determinants

Study Population

Riksmaten Adolescents (RMA) 2016-17

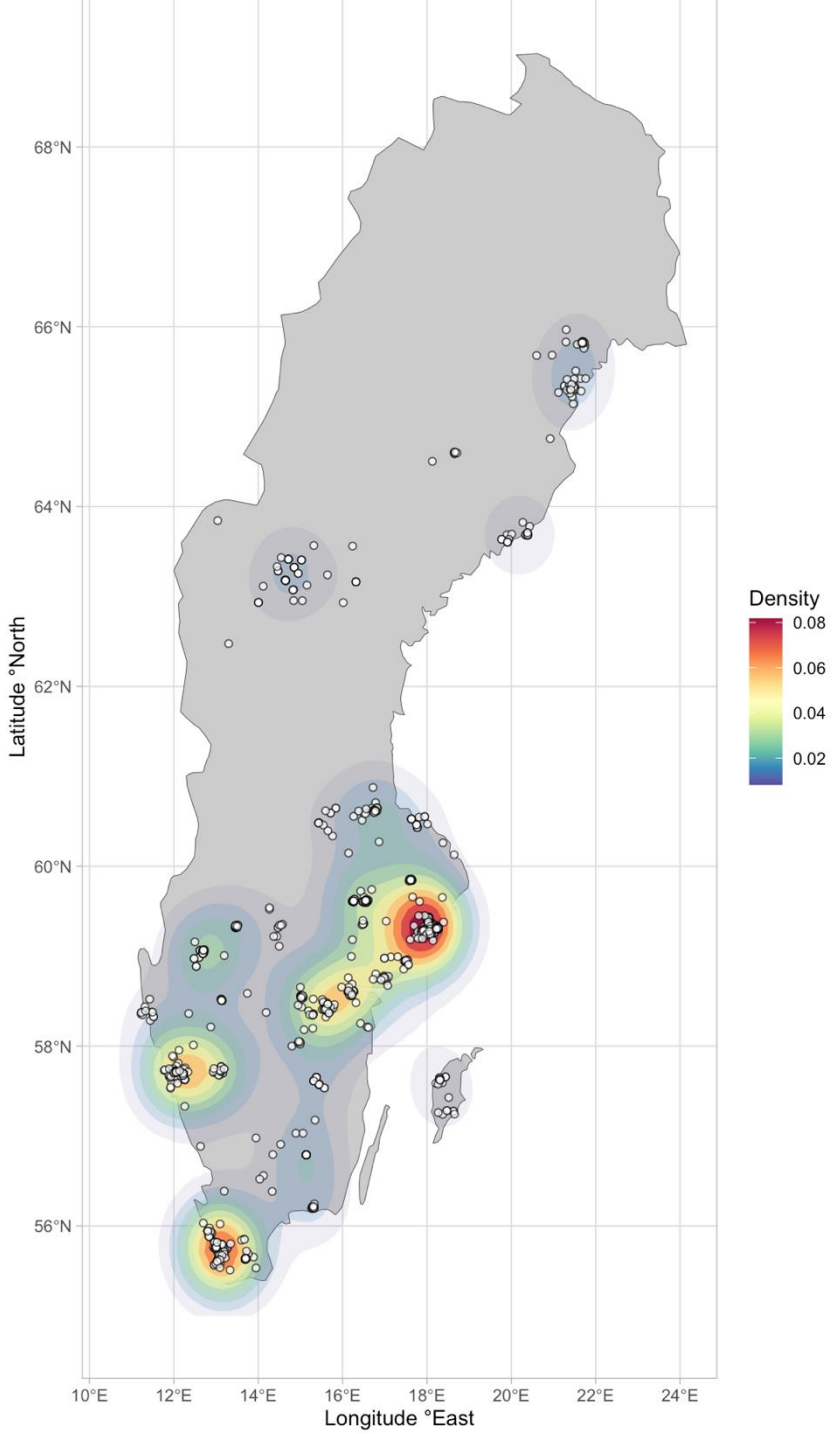
- Nation-wide cross-sectional dietary survey conducted by the Swedish Food Agency
- Aged 11-21
- Living in Sweden, although some born outside
- Sampled in groups of school classes
- Dietary and lifestyle habit data along with urine analysis of toxic substances

1082 participants in total

- Used for analysis with base socio-demographic determinants

983 participants with complete data

- Used for analysis of associations with food consumption and sampling time



Livsmedelsverket
Swedish Food Agency

Substances

21 different bisphenols and metabolites of phthalates and phosphorus flame retardants analysed

Measured from single spot urine samples

Density adjusted levels

DEP	**Diethyl phthalate**	**Plasticizer**
MEP	Monoethyl phthalate	Metabolite of DEP
DBP	**Dibutyl phthalate**	**Plasticizer**
MBP	Monobutyl phthalate	Sum of DEP metabolites
BBzP	**Butylbenzyl phthalate**	**Plasticizer**
MBzP	Monobenzyl phthalate	Metabolite of BBzP
DEHP	**Di-2-ethylhexyl phthalate**	**Plasticizer**
MEHP	Mono(2-ethylhexyl) phthalate	Metabolite of DEHP
5-OH-MEHP	Mono-(2-ethyl-5-hydroxyhexyl) phthalate	Metabolite of DEHP
5-oxo-MEHP	Mono-(2-ethyl-5-oxohexyl) phthalate	Metabolite of DEHP
5-cx-MEPP	Mono-(2-ethyl-5-carboxypentyl) phthalate	Metabolite of DEHP
2-cx-MEHP	Mono(2-(carboxymethyl-hexyl) phthalate	Metabolite of DEHP
DiNP	**Di-isononyl phthalate**	**Plasticizer**
OH-MiNP	Mono-(4-methyl-7-hydroxyoctyl) phthalate	Metabolite of DiNP
oxo-MiNP	Mono-(4-methyl-7-oxooctyl) phthalate	Metabolite of DiNP
cx-MiNP	Mono-(4-methyl-7-carboxyheptyl) phthalate	Metabolite of DiNP
DiDP	**Di-isodecyl phthalate**	**Plasticizer**
cx-MiDP	Mono-carboxy-isononyl phthalate	Metabolite of DiDP
DPHP	**Di-(2-propylheptyl) phthalate**	**Plasticizer**
OH-MPHP	6-Hydroxy monopropylheptyl phthalate	Metabolite of DPHP
DiNCH	**Diisononyl-cyclohexane-1,2-dicarboxylate**	**Plasticizer**
cx-MINCH	Cyclohexane-1,2-dicarboxylate-mono (7-carboxylate-4-methyl)heptylester	DiNCH metabolite
OH-MINCH	Cyclohexane-1,2-dicarboxylate-mono-(7-hydroxy-4-methyl)octyl ester	DiNCH metabolite
TPP	**Triphenyl phosphate**	**Flame retardant, plasticizer**
DPP	Diphenyl phosphate	Metabolite of TPP
TBP	**Tri-n-butyl phosphate**	**Flame retardant, plasticizer**
DBP	Dibutyl phosphate	Metabolite of TBP
TBEP	**Tri(2-butoxyethyl) phosphate**	**Flame retardant, plasticizer**
BBOEP	Bis(2-butoxyethyl) phosphate	Metabolite of TBEP
Bisphenols		**Plastics, epoxy resins, dyes, additives**
BPA	Bisphenol A	
BPS	Bisphenol S	
4,4-BPF	4,4-Bisphenol F	

Determinants & models

3 models used	Base socio-demographic determinants	Additional social-demographic determinants *
• Ordinal regression model with base determinants • Log linear models with base + additional determinant • Log linear models with base + additional + food consumption determinants	• Age • Gender • Participant/maternal birth country income level • Parental education levels • Latitude and longitude of home address	• Drinking water source • Weekday and Month of sampling • BMI (IOTF standard for children/adolescents) • Smoking • Snus • Alcohol • Urban/rural living

**Included in log linear models only*

Determinants – Food consumption

- Legumes
- Vegetables
- Root vegetables
- Mushrooms
- Fruits
- Potatoes
- Soft bread
- Hard bread
- Rice
- Pasta
- Cornflakes
- Nuts & seeds
- Red meat
- Processed meat
- Poultry
- Fish
- Seafood
- Eggs
- Vegetarian alternatives
- Milk/ Filmjölk/ Yoghurt
- Cream
- Cheese
- Margarine
- Butter
- Drinks
- Coffee & tea
- Ice-cream
- Chocolate
- Sweets
- Snacks
- Pastries
- Hamburgers
- Pizza
- Soup

Results

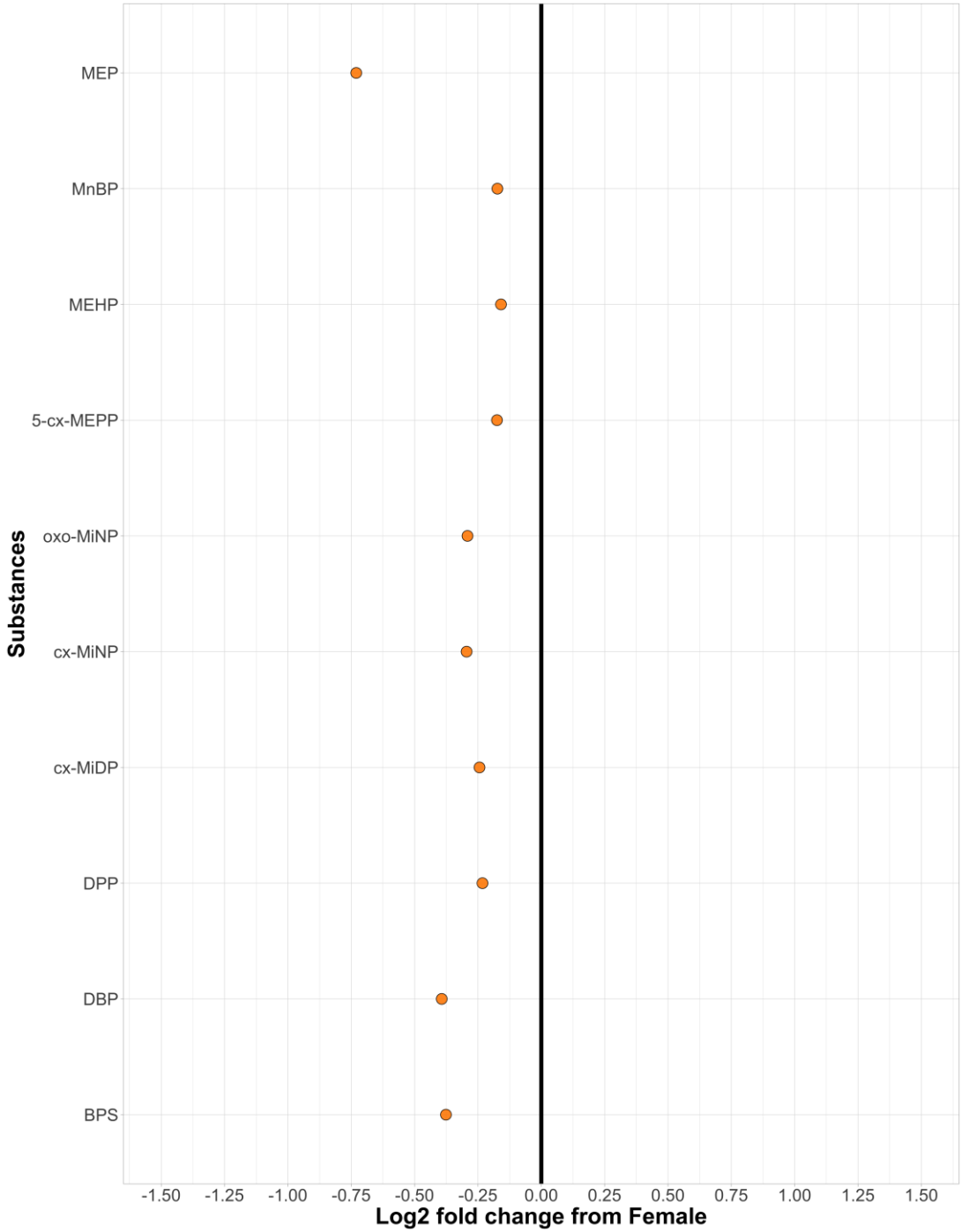
Gender

Adjusted for base determinants

The black line represents female participants. Points are male participants fold-change of adjusted mean concentrations.

On log_2 scale. Therefore;

log_2 0.5 = 1.4-fold	log_2 1 = 2-fold	log_2 1.5 = 2.8-fold



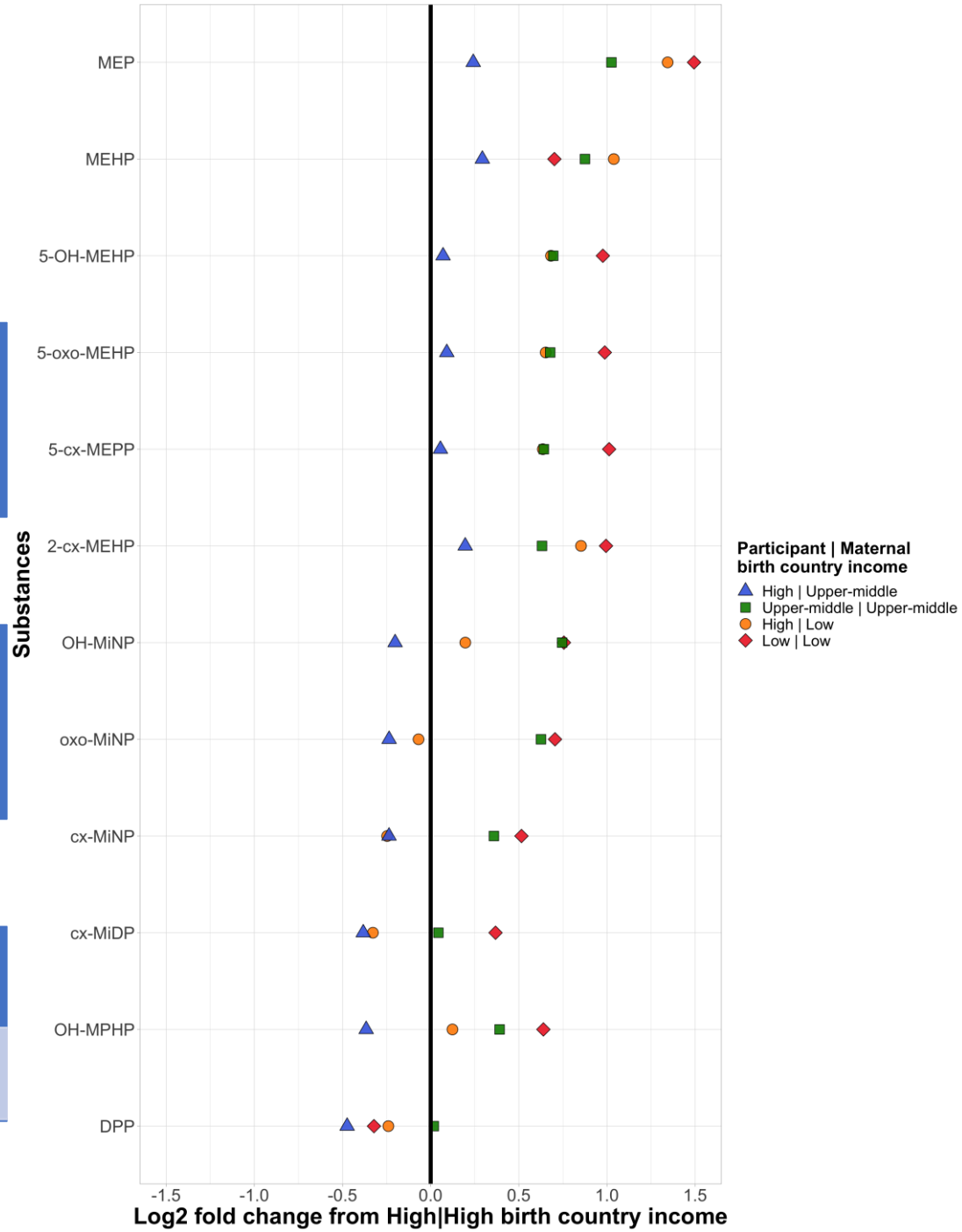
Birth country income level

Adjusted for base determinants

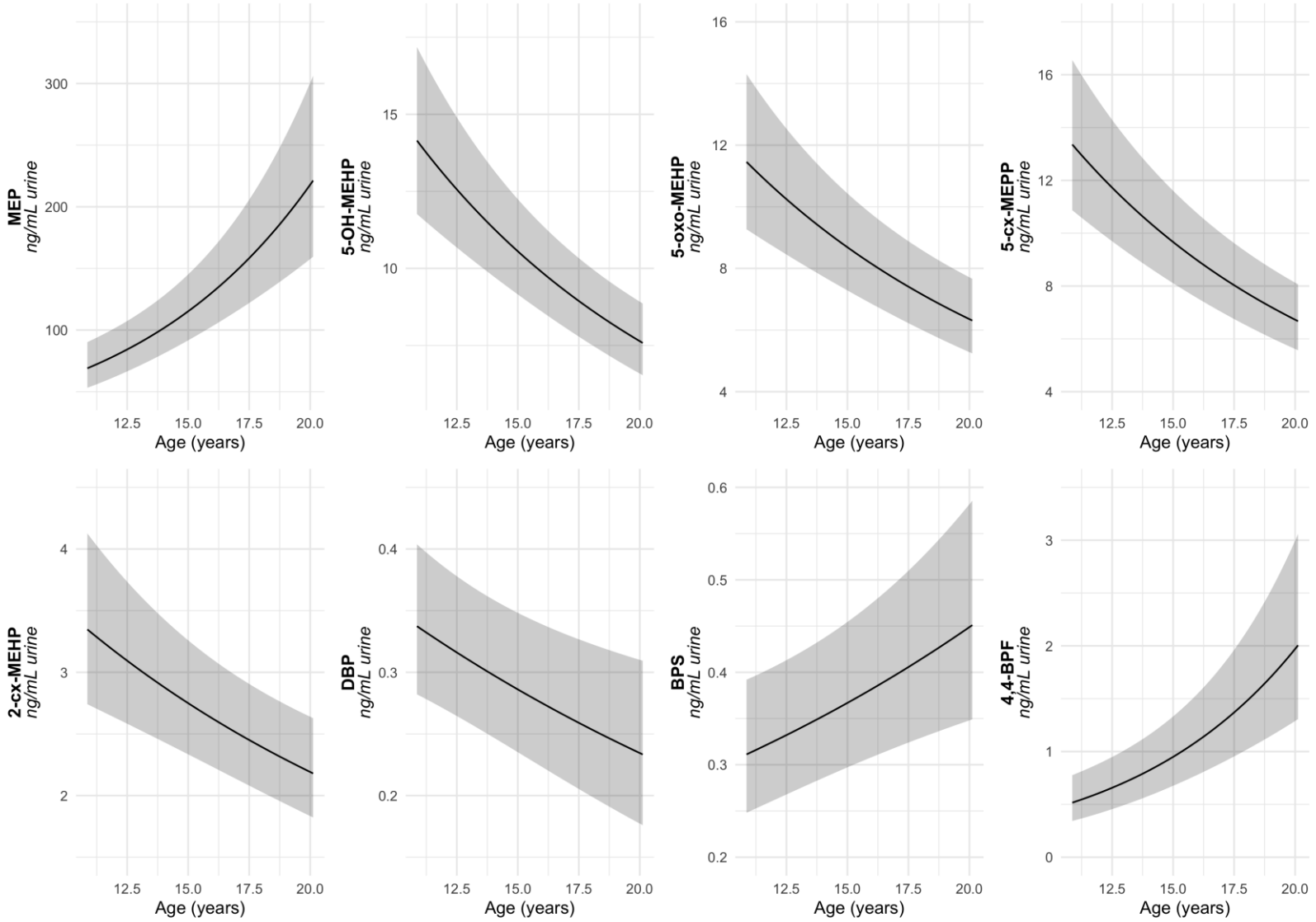
The black line represents participants born in a high-income country | with a mother born in a high-income country.

On log_2 scale. Therefore;

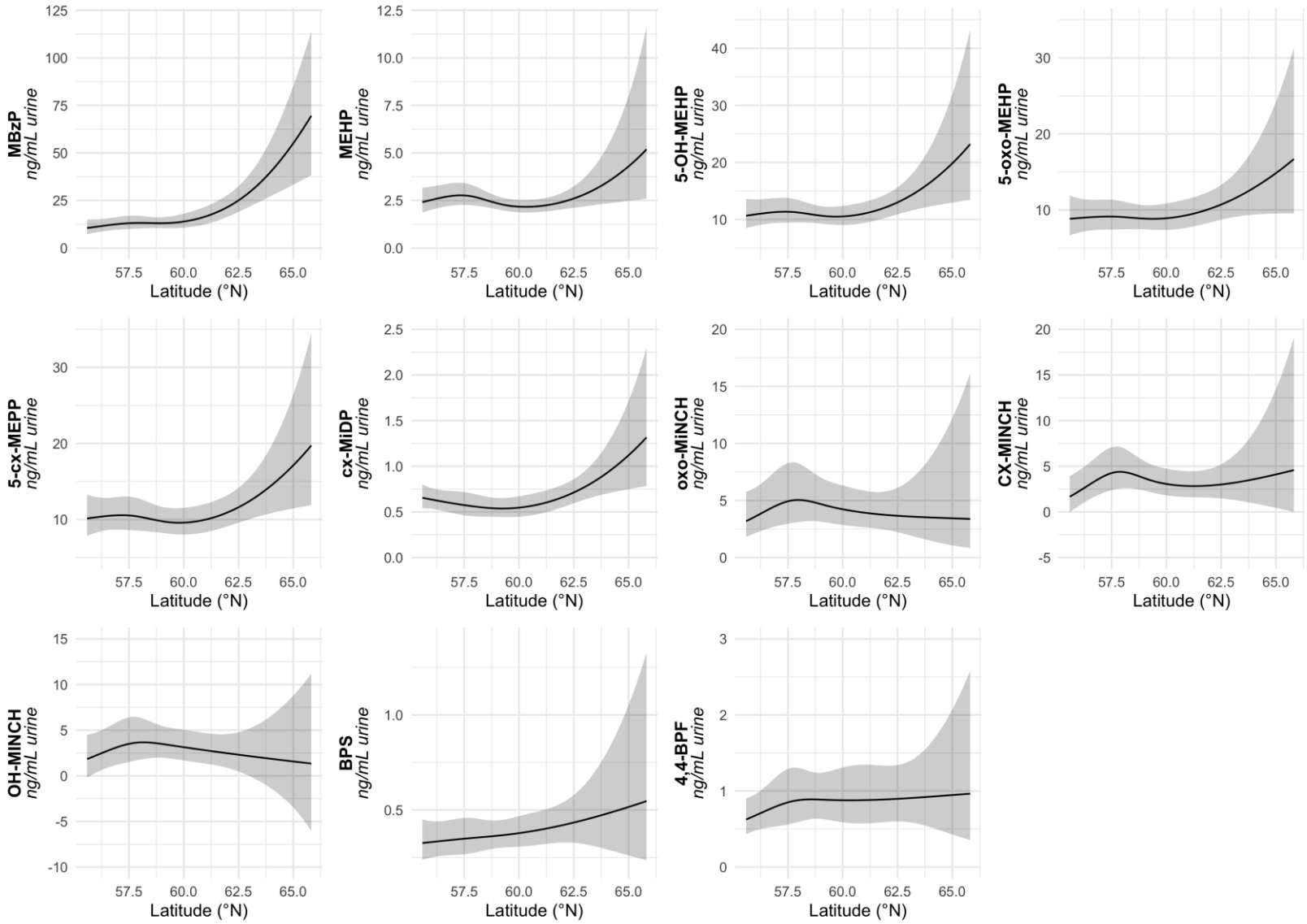
log_2 0.5 = 1.4-fold	log_2 1 = 2-fold	log_2 1.5 = 2.8-fold



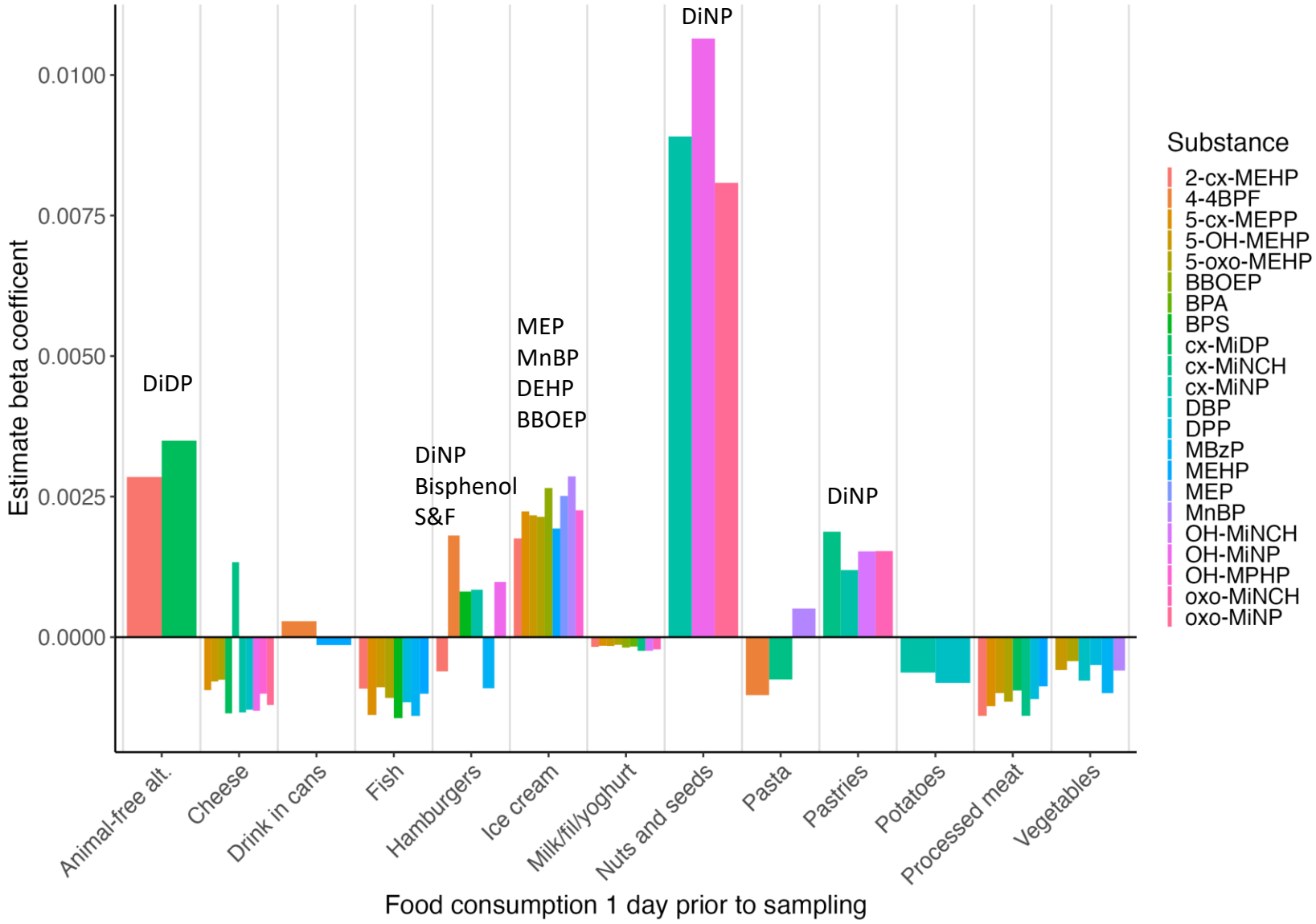
Age


MEP
ng/mL urine
300
200
100
5-OH-MEHP
ng/mL urine
15
10
5-oxo-MEHP
ng/mL urine
16
12
8
4
5-cx-MEPP
ng/mL urine
16
12
8
4
2-cx-MEHP
ng/mL urine
4
3
2
DBP
ng/mL urine
0.4
0.3
0.2
BPS
ng/mL urine
0.6
0.5
0.4
0.3
0.2
4,4-BPF
ng/mL urine
3
2
1
0
12.5
15.0
17.5
20.0
Age (years)

Latitude


MBzP
ng/mL urine
125
100
75
50
25
0
MEHP
ng/mL urine
12.5
10.0
7.5
5.0
2.5
0.0
5-OH-MEHP
ng/mL urine
40
30
20
10
5-oxo-MEHP
ng/mL urine
30
20
10
5-cx-MEPP
ng/mL urine
30
20
10
cx-MiDP
ng/mL urine
2.5
2.0
1.5
1.0
0.5
0.0
oxo-MiNCH
ng/mL urine
20
15
10
5
0
CX-MINCH
ng/mL urine
20
15
10
5
0
-5
OH-MINCH
ng/mL urine
15
10
5
0
-5
-10
BPS
ng/mL urine
1.0
0.5
4,4-BPF
ng/mL urine
3
2
1
0
57.5
60.0
62.5
65.0
Latitude (°N)

Food consumption results

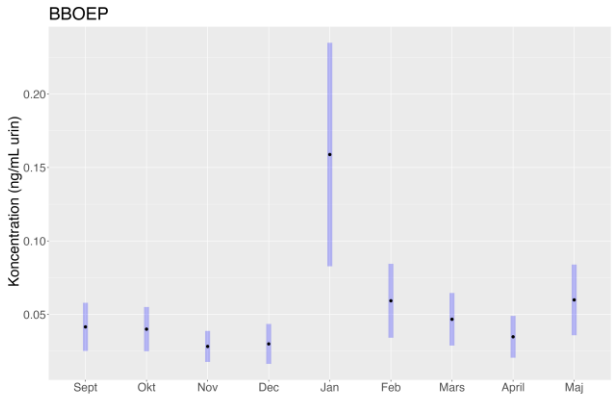


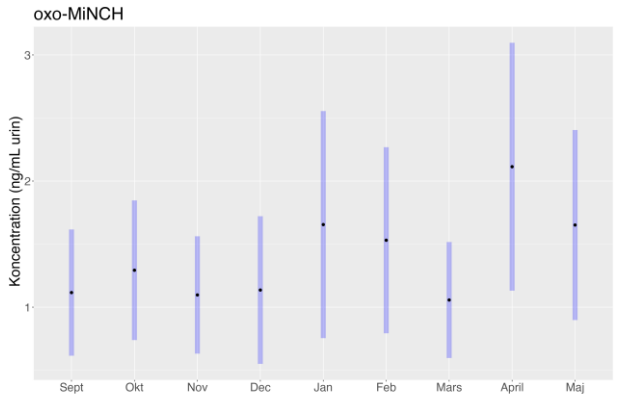
Sampling months

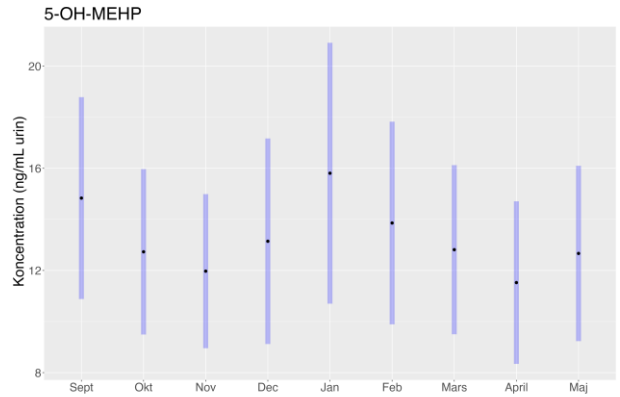
DiNCH

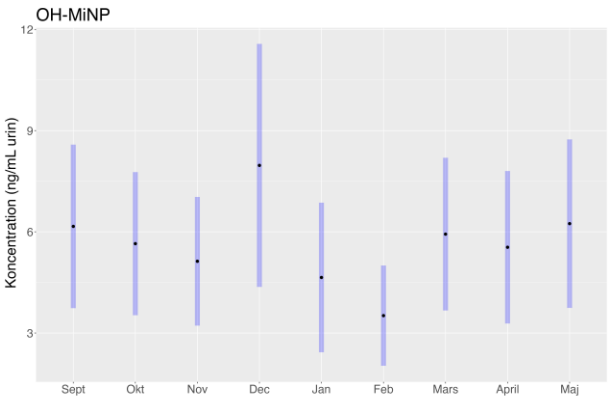
DEHP

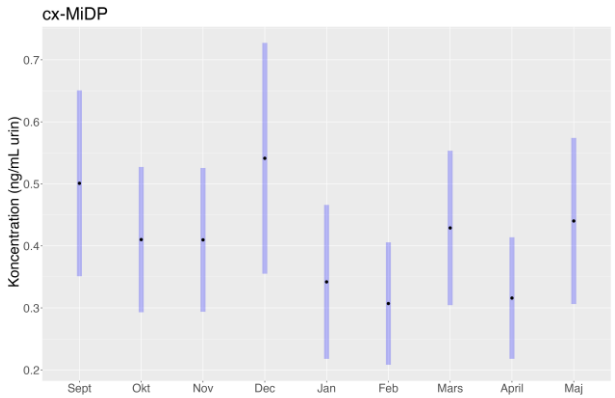
DiNP

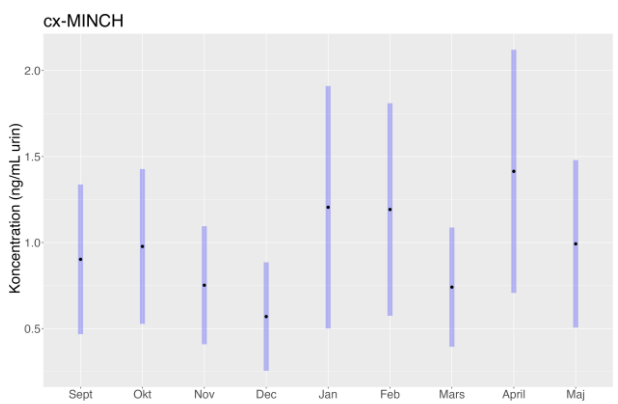


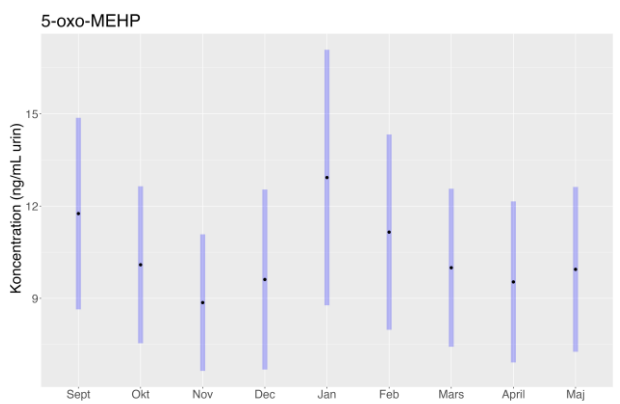


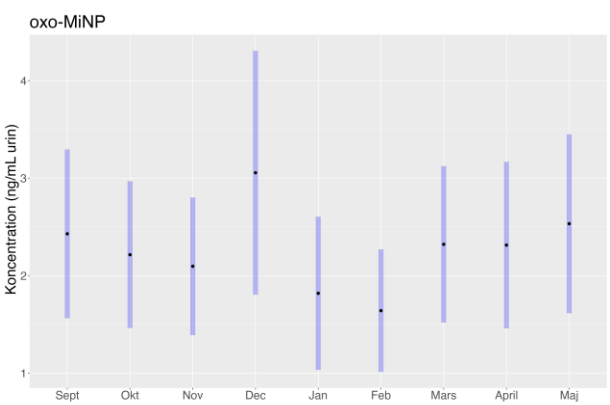


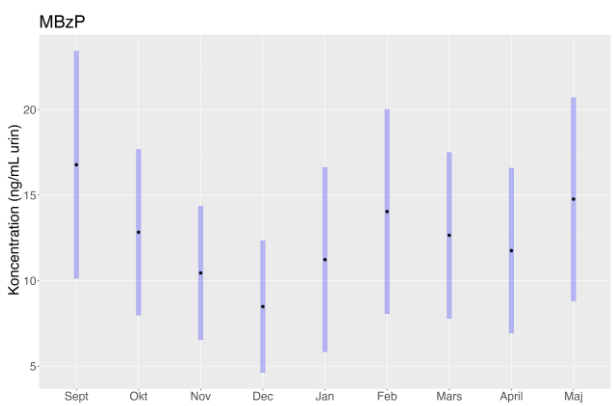


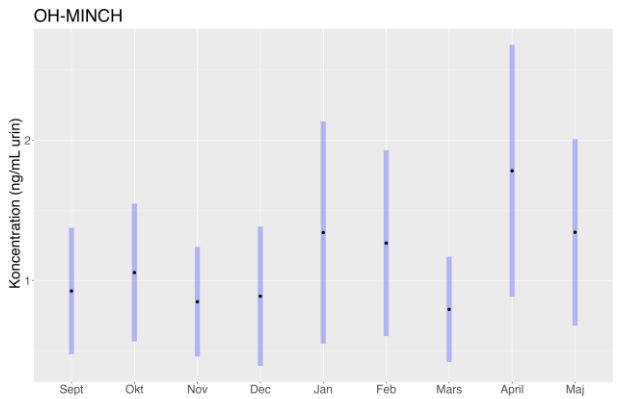


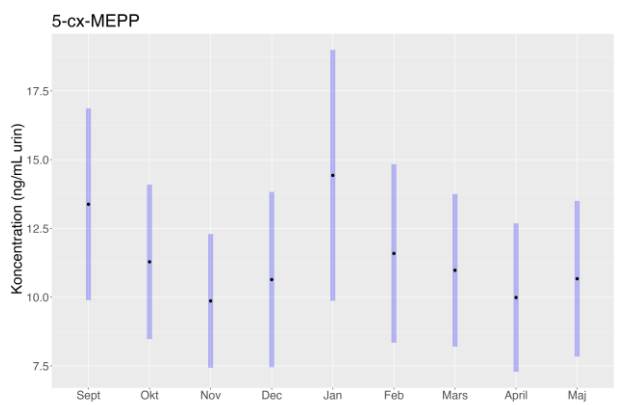


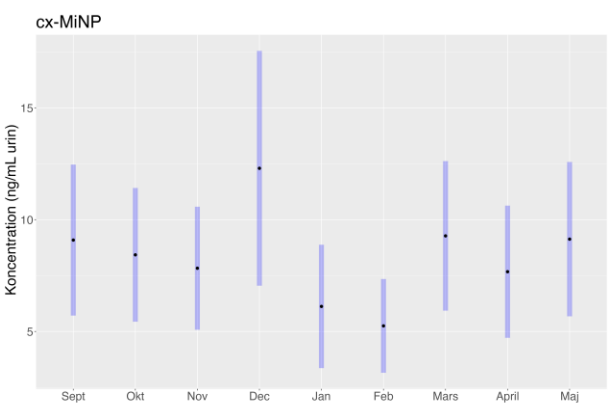








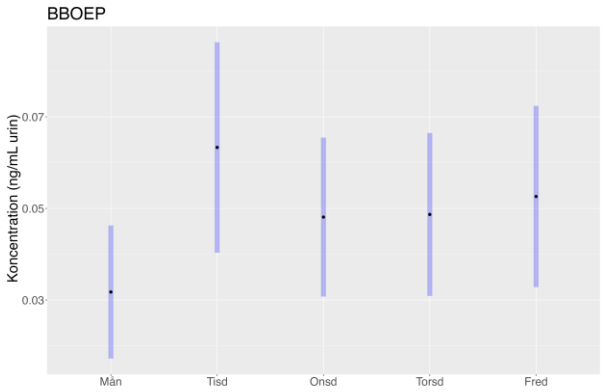


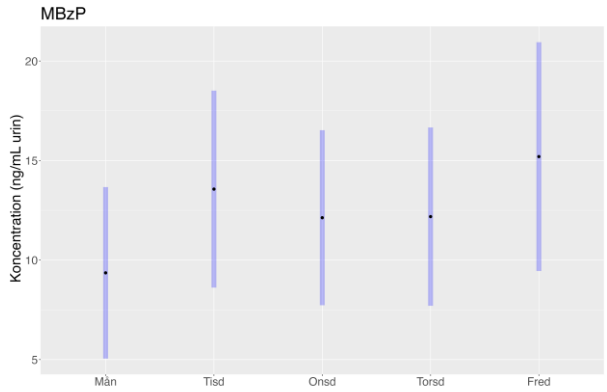


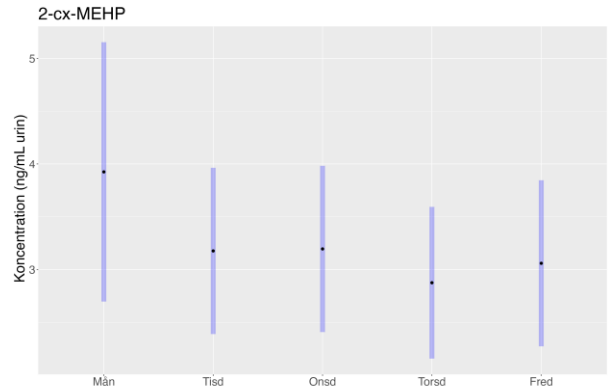
Sampling days

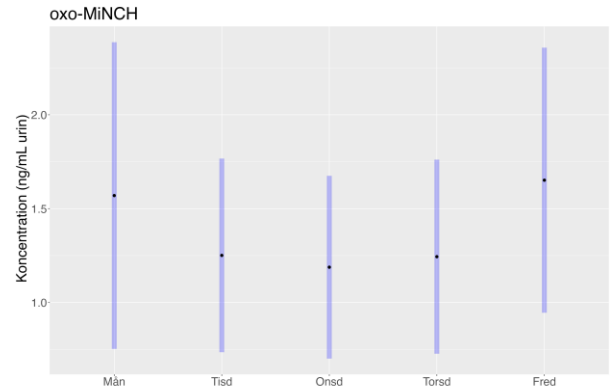
DEHP

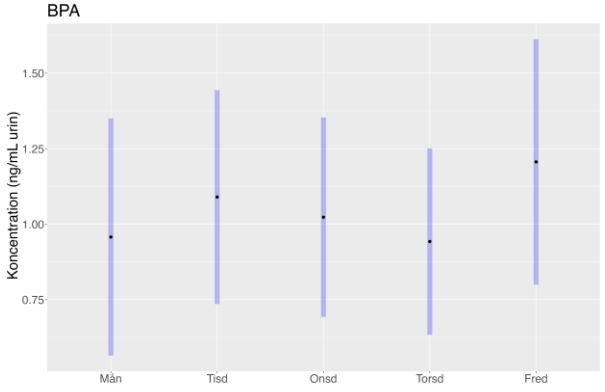
DiNCH

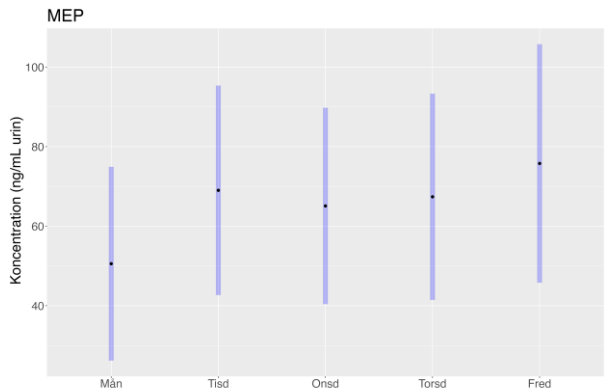


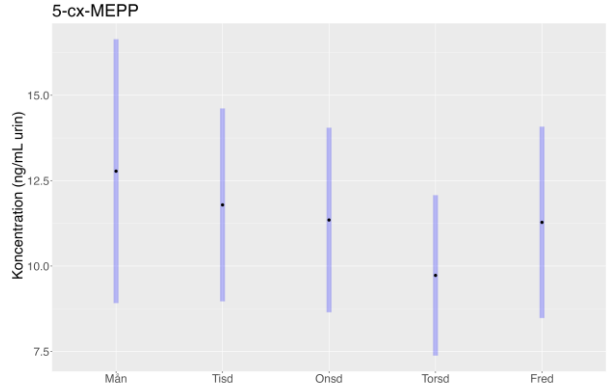


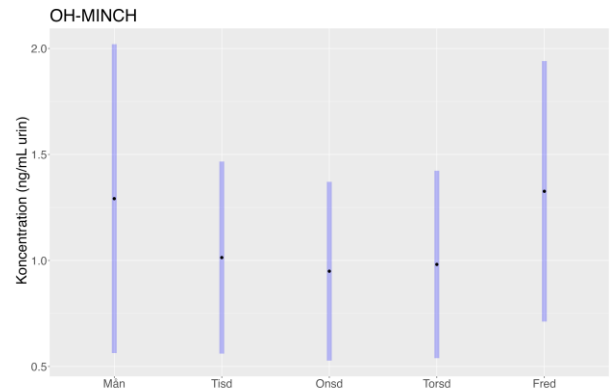


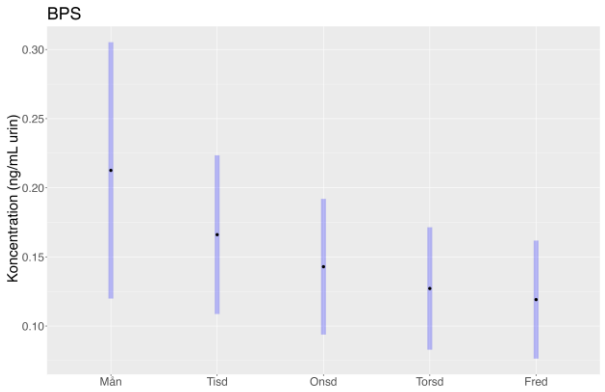


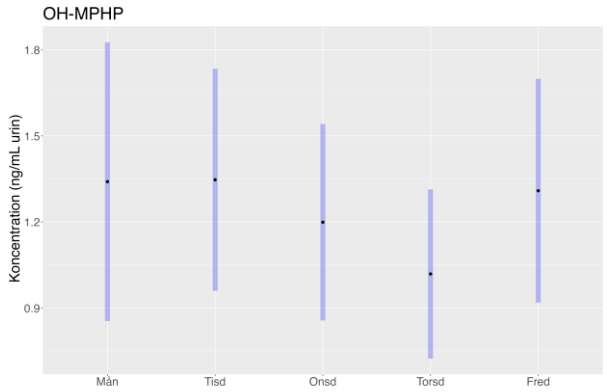


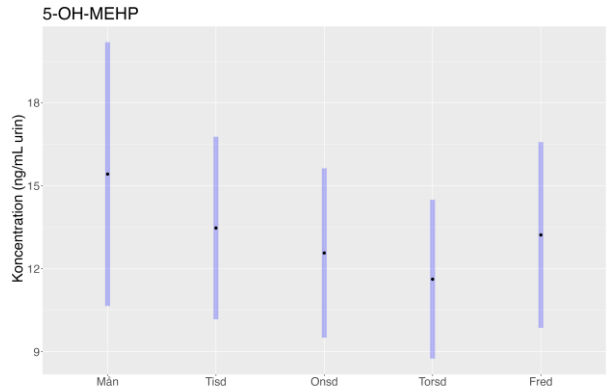


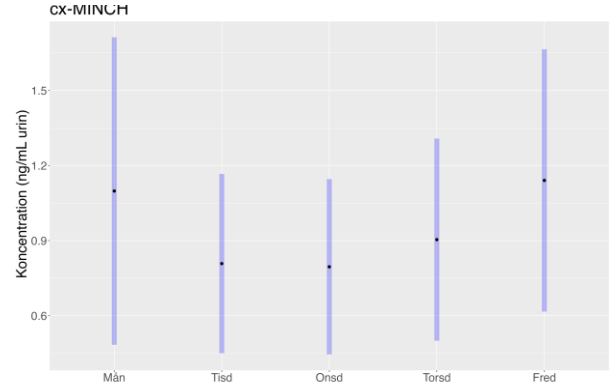












Conclusions

Participants born in low-income countries with mothers born in low-income countries tended to have higher concentrations than those from high income-countries
Female participants had higher concentrations than males across all significant associated substances
Generally, most substances with significant latitude trends showed higher concentrations in the northern part of the country compared to the south
Certain substances from plastics have significant and positive associations with animal-free alternative foods, hamburgers, ice-cream, nuts & seeds and pastries
Sampling days and months show that some substances from plastics have seasonal and weekly trends that should be investigated further

Where can I read more?

First paper ->

Second paper soon submitted for publication (ORM looking at base social-demographic associations)

Report on substances in urine looking at food associations (Swedish only) ->

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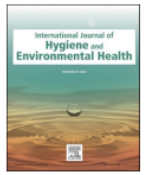

Exposure of Swedish adolescents to elements, persistent organic pollutants (POPs), and rapidly excreted substances – The Riksmaten adolescents 2016-17 national survey

Sebastian Pineda [a,*], Sanna Lignell [b], Irina Gyllenhammar [b], Erik Lampa [c], Jonathan P. Benskin [d], Thomas Lundh [e], Christian Lindh [e], Hannu Kiviranta [f], Anders Glynn [a]

https://naturvardsverket.diva-portal.org/smash/get/diva2:1787123/FULLTEXT01.pdf

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