Organic pollutants in urine 2014 and levels of bisphenol A 2009 and 2014 in the adult population of Northern Sweden

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Summary

It is important to monitor levels of organic compounds in the population for risk assessment.

In the northern Sweden MONICA Study 2014, urine was sampled from women (n=67 aged 25-35 years and n=86 aged 50-60 years) and men (n=75 aged 25-35 years) and analyzed for pesticide metabolites (3-phenoxybenzoic acid and trichloropyridinol), alkylphenols (bisphenol A, bisphenol F, triclosan), 1-hydroxypyrene and ten phthalate metabolites. Correlations between concentrations and lifestyle, mainly dietary factors, were investigated. Concentrations of these compounds in young men and women in northern Sweden were compared with data from high school students in southern Sweden (Skåne). For bisphenol A, concentrations were compared with data from the MONICA study in 2009 (n=243).

Concentrations of bisphenol A were approximately halved in the northern Sweden population from 2009 until 2014. It was higher in those eating canned food more than once a week than in others. The phthalate metabolite mono-benzyl phthalate (MBzP) was higher in those having plastic floor in the bedroom than in others. Several phthalate metabolites were higher in northern Sweden compared to in the south, especially MBzP, whilst triclosan and the phthalate metabolite mono-ethyl phthalate (MEP) appeared to be higher in southern Sweden.

The reason of higher concentrations of many phthalate metabolites in northern compared to southern Sweden need to be investigated further.

Introduction

We are exposed to numerous chemical substances in our everyday life. The use changes over time. New chemicals are introduced and while some substances remain in use, others are phased out or replaced. When health effects are documented or suspected for a substance, a modified substance often replaces the old one in products. Information on human burdens of chemical substances are important for risk assessment. Correlations with lifestyle factors are of interest for efforts to limit exposure and for identification of groups with high risk of harmful exposure levels. In the Northern Sweden MONICA Study 2014 16 organic pollutants were determined in urine from a subsample of the study population (n=232). These pollutants were: two pesticide metabolites, bisphenol A and F, triclosan, 1-hydroxypyrene, and 10 different phthalate metabolites.

Pesticides are used to improve harvest and are often controlled by legal restrictions. Monitoring of human levels are important to see the effect of regulations. Here a metabolite of the pesticide chlorpyrifos, trichloropyridinol (TCP), and a general pyrethroid metabolite, 3-phenoxybenzoic acid (PBA), were measured (van Wendel de Joode et al. 2012, Elfman et al. 2009).

The alkylphenol bisphenol A cause much concern and has been highlighted in media and politics because it was identified as an endocrine disrupter (Srivastava et al. 2015) found in plastics in for example feeding bottles for infants. Bisphenol A is used in the production of many other plastics, as well as in paper used for example for receipts and in plastic inner lining of food cans. The media attention caused new regulations in some countries and created a market for bisphenol A-free products. As a consequence, bisphenol A may be replaced by similar but less investigated alkylphenols, such as bisphenol F. In addition to the data from the 2014 MONICA Study, bisphenol A was monitored in urine from the 2009 MONICA Study (n=243), enabling a study of changes over a five year period in the northern Sweden population.

Triclosan, another alkylphenol, is antibacterial and used in for example soaps and toothpaste. In Sweden, many stores have stopped selling triclosan-containing toothpaste after triclosan was identified as an endocrine disruptor (Wolff et al. 2010). There are also studies indicating effects on the immune system (Clayton et al. 2011).

Hydroxypyrene (1-HP) is a metabolite of the polycyclic aromatic hydrocarbon (PAH) pyrene (Jongeneelen et al. 2001). PAHs originate from pyrolytic processes, e.g. in combustion (diesel engines, coal combustion) and in food processing at high temperature.

Phthalates are a group of chemical substances used to make some plastics (e.g. PVC) softer and also in some skin care products (Jönsson et al. 2005). Endocrine disrupting effects of phthalates have been demonstrated in animal studies at high exposure levels (Foster et al 2001). Epidemiological studies on humans have found associations with endocrine-related outcomes at low exposure levels in the normal population (Swan et al. 2005, Bornehag et al. 2015, Jönsson et al. 2005).

The organic compounds studied in this report have previously been determined in urine samples from high school students in southern Sweden (Jönsson et al. 2014) and the levels in the younger age group (25-35 years) in the Northern Sweden MONICA Study are compared with high school students (about 18 years) in Skåne to learn about geographical variation.

The aim of this study was to monitor levels of some organic compounds in the population of northern Sweden, and to evaluate associations with lifestyle factors of potential importance for these levels. We also aimed to compare levels in northern and southern Sweden, and for bisphenol A, changes since 2009 were studied.

Materials and Methods

Study population

The Northern Sweden MONICA (multinational monitoring of trends and determinants in cardiovascular disease) Study was initially a part of a WHO multicenter study that started in the middle of the 80ties. Sampling in the two most northern counties of Sweden, Norr- and Västerbotten, with a population of around 500,000 has continued every fourth or fifth year and the latest survey was performed in 2014. Each survey year 2000 or 2500 randomly selected participants aged 25-75 years (upper limit 65 years in 1986 and 1990) were invited to participate in the survey which consisted of a medical examination with focus on cardiovascular disease and a life-style questionnaire (Stegmayr et al. 2003).

In the MONICA survey 2009 and 2014 urine was sampled from a sub-cohort of participants in the age groups 25-35 years and 50-60 years, with the goal to measure environmental pollutants (2009 n=243, 2014 n=228). In 2009 men and women from both age groups were included but in 2014 men and women were included in the younger age group but only women were included in the older age group.

Total participation rate 1990, 1994 and 1999 was 79.2, 76.8 and 72.9%, respectively. The participation rate was 76.2% in 2004, 69.2% in 2009 (Eriksson et al. 2011) and 62.5 in 2014.

The study was approved by the Ethical Review Board in Umeå.

Sampling of urine

Morning urine was sampled by the study participants in their homes. A package containing an acid washed paper cup in a plastic bag and two polypropylene tubes with screw caps (Sahrstedt 13 ml no. 60.540.014) were sent by mail to the participants along with an instruction for the sampling. The instruction was to urinate the first morning urine directly into the paper cup without touching the inside of the cup, then press the sides of the cup slightly to form a lip for pouring, and fill the two tubes by pouring the urine directly into them. The tubes were screw-capped, put into a plastic bag and brought to the examination site on the same day. The urine samples were kept cool (about +4ºC) in a refrigerator at the examination site until shipment to the laboratory. Shipment was done once a week.

Chemical analysis

All environmental contaminants were analyzed by the method described by Bornehag et al. 2015. Aliquots of urine were added with ammonium acetate and glucoronidase (E-coli) to remove glucoronide conjugation. Then, a water-acetonitrile solution of labelled (^{3}H or ^{13}C) internal standards of all analyzed compounds were added. The samples were analyzed without any further workup by liquid chromatograph tandem mass spectrometry. To reduce the interferences of contaminants in the mobile phase a C18 column was used prior to the injector. The samples were analyzed on a Shimadzu UFLC system (Shimadzu Corporation, Kyoto, Japan) coupled to a QTRAP5500 triple quadrupole linear ion trap mass spectrometer equipped with a TurboIon Spray source (AB Sciex, Foster City, CA, USA). The samples were analyzed in triplicates and the mean of the two closest for each compound were reported. All samples were analyzed in a randomized order. For quality control of the analyses, four chemical blanks and an in-house prepared quality control (QC) sample were analyzed two times in all sample batches. The limit of detection (LOD) was defined as the concentration corresponding to a peak area ratio of three times the standard deviation of the chemical blanks. The precision was determined as the coefficient of variation (CV) in the concentrations found in the QC sample in all analyzed batches. The creatinine concentrations were analyzed according to an enzymatic method described by Mazzachi et al. (2000).

Accuracy

The laboratory at Lund University is a reference laboratory for analyses of urinary phthalate and BPA metabolites in a European biomonitoring project (www.eu-hbm.info/cophes). Moreover, the laboratory is part of the Erlangen Round Robin interlaboratory comparison program for phthalate metabolites, bisphenol A, 1-HP, 3PBA and TCP with results within the tolerance limits.

Lifestyle variables

From the questionnaire, we selected those lifestyle factors for which a hypothesis could be formulated about an association with one or several organic compounds. We tested for associations between all these lifestyle factors and all analyzed substances.

Current cigarette smoking were asked for with the answer alternatives “yes, regularly (at least one cigarette a day)”, “no”, or “sometimes (less than one cigarette a day)”. Those not reporting being current daily smokers were asked for previous smoking with the question “Did you ever smoke regularly?” with answer alternatives “yes, regularly” or “no”. In this study, participants were categorized as current smokers, ex-smokers or never smokers.

The questionnaire included an 85 item food frequency questionnaire (FFQ) (84 items in the 2009 FFQ, excluding egg consumption). Frequency of the consumption of the food items were asked for the last year with an increasing nine-level scale ranging from never to four or more times a day (Johansson et al. 2002). Intake frequencies per day of different vegetables (white cabbage, root vegetables, tomatoes/cucumber, lettuce, spinach/borecole, frozen vegetables), fruits (berries, apples/pears/peaches, citrus fruit, bananas) and potatoe products (boiled/baked, fried, pommes frites, mashed, potatoe salad) were computed to summary variables.

Bisphenol A: In the 2014 MONICA main questionnaire the question “How often do you eat canned food?” was added with the purpose to find out if consumption of canned food is associated to the bisphenol A concentrations in urine. The answer alternatives were: every day, every second day, a couple of times a week, once a week and more seldom than once a week. In the analysis the answers were merged to the alternatives more than once a week, once a week and less than once a week.

Phthalates: Questions were also added with the purpose to examine associations between levels of phthalates and type of floor in bedrooms and also age of the bedroom floor. The questions asked were: “What type of floor do you have in the bedroom?” with the answer alternatives wood, plastic, broadloom, linoleum, laminate, stone/ brick; and “How old is the floor in your bedroom?” with the answer alternatives less than 5 years, 5-15 years, 16-30 years and more than 30 years. In the analysis participants with a floor less than 5 years old was compared to those with older floors.

Adjustment for urinary dilution

All the urinary concentrations were density adjusted to a specific gravity (1.016 g/ml) in order to adjust for variation in urinary dilution using the formula $U_{adjusted} = U_{observed}$ x [(1.016-1)/ dens-1]. Creatinine-adjusted concentrations were also calculated but were not used in the statistical analyses, as creatinine-adjusted levels are not comparable between men and women, because of difference in creatinine levels between the sexes. To enable comparisons with other studies both density- and creatinine-adjusted levels are presented, though without statistical evaluation of differences in creatinine-adjusted results.

Statistical analyses

Median density-adjusted concentrations of all organic pollutants in urine were tabulated. Comparisons between groups were evaluated using Mann-Whitney non-parametric t-test because levels were not normally distributed.

Spearman correlations were analyzed between density-adjusted levels of organic pollutants and lifestyle factors of relevance. This non-parametric method was also chosen because of the non-normal distributions.

SPSS for Windows (version 22 SPSS Inc., Chicago. IL, USA) was used for statistical analyses.

A file with concentrations of all analyzed organic compounds in urine and background data (sex, age, smoking habits), from participants in MONICA 2014, has been delivered to the host of health related environmental monitoring data.

Results

There were few differences between young men and women in density-adjusted levels of organic pollutants; only the pesticide metabolite PBA and the phthalate metabolite MEP were higher in young women (Table 1a and Table 2a). The median concentrations were: PBA men: 0.21 vs. women: 0.26 ng/ml; MEP men: 25.1 vs. women: 37.2 ng/ml. When comparing older and younger women, hydroxypyrene (Table 1a) and most of the phthalate metabolites (Table 2a) were higher in young women compared to older women.

Comparison of bisphenol A in urine from 2009 and 2014 revealed a decrease with approximately 50% in all three gender- and age groups (Table 3). Those reporting consumption of canned food more than once a week had statistically significantly higher level of bisfenol A but not of bisfenol F compared to those with lower consumption (Table 4).

Having plastic floor in the bedroom was associated with the phthalate metabolite MBzP (Figure 1) but not with any other phthalate metabolites (Table 5). No associations were found between any organic compounds and age of the bedroom floor (data not shown).

There were some further statistically significant positive correlations between organic pollutants and life style factors examined (Table 5). The pesticide metabolite PBA correlated with consumption of vegetables and the pesticide metabolite TCP with consumption of wine. Triclosan was also correlated to consumption of wine. None of these three correlated with fruit consumption. 1-HP was the only examined organic pollutant correlated to smoking. The phthalate metabolite MEP correlated with consumption of canned food and wine. Interestingly, consumption of lean fish correlated negatively with many of the phthalate metabolites. Consumption of meat or egg did not correlated with any of the organic pollutants (data not shown). Young women had a higher reported intake frequency of vegetables than men (1.3 times/day and 1.0 times/day respectively), and women from the oldest age group had the highest vegetable intake (1.8 times/day).

Median concentrations of the organic pollutants in young men and young women in northern Sweden (25-35 years) were compared with medians in young men and women (approx. 18 years) in southern Sweden (Jönsson et al. 2014) (Table 6). For pesticide metabolites and many of the phthalate metabolites medians were higher in northern Sweden compared to southern Sweden. The difference was largest for MBzP, with approximately four times as high concentrations in the northern vs. southern Sweden study. Limited to those in the northern Swedish study who did not have plastic floor in bedroom, concentrations of MBzP was still more than twice as high (11.8 ng/ml in women and 15.2 ng/ml in men) as in the young in southern Sweden. On the contrary, median triclosan and the phthalate metabolite MEP were higher in southern Sweden. No statistical analysis of regional differences were done, as only medians were used for this comparison.

Discussion

Main findings

The bisphenol A concentration in urine has been approximately halved in the northern Sweden population between 2009 and 2014. No time trends can be studied for the other investigated substances. As to geographical differences, a comparison with southern Sweden suggests that the concentrations of two phthalate metabolites (MnBP and MBzP, originating from phtalates used as softeners in plastic products), and PBA (a pesticide metabolite) may be higher in northern Sweden than in southern Sweden, while the opposite appears to be the case for triclosan.

Time trend of bisphenol A

The observation of a decrease over time in bisphenol A is in accordance with findings in southern Sweden, where bisphenol A concentrations were measured in urine from young men 2010 and 2013 (Jönsson et al. 2014). A decrease in consumption of canned foods may be the reason, as cans have been replaced to a considerable extent by other food containers.

Sex differences

Higher concentrations of the pesticide metabolite PBA in young women compared to young men could be speculated to be caused by the higher intake of vegetables in women in the MONICA Study, as this metabolite was correlated to consumption of vegetables. However, older women did not have higher levels of PBA compared to young, despite even higher reported intake of vegetables than young women, which contradicts this as explanation.

Differences between northern and southern Sweden

Higher concentrations of the phthalate metabolites MBzP and MnBP in northern Sweden were also found in a comparison between women and children in a rural northern area (Kågedalen, Västerbotten) and an urban area (Uppsala) in central Sweden. This was thought to be caused by higher presence of PVC in floors and wall coverings, which was asked for in that study (Larsson et al. 2014). It can be questioned if that really is sufficient to explain the rather large difference here observed, with northern Sweden concentrations that are four times as high compared to a southern Sweden study. Even if we only include the MONICA participants that report non-plastic floor in their bedroom, the median concentrations of MBzP are more than twice as high in the northern compared to the southern Sweden study. A previous Swedish study of pollutants in breast milk (Glynn et al. 2011) indicated higher exposure to flame retardants in northern compared to southern Sweden. It can be speculated that climate, e.g. dryness of indoor air or more use of heating systems (including underfloor heating), may influence exposure to chemicals in indoor environments, possibly leading to a higher exposure to some substances in areas with cold winter climate.

Higher concentrations of PBA was found in young men and women in northern Sweden compared to in southern Sweden. For this substance we can also compare middle-aged women because pesticides were studied in women in Skåne aged 43-60 years in 2010. That study did not report lower concentrations of PBA compared to the older age group of women in northern Sweden (density adjusted median for PBA 0.27 ng/ml in Skåne compared to 0.23 ng/ml in northern Sweden) (Littorin et al. 2013).

A likely explanation of higher concentration of triclosan in southern Sweden is that toothpaste, and possibly also other products, containing triclosan are more frequently sold in Denmark, geographically close to southern Sweden.

The concentrations of the pesticide metabolite TCP, the PAH-marker 1-HP, the epoxy precursors bisphenol A and F, and other measured phthalate metabolites did not show any large discrepancies between young men and women in southern and northern Sweden in this simple analysis, but a more elaborate data analysis would be necessary to detect moderate differences.

Correlations with lifestyle factors

Some expected associations appeared between concentrations and e.g. food consumption and product use, for example was bisphenol A higher in persons frequently consuming canned food, the phthalate metabolite MBzP was higher in persons with plastic floor in their bedroom, smokers had higher 1-HP concentrations than non-smokers, and the concentration of pesticide metabolites was related to consumption of vegetables (PBA) and wine (TCP). Several phthalate metabolites showed higher concentrations among persons with low consumption of lean fish – an association that is difficult to explain. Some of these substances have previously been shown to correlate to intake of chocolate and icecream (Larsson et al. 2014), food items that are not considered very healthy. Possibly, lean fish consumption could be a marker for a relatively healthy food pattern with low content of these substances.

Conclusions

We conclude that exposure to bisphenol A has decreased with approximately 50% from 2009 to 2014 in northern Sweden. There is a large geographic difference in exposure to the phthalates MBzP and MnBP, with maybe a fourfold higher exposure in northern than in southern Sweden. The reasons are probably to be found in indoor exposure from plastic floors and other products, possibly with human exposure being modified by e.g. cold climate. Firm conclusions can however not be made now.

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Tables

Table 1a. Median density-adjusted concentrations (ng/ml) of PBA, TCP, triclosan, 1-HP and alkylphenoles in urine in men and women in northern Sweden 2014.

	Men age 25-35 years (n=75)		Women age 25-35 years (n=67)		Women age 50-64 years (n=86)	
	Median (max)	25th, 75th percentile	Median (max)	25th, 75th percentile	Median (max)	25th, 75th percentile
PBA	0.21 (2.82)*	0.11, 0.30	0.26 (2.10)*	0.15, 0.44	0.23 (1.09)	0.13, 0.33
TCP	0.95 (9.91)	0.65, 1.60	1.18 (6.38)	0.70, 2.43	0.94 (16.5)	0.58, 1.63
Triclosan	0.23 (30.2)	0.12, 0.70	0.22 (680)	0.10, 1.12	0.17 (137)	0.06, 0.48
1-HP	0.07 (0.31)	0.04, 0.12	0.09 (0.25)†	0.05, 0.14	0.06 (0.84)†	0.04, 0.10
Bisphenol A	1.22 (61.7)	0.87, 2.60	1.35 (45.2)	0.88, 2.16	1.03 (23.5)	0.74, 1.94
Bisphenol F	0.14 (8.63)	0.06, 0.42	0.17 (8.21)	0.08, 0.47	0.12 (20.6)	0.06, 0.48

PBA, 3-phenoxynenzoic acid; TCP, trichloropyridinol; 1-HP, 1-hydroxypyrene

*Statistically significant differences between young men and young women

†Statistically significant differences between younger and older women

Table 1b. Median concentrations adjusted for creatinine (nmol/mmol creatinine) of PBA, TCP, triclosan, 1-HP and alkylphenoles in urine in men and women in northern Sweden 2014. Data are presented for comparability with other studies. No statistical tests for differences are presented, as creatinine excretion systematically differs between men and women.

	Men age 25-35 y (n=75)		Women age 25-35 y (n=67)		Women age 50-64 y (n=86)	
	Median (max)	25th, 75th percentile	Median (max)	25th, 75th percentile	Median (max)	25th, 75th percentile
PBA	0.07 (1.25)	0.04, 0.11	0.10 (1.22)	0.06, 0.16	0.11 (0.53)	0.07, 0.18
TCP	0.41 (4.30)	0.25, 0.61	0.50 (2.30)	0.32, 1.10	0.55 (9.52)	0.32, 0.84
Triclosan	0.07 (10.1)	0.03, 0.20	0.09 (137)	0.03, 0.35	0.07 (63.5)	0.02, 0.20
1-HP	0.03 (0.11)	0.02, 0.04	0.04 (0.10)	0.02, 0.06	0.03 (0.32)	0.02, 0.05
Bisphenol A	0.44 (20.9)	0.29, 0.86	0.53 (16.4)	0.28, 0.73	0.54 (15.5)	0.35, 0.89
Bisphenol F	0.06 (3.21)	0.03, 0.15	0.08 (3.18)	0.04, 0.20	0.06 (18.2)	0.04, 0.34

PBA, 3-phenoxynenzoic acid; TCP, trichloropyridinol; 1-HP, 1-hydroxypyrene

Table 2a. Median density-adjusted concentrations (ng/ml) of ten phthalates in urine in men and women in northern Sweden 2014.

	Men age 25-35 y (n=75)		Women age 25-35 y (n=67)		Women age 50-64 y (n=86)	
	Median	25th, 75th percentile	Median	25th, 75th percentile	Median	25th, 75th percentile
MEP	25.1 (556)*	15.5, 56.7	37.2 (747)*	21.5, 101	52.5 (3136)	21.7, 99.7
MnBP	60.9 (154)	36.1, 85.7	58.0 (345)†	45.9, 112	49.2 (1141)†	34.7, 81.0
MBzP	18.6 (180)	9.72, 33.8	17.9 (179)†	10.0, 32.5	10.3 (58.4)†	5.24, 16.9
MEHP	2.32 (17.8)	1.49, 3.70	2.19 (118)†	1.33, 4.20	1.52 (9.78)†	0.85, 2.13
MEHHP	10.2 (94.8)	8.07, 15.3	10.5 (592)†	7.15, 15.6	9.08 (28.3)†	5.41, 11.5
MEOHP	6.82 (68.2)	4.43, 10.1	7.04 (402)†	4.70, 10.1	5.36 (15.2)†	3.29, 7.70
MECPP	8.40 (78.6)	5.79, 13.4	9.77 (474)†	6.71, 15.6	6.89 (33.7)†	4.84, 10.5
MHiNP	8.87 (407)	5.27, 15.6	9.04 (1784)	5.45, 19.1	6.52 (302)	3.86, 15.0
MOiNP	2.87 (129)	1.77, 5.88	2.75 (1316)†	1.74, 7.04	2.09 (126)†	1.26, 4.99
MCiOP	9.60 (243)	5.10, 19.8	11.7 (1519)	6.85, 27.7	7.84 (323)	5.01, 20.2

MEP, mono-ethyl phthalate; MnBP, mono-n-butan phthalate; MBzP, mono-benzyl phthalate; MEHP, mono-ethylhexyl phthalate; MEHHP, 5-hydroxy-mono-ethylhexylphthalate; MEOHP, 5-oxo-mono-ethylhexyl phthalate; MECPP, 5-carboxy-mono-ethylpentyl phthalate; MHiNP, mono-hydroxy-isononyl phthalate; MOiNP, mono-oxo-isononyl phthalate; MCiOP, mono-carboxy-isooctyl phthalate

*Statistically significant differences between young men and young women

†Statistically significant differences between younger and older women

Table 2b. Median concentrations adjusted for creatinine (nmol/mmol creatinine) of ten phthalates in urine in men and women in northern Sweden 2014. Data are presented for comparability with other studies. No statistical tests for differences are presented, as creatinine excretion systematically differs between men and women.

	Men age 25-35 y (n=75)		Women age 25-35 y (n=67)		Women age 50-64 y (n=86)	
	Median	25th, 75th percentile	Median	25th, 75th percentile	Median	25th, 75th percentile
MEP	10.5 (234)	6.36, 24.0	17.0 (244)	9.96, 47.5	32.0 (1527)	12.4, 61.8
MnBP	19.3 (77.4)	13.9, 31.2	24.8 (223)	16.8, 39.2	24.2 (518)	18.0, 38.8
MBzP	5.50 (38.6)	2.97, 9.50	6.29 (65.6)	3.67, 11.1	4.63 (32.2)	2.31, 6.90
MEHP	0.70 (3.88)	0.40, 1.20	0.72 (40.1)	0.39, 1.32	0.58 (3.75)	0.35, 0.96
MEHHP	2.80 (14.1)	1.95, 3.94	3.07 (191)	2.13, 5.33	3.17 (10.3)	2.26, 4.24
MEOHP	1.76 (10.2)	1.23, 2.79	2.13 (131)	1.43, 3.55	1.96 (6.12)	1.32, 2.87
MECPP	2.07 (12.5)	1.66, 3.35	2.71 (147)	1.90, 4.45	2.58 (9.19)	1.82, 3.66
MHiNP	2.19 (93.9)	1.36, 3.89	2.74 (273)	1.55, 6.71	2.34 (80.7)	1.46, 5.19
MOiNP	0.70 (29.8)	0.20, 12.1	0.84 (202)	0.56, 2.37	0.79 (33.9)	0.44, 1.75
MCiOP	2.39 (59.2)	0.79, 23.4	3.22 (223)	1.83, 8.03	2.96 (82.7)	1.70, 6.74

MEP, mono-ethyl phthalate; MnBP, mono-n-butan phthalate; MBzP, mono-benzyl phthalate; MEHP, mono-ethylhexyl phthalate; MEHHP, 5-hydroxy-mono-ethylhexylphthalate; MEOHP, 5-oxo-mono-ethylhexyl phthalate; MECPP, 5-carboxy-mono-ethylpentyl phthalate; MHiNP, mono-hydroxy-isononyl phthalate; MOiNP, mono-oxo-isononyl phthalate; MCiOP, mono-carboxy-isooctyl phthalate

Table 3. Median density-adjusted concentrations (ng/ml) of bisphenol A in urine 2009 and 2014 in men and women in northern Sweden.

	2009*			2014		
	N	Median	25th, 75th percentile	N	Median	25th, 75th percentile
Men						
25-35 years	66	2.7	2.0, 4.1	75	1.2	0.87, 2.6
Women						
25-35 years	89	3.0	2.0, 4.8	67	1.4	0.88, 2.2
50-64 years	88	2.1	1.3, 4.0	86	1.0	0.74, 1.9

*Reference Lindh et al. 2010

Table 4. Median density-adjusted concentrations (ng/ml) of bisphenol A and bisphenol F in groups with varying intake of canned food in northern Sweden 2014.

	Frequency of consumption of canned food					
	< once a week (n=148)		once a week (n=56)		> once a week (n=27)	
	Median (max)	25th, 75th percentile	Median (max)	25th, 75th percentile	Median (max)	25th, 75th percentile
Bisphenol A	1.22 (61.7)	0.79, 2.03	1.11 (16.8)	0.83, 1.55	2.16 (45.2)*	0.87, 5.41
Bisphenol F	0.15 (8.21)	0.07, 0.49	0.14 (8.63)	0.07, 0.42	0.17 (20.6)	0.05, 0.48

*Statistically significant difference from < once a week (p=0.042)

Table 5. Spearman correlations between density-adjusted levels of organic pollutants and lifestyle factors (positive correlations in bold). Intake frequencies are used for food consumption.

	Smoking	Fish fatty	Fish lean	Shellfish	Potatoes	Vegetables*	Fruits**	Wine	Smoked fish/ meat	Canned food (in/wk)	Plastic floor bedroom
PBA	NS	NS	NS	NS	NS	**Rs=0.14 P=0.034**	NS	NS	NS	NS	NS
TCP	NS	NS	NS	NS	Rs=-0.15 P=0.025	NS	NS	**Rs=0.16 P=0.014**	NS	NS	NS
Triclosan	NS	NS	NS	NS	NS	NS	NS	**Rs=0.15 P=0.023**	NS	NS	NS
1-HP	**Rs=0.23 P<0.001**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Bisphenol A	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Bisphenol F	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	Rs=-0.18 P=0.007
MEP	NS	NS	NS	NS	NS	NS	NS	**Rs=0.13 P=0.043**	NS	**Rs=0.14 P=0.033**	NS
MnBP	NS	NS	Rs=-0.18 P=0.006	NS	NS	Ns	NS	Rs=-0.19 P=0.005	NS	NS	NS

MBzP	NS	NS	NS	NS	NS	Rs=-0.22 P=0.001	Rs=-0.17 P=0.010	Rs=-0.16 P=0.018	NS	NS	**Rs=0.38 P<0.001**
MEHP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MEHHP	NS	Rs=-0.16 P=0.018	Rs=-0.18 P=0.006	NS	NS	NS	NS	NS	NS	NS	NS
MEOHP	NS	NS	Rs=-0.18 P=0.005	NS	NS	NS	NS	NS	NS	NS	NS
MECPP	NS	NS	Rs=-0.22 P=0.001	NS	NS	NS	NS	NS	NS	NS	NS
MHiNP	NS	NS	Rs=-0.14 P=0.028	NS	NS	NS	NS	NS	NS	NS	NS
MOiNP	NS	NS	Rs=-0.17 P=0.010	NS	NS	Rs=-0.13 P=0.050	NS	NS	NS	NS	NS
MCiOP	NS	NS	Rs=-0.17 P=0.009	NS	NS	NS	NS	NS	NS	NS	NS

PBA, 3-phenoxynenzoic acid; TCP, trichloropyridinol; 1-HP, 1-hydroxypyrene; MEP, mono-ethyl phthalate; MnBP, mono-n-butan phthalate; MBzP, mono-benzyl phthalate; MEHP, mono-ethylhexyl phthalate; MEHHP, 5-hydroxy-mono-ethylhexylphthalate; MEOHP, 5-oxo-mono-ethylhexyl phthalate; MECPP, 5-carboxy-mono-ethylpentyl phthalate; MHiNP, mono-hydroxy-isononyl phthalate; MOiNP, mono-oxo-isononyl phthalate; MCiOP, mono-carboxy-isooctyl phthalate

*sum of vegetables, **sum of fruits

Table 6. Median density-adjusted concentrations (ng/ml) of organic pollutants in young men and women (25-35 years) in northern (Norr- and Västerbotten) compared to high school students (about 18 years) in southern Sweden (Skåne).

	Men		Women	
	north	south	north	south
	Median N=75	Median N=97	Median N=67	Median N=107
PBA	0.21	0.11	0.26	0.18
TCP	0.95	0.88	1.18	0.96
Triclosan	0.23	0.64	0.22	0.78
1-HP	0.07	0.06	0.09	0.09
Bisphenol A	1.22	1.18	1.35	1.06
Bisphenol F	0.14	0.11	0.17	0.13
MEP	25.1	30.8	37.2	54.4
MnBP	60.9	28.8	58.0	36.9
MBzP	18.6	3.98	17.9	5.04
MEHP	2.32	1.62	2.19	2.43
MEHHP	10.2	6.48	10.5	8.28
MEOHP	6.82	3.97	7.04	5.61
MECPP	8.40	5.93	9.77	7.73
MHiNP	8.87	5.03	9.04	7.20
MOiNP	2.87	1.79	2.75	2.56
MCiOP	9.60	5.60	11.7	7.63

PBA, 3-phenoxynenzoic acid; TCP, trichloropyridinol; 1-HP, 1-hydroxypyrene; MEP, mono-ethyl phthalate; MnBP, mono-n-butan phthalate; MBzP, mono-benzyl phthalate; MEHP, mono-ethylhexyl phthalate; MEHHP, 5-hydroxy-mono-ethylhexylphthalate; MEOHP, 5-oxo-mono-ethylhexyl phthalate; MECPP, 5-carboxy-mono-ethylpentyl phthalate; MHiNP, mono-hydroxy-isononyl phthalate; MOiNP, mono-oxo-isononyl phthalate; MCiOP, mono-carboxy-isooctyl phthalate

Figure

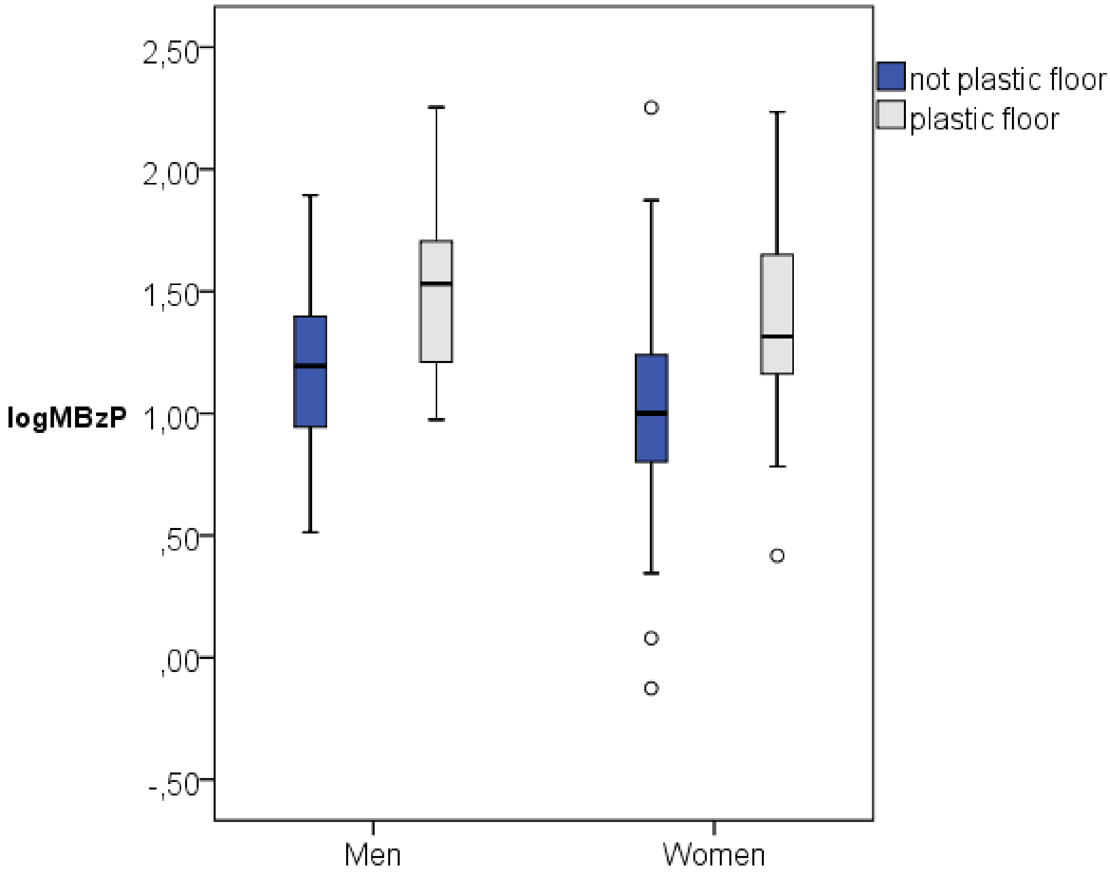

Figure 1. Median density-adjusted concentrations (max, min) of the phthalate MBzP (log scale) in men and women without (dark blue bars) or with (grey bars) plastic floor in bedroom. Men: not plastic floor median 15.6 ng/ml, plastic floor median 34.0 ng/ml; Women: not plastic floor median 10.0 ng/ml, plastic floor median 20.6 ng/ml. There were no difference in levels in MBZP with floor in bedroom newer than 5 years compared to older floors (p=0.329) and no differences between those without or with plastic floor in bedroom in any other phthalates.

MBzP, mono-benzyl phthalate