EXPOSURE OF GDANSK INHABITANTS TO SELECTED ENDOCRINE DISRUPTORS AS PART OF THE "NONHAZCITY" PROJECT

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Editorial

The Interreg Baltic Sea Region Project NonHazCity ("Innovative management solutions for minimizing emissions of hazardous substances from urban areas in the Baltic Sea Region") aims to demonstrate possibilities for municipalities and WWTPs to reduce emissions of priority hazardous substances (HS) and other pollutants from small scale emitters in urban areas that cannot be controlled by traditional water treatment and enforcement techniques: private households, offices, schools and day-cares, recreational facilities, and businesses served by municipal wastewater plants. To achieve knowledge of HS presence, target substances of concern have been identified, prioritized and analysed (3).

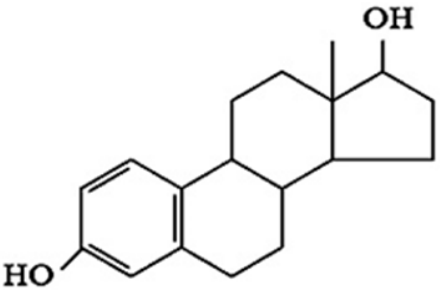
The NonHazCity consortium consisted of eighteen partners from nine municipalities as well as expert organisations in the Baltic Sea Region (BSR). The consortium has taken responsibility for finding new ways to tackle the large number of HS emissions from small and scattered sources in its urban territories. In addition, a network of 26 associated organisations including municipalities, water utilities, national and international environmental authorities, and non-governmental organisations (NGOs) supported them.

Within NonHazCity, three stakeholder groups were approached: municipalities, businesses and private households. Private households were invited to volunteer for check-up of articles and products potentially containing HS in their daily use. The project teams visited the voluntary families in the partners cities, did inventories in the households, discussed about the HS in certain products or articles, their health effects and advised on alternatives. Families from the partner city Gdansk were offered to analyse dust in their flats and their urine for the occurrence of the target substances.

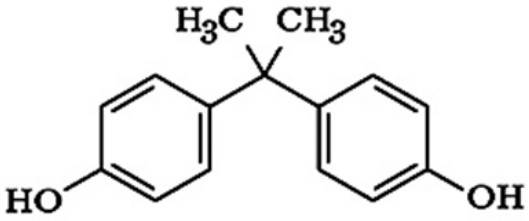
The present study shows the results of the dust and urine samples from 7 families in Gdansk during the household campaign ("Test your household") which appeared under the slogan "City on Detox". The overall aim of the analyses was to quantify concentrations of endocrine disruptors in the bodies and dust before and after changing the inventory of the participating households. Samples were taken and analyzed by the scientific team "DetoxED".

Introduction

Endocrine disruptors (ED) are chemical compounds similar in structure to natural hormones, affecting their proper functioning (1). Due to that similarity, the body is unable to determine which substance acts on the receptor – an ED or a hormone; thus, the synthesis, action or elimination of endogenous hormones is disturbed. Consequently, ED exposure leads to hormonal disorders and increase the risk of many so-called *diseases of civilization,* including cancer (e.g. breast cancer, prostate cancer, testicular cancer), obesity, diabetes or metabolic as well as fertility disorders (5-8). Exposure of a pregnant woman increases the risk of developmental disorders and birth defects of children and epigenetic changes in subsequent generations (6).



Bisphenol A



17β-estradiol

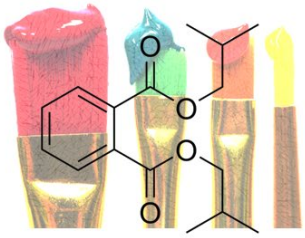
We are constantly dealing with ED in everyday life. Currently, the list of substances presenting ED properties includes over 1,400 chemical compounds and is regularly growing (1,2,4). Among them, pesticides, plasticizers and industrial intermediates are of the highest concerns. One of the best-known EDs are commonly used plasticizers: bisphenol A (BPA) and its derivatives (including bisphenol S, BPS), phthalates and dioxins, polychlorinated biphenyls (PCBs) and brominated flame retardant. The afore-mentioned compounds are present in food packaging, cans, water and beverages bottles, electronic equipment, contact lenses, dental fillings, toys, accessories for children, cosmetics, furniture, receipts. Each of us, using products that are the source of ED, contributes to the constantly increasing pollution of the environment and water contamination, and consequently to permanent exposure to ED and increased risk of *diseases of civilization.*

The project "City on Detox" – methods

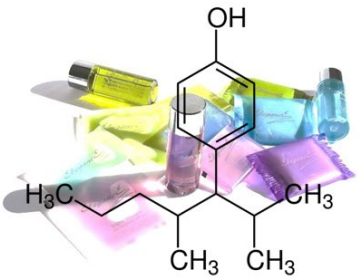
The study included 9 families living in the area of Gdańsk. All houses and apartments were renovated (floor changed, walls painted, windows replaced with new ones), in a period not longer than 1.5 years to 2 years prior to the date of the test. As a part of the study, the concentration of selected EDs in the urine of the participants and their home dust were determined. Dust and urine samples were collected twice: The first collection took place at the beginning of the "City on Detox" project, in November 2017, and the second at the end of the project, in June 2018. Each participant collected approximately 60 mL of urine in a glass jar sealed with a metal cap, that was previously autoclaved and washed with concentrated ethanol. The DetoxED team collected dust samples using a cellulose fibre. The samples were collected in rooms in which residents usually spent most of the time (living room), from shelves located at a height of 120-150 cm and close to electronic equipment (TV, speakers). Three days prior to sampling, the selected shelves were not cleaned. In June 2018, additional dust samples were collected from the floor under the bed. Dust samples were then stored in glass vials until the day of analysis.

The participants were surveyed and thereby asked questions about household conditions (furniture, plastic accessories, renovation) and lifestyle (cosmetics, cleaning, cooking). The survey aimed to determine the relationships between different home furnishings and the concentration of selected ED in domestic dust, as well as between lifestyle and eating habits, and the concentration of ED in the urine of the participants.

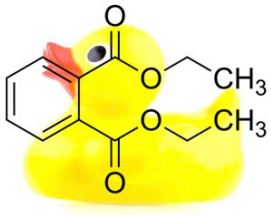
The questionnaire, carried out in November 2017, was conducted among 26 people from a total of 9 households and was filled in by a person collecting dust in the presence of at least one of the household members. The questionnaire was divided into two parts: The first part concerned equipment and rooms (e.g. kitchen) and which equipment (plastic kitchen utensils, cans or plastic boxes for storing or heating food), and cooking techniques (baking in the baking sleeve, cooking products loose in plastic packaging, etc.) were used by the person preparing meals. The second part concerned individual behaviours, working conditions, the frequency of use of cosmetics and household cleaning chemicals as well as surgical and dental treatment or physical activity.



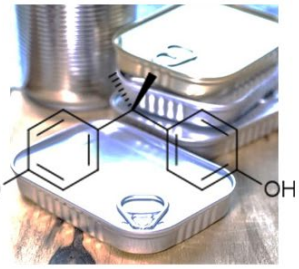
Diisobutyl phthalate



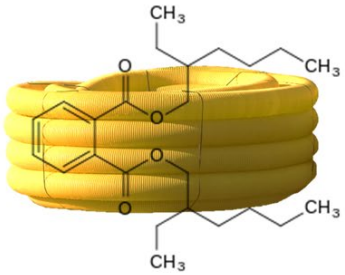
4-Nonylphenol



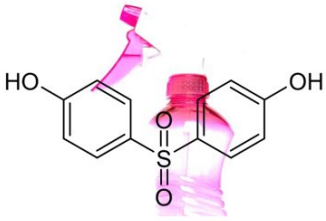
Diethyl phthalate



Bisphenol A



Bis(2-ethylhexyl) phthalate



Bisphenol S

During the period of 6 months City on Detox" representatives organized regular meetings for volunteers. Participants were given advice about reducing their exposure to selected EDs and possible healthier alternatives to household cleaning products, cosmetics, and food packaging, to name a few. It is worth noting that volunteers received recommendations only and were to introduce the changes according to their own concept and possibilities at home.

Finally, ED concentrations in urine and dust were determined in duplicates using liquid chromatography-electrospray ionization tandem mass spectrometry (LC-ESI-MS/MS).

For statistical analyses, results were obtained from 7 families, in which it was possible to collect samples both at the beginning and at the end of the project. Statistical analyses were performed using the Statistica 13.1 software. For quantitative data, the Shapiro-Wilk test was performed in order to check the normality of the distribution of the variables tested. The analysis of non-normally distributed variables was performed using non-parametric tests (Mann Whitney U test, Wilcoxon pairs order test). The p-value of 0.05 was considered statistically significant in all performed calculations.

Results

Endocrine disruptors (ED) were detected in 100% of urine and dust samples collected at the beginning of the project. Mean, minimum and maximum concentrations for the first and second urine ED determination are presented in Table 1. The p-value was the probability that the phenomenon observed in some measurement on a random statistical sample from the population could occur accidentally due to random variability of the sample. There were statistically significant differences (p-value <0.05) between the concentration of ED in the urine at the beginning and end of the project. The exception was diisobutyl phthalate (DiBP) which mean value in the second measurement was not statistically significantly lower. Differences in the concentration of ED in the urine in the first and second measurements are shown in Table 1.

ED [ng/g]	BPA	BPA2	BPS	BPS2	NF	NF 2	DEP	DEP2	DiBP	DiBP2	DEHP	DEHP 2
N	22	23	22	23	22	23	22	23	22	23	22	23
Mean	5 .34	4 .36	0 .6	0 .38	1 .47	0 .81	0.6	0.50	0.27	0.22	0.42	0.22
Min	1 .05	1 .16	0 .14	0	0 .14	0	0.14	0	0.01	0	0.1	0
Max	14 .2	11 .2	2 .15	1 .52	7 .01	4 .19	2.16	2.3	1.7	1.02	1.19	0.87
SD	3 .53	2 .79	0 .54	0 .45	1 .75	0 .86	0.5	0.59	0.37	0.31	0.29	0.26
P	0.003		0.004		0.0009		0.012		0.08		0.000074	

Table 1. Comparison of the concentration of selected endocrine disruptors in the urine of participants in pilot studies "City on Detox" at the beginning and at the end of the project (columns with number "2").

BPA – bisphenol A, BPS – bisphenol S, NF – nonylphenol, DEP – diethyl phthalate, DiBP – diisobutyl phthalate, DEHP – bis(2-ethylhexyl)phthalate, Min – minimal value, Max – maximum value , SD – standard deviation, p – p-value

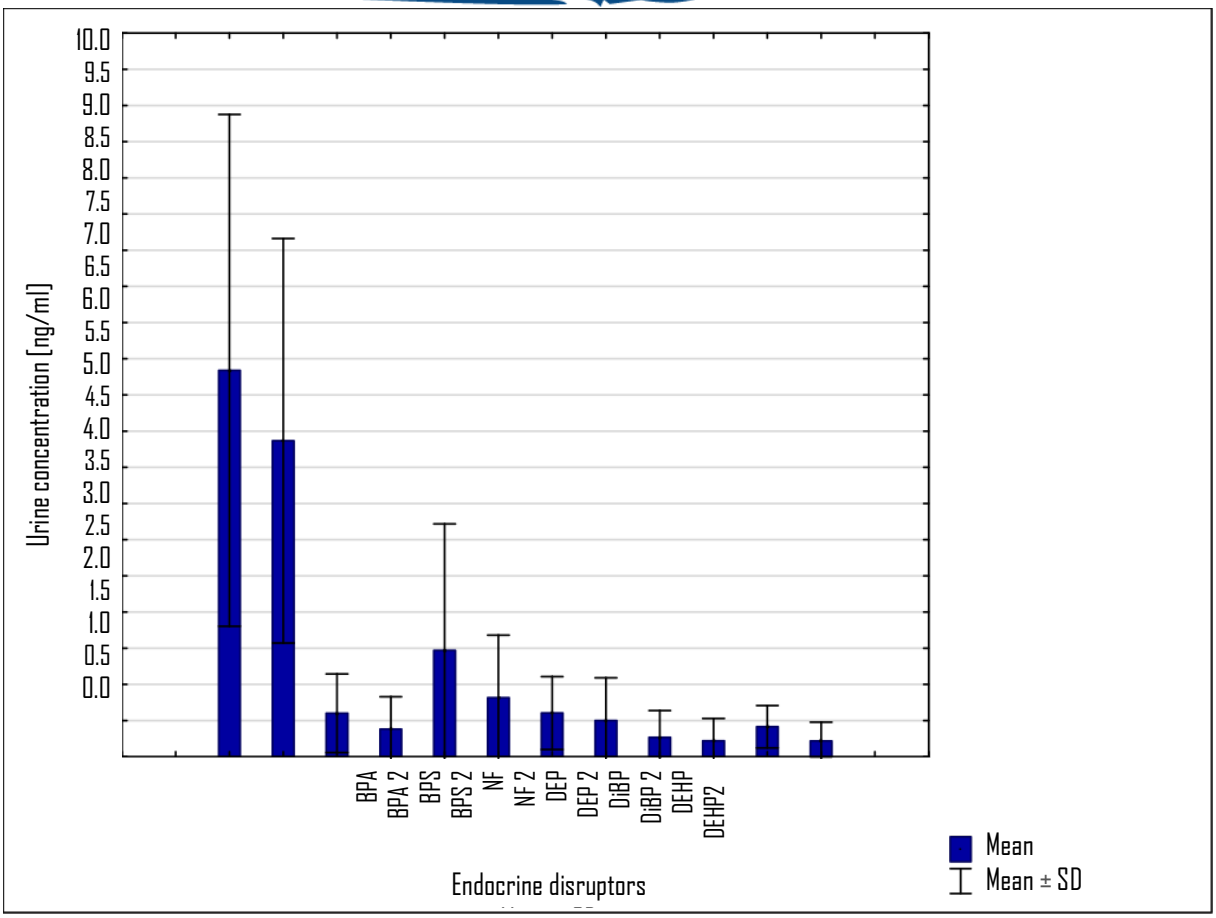


Fig 1. Comparison of the mean concentration of selected endocrine disruptors in the urine of participants of the project "City on Detox" at the beginning and at the end of the project (column with number "2").

BPA – bisphenol A, BPS – bisphenol S, NF – nonylphenol, DEP – diethyl phthalate, DiBP – diisobutyl phthalate, DEHP – bis(2-ethylhexyl)phthalate, SD – standard deviation

The results of the concentration of endocrine disruptors in dust samples

Carried out pilot studies showed that the actions undertaken by the participants led to a reduction in the concentration of ED in house dust. A detailed summary of the results is presented in Table 2 and Figure 2.

ED [ng/g]	BPA	BPA2	BPS	BPS2	NF	NF2	DEP	DEP2	DiBP	DiBP2	DEHP	DEHP 2
N	7	7	7	7	7	7	7	7	7	7	7	7
Mean	20 .1	15 .3	4 .84	2 .86	7 .71	3 .94	3.87	2.77	2.50	1.79	1.63	0.55
Min	13 .5	6 .4	2 .05	0 .82	2 .01	0 .85	1.12	1.08	1.05	0.0	0.8	0.0
Max	32 .2	26 .2	10 .1	7 .15	12 .0	7 .1	12.4	9.16	9.51	7.2	3.15	1.05
SD	5 .97	6 .60	2 .87	2 .04	4 .04	2 .37	3.98	2.94	3.11	2.46	0.81	0.43
P	0 .09		0 .042		0 .017		0 .06		0 .09		0 .017	

Table 2. Comparison of the concentration of selected endocrine disruptors in the house dust of participants of "City on Detox" at the beginning and at the end of the project (columns with number "2").

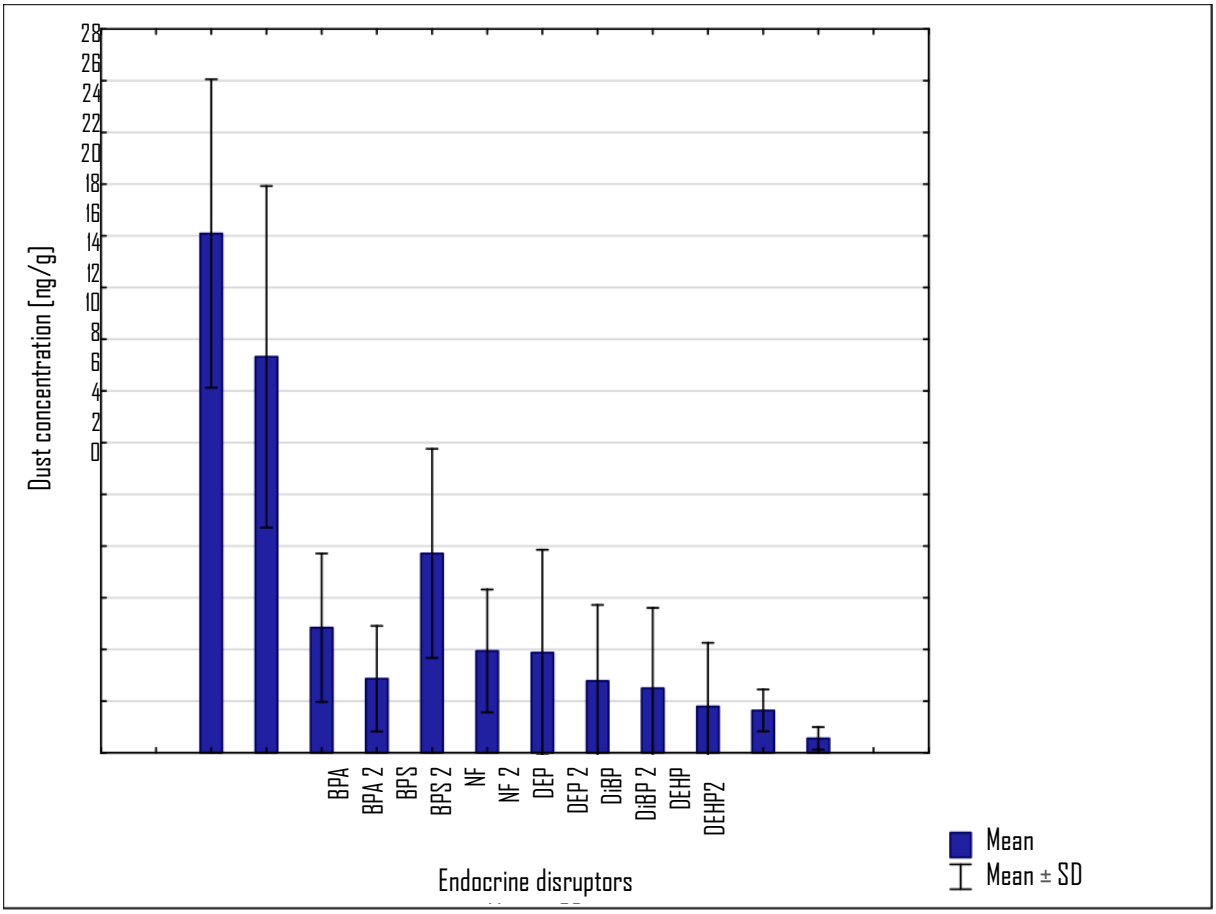


Fig 2. Comparison of the mean concentration of selected endocrine disruptors in the house dust of participants of the project "City on Detox" at the beginning and at the end of the project (column with number "2").
BPA – bisphenol A, BPS – bisphenol S, NF – nonylphenol, DEP – diethyl phthalate, DiBP – diisobutyl phthalate, DEHP – bis(2-ethylhexyl)phthalate, SD – standard deviation

In house dust, the concentration of phenols (bisphenol A – BPA, bisphenol S – BPS, nonylphenol – NF) was higher in households where more plastic elements were used e.g. kitchen utensils, plastic decorations and boxes, as well as electronics. At the same time, the concentration of phthalates (diethyl phthalate – DEP, diisobutyl phthalate – DiBP, diethylhexyl phthalate – DEHP) was higher in households in which floors were changed and walls painted, as well as where more furniture from the so-called plywood was present.

Participants who had higher ED concentrations in their urine were more likely to use both cooking techniques related to plastic (e.g. boiling rice in plastic sacks) and plastic food packaging.

In addition, the consumption of canned food and drinks in plastic bottles, together with contact with receipts was associated with higher BPA concentration in urine of the participants.

Conclusions

The results showed that the lifestyle changes carried out by the participants contributed to a significant reduction in their exposure to endocrine disruptors (ED), confirmed by a nearly twiced reduced decrease in ED concentration in samples of urine and house dust. The greater significance of the above changes in the urine of the participants is due to the greater number of samples in comparison to the number of dust samples.

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