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PRENATAL EXPOSURE TO OCPS, PCBS, BFRS, PFASS, DIOXIN-LIKE COMPOUNDS -POTENTIAL HEALTH RISKS TO TANZANIAN INFANTS?

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Background: Tanzania experiences a rapid increase in industry, agriculture, as well as urbanization and population growth. The increasing use of chemicals and improper municipal waste treatment may result in discharge of potentially toxic chemicals, such as persistent organic pollutants (POPs). Human exposure to these chemicals are associated with adverse health effects, such as reproductive, endocrine, neurodevelopmental and immune disorders. Chemical exposure during vulnerable life stages, such as fetal life and infancy, are of specific concern due to their immature metabolism and sensitive developing processes. The main aims of this study were to assess prenatal exposure to organochlorine pesticides (OCPs), polychlorinated biphenyls (PCBs), brominated flame retardants (BFRs), perfluorinated alkyl substances (PFASs) and dioxin- like compounds (DLCs) to Tanzanian infants and assess associations between POPs concentrations and maternal/infant characteristics.

Materials and methods: Maternal blood, placenta and cord blood were collected after delivery from healthy, primiparous mothers (N= 150) at Mount Meru Regional Hospital, Arusha Tanzania, in 2012. All mothers signed consent prior to donation of samples and answered a detailed questionnaire on demographics. The samples were kept frozen at -20 until analysis at the Laboratory of Environmental Toxicology, Norwegian University of Life Sciences. National Institute for Medical Research, Tanzania, and Norwegian Regional Ethics Committee approved this study.

Maternal plasma (N=48), placenta (N=46) and cord plasma (N=46) were analyzed for OCPs, PCBs and BFRs, using GC-MS and GC- ECD. In addition, maternal plasma (N=48) were analyzed for PFASs and DLCs using LC- MS/MS and Dioxin- Responsive Chemically Activated Luciferase eXpression (DR CALUX®) bioassay, respectively.

Results: The POPs concentrations (ng/g lw) in maternal blood are presented in Table 1. p,p'-DDE and PFOS were detected in 100% of the maternal blood samples. Women working in occupations other than farming had significantly higher levels of p,p'-DDE (p=0.03) than women working in farming. Women living close to industry or incinerators had significantly higher levels of BDE 47 (p=0.05) and dioxin-like activity (p= 0.01) than women living far from industry (Fig. 1). Women living in urban areas had significantly higher levels of PFDA (p=0.04) and PFOS (p=0.03) than women living in rural areas. Birth weight, birth length and head circumference were not correlated to POPs levels in maternal blood. However, when stratifying by gender, birth weight was negatively correlated to PFOS (p=0.01) in male infants.

p,p`-DDE was also the dominating POP in cord blood. Spearman correlations between paired cord blood and maternal blood samples showed strong significant correlation for p,p`-DDE. When adjusted for lipids, 37 of the 46 cord blood samples had higher p,p`-DDE concentrations than maternal blood, with ratio up to 2.6 (Fig. 2).

Discussion: This study is the first to report levels of BFRs, PFCs and dioxin- like activity in humans from Tanzania. DDE was within the same range as non-malaria areas in South Africa1 and comparable with DDE concentrations associated to higher risk of neurodevelopmental and immune system disorders in other studies2, 3. PBDEs were higher than reported from maternal serum in Denmark4 and Spain5. PFASs were low compared to other countries6. Dioxin- like activity were higher than reported from

Norway and England, but lower than Denmark and Spain7. The increase in industry, importation of consumer goods and the improper waste treatment, including e- waste, may be important exposure sources to PBDEs, PFASs and DLCs. Whether these potential harmful compounds are increasing in the Tanzanian environment need further investigations.
There are inconsistency between studies on associations between POPs exposure and fetal growth. In the present study, PFOS was negatively associated to birth weight in male infants. In a Japanese birth cohort including 306 mother-child pairs, prenatal exposure to PFOS was negatively associated to birth weight in female infants8. POPs may influence fetal growth through genotoxicity, immunotoxicity, cytotoxicity, placental dysfunction and endocrine disrupting mechanisms. Further assessments of the exact cause-effect relationship between continued POPs exposure and fetal growth are needed.

The knowledge on how POPs are transported across the placental barrier is limited. POPs with log Kow > 4 are reported to be distributed between tissues by passive diffusion solely driven by lipid content9. If so, the ratio between POPs levels in maternal and cord blood are expected to be close to 1 when adjusted for lipids. In the present study, the p,p`-DDE levels in cord blood were higher than maternal blood in 80% of the paired samples, with ratios up to 2.6, indicating that other mechanisms, like active transport by carrier proteins, may influence the distribution of these compounds between maternal and fetal tissues. Altogether, prenatal exposure to POPs in Tanzania are of concern and warrant further assessments on adverse health effects.

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Table 1: Summary of POPs concentrations (ng/g lw, *=ng/g plasma) in maternal blood from Arusha, Tanzania (N=48). Median and range (min-max) are given in the Table. For compounds where less than 65% of the samples are above LOD, only range (min-max) is given.

N=48	Median	Min	Max
∑DDTs	117	29.9	1910
PCB-153		<LOD	116
∑$_7$PBDEs	*2.25*	*<LOD*	*299*
∑PBDEs	*2.43*	*<LOD*	*299*
HBCD		<LOD	181
∑PFASs*	*1.18*	*0.18*	*3.14*
Dioxin- like activity*	30.2	<LOD	114

∑$_7$PBDEs= BDE 28, 47, 99, 100, 153, 154, 183

∑PBDEs= BDE 28, 47, 99, 100, 153, 154, 183, 206, 207, 208, 209

**=pg CALUX TEQ/g lipid

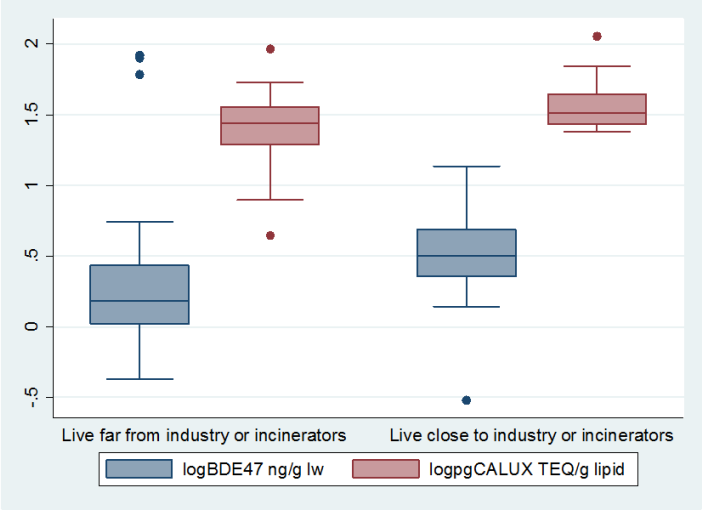

Fig 1: Women living close to industry or incinerators had significantly higher levels (lipid weight) of BDE 47 (p=0.05) and dioxin- like activity (p= 0.01) in their blood than women living far from industry or incinerators.

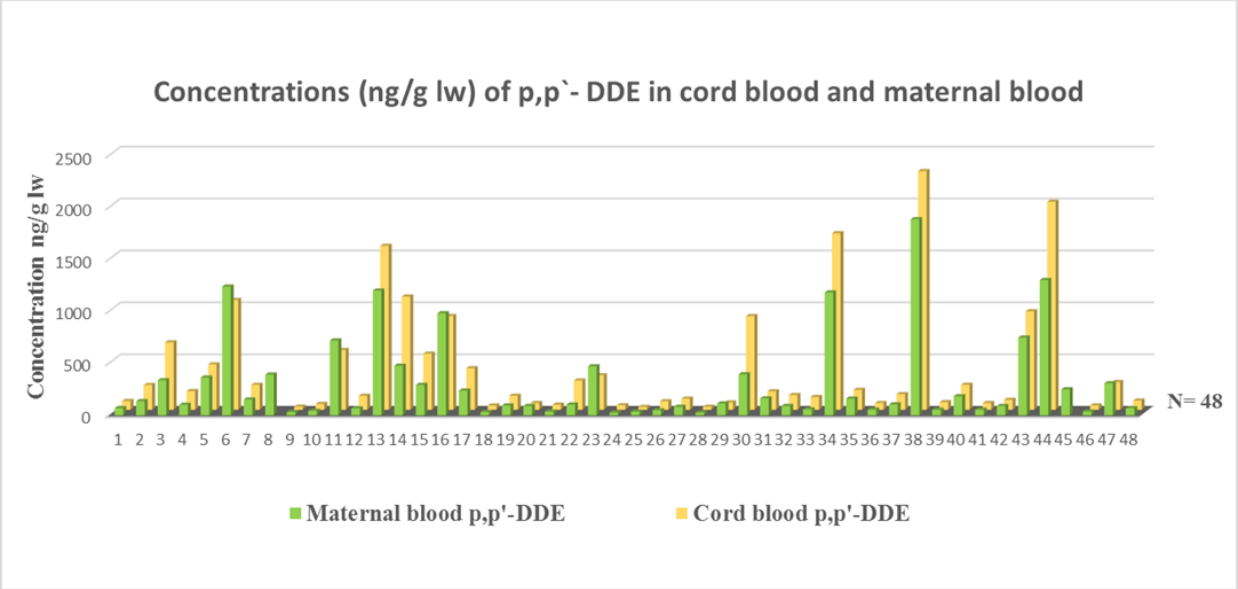

Fig. 2: Concentrations of p,p`DDE in cord blood and maternal blood. The p,p`DDE concentrations were higher in cord blood than in maternal blood in 37 of 46 paired samples.