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CHARACTERIZATION OF ENVIRONMENTAL MULTI-EXPOSURE TO PESTICIDES IN PREGNANT WOMEN

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ABSTRACT

The objective was to develop a multi-residue approach to quantify different pesticides in urine from pregnant women and to assess their determinants of exposure. 244 urine samples from a mother-child cohort were analyzed by UHPLC/QTOFMS after a sample preparation step to look for 42 different molecules. Bayesian statistical analyses were used to study the determinants of exposure to >10% detected pesticides. Methylated organophosphorous (OP) were the most concentrated (600 µg/L). Determinants of exposure were: location in rural zone and proximity / presence of crops, diet, and smoking status. Surprisingly, an inverse association between the presence of potatoes or peas crops in the town of residence and urinary metabolites of pyrethroids was found. Keywords: pesticide exposure, biological monitoring, multiresidue.

1 INTRODUCTION

Pesticides are commonly used in agriculture and it may result in human exposure. Biological measurement for exposure characterization is interesting because it may consider all sources, but it is still challenging due to the biotransformation mechanisms and the availability of small amounts of sample requiring very sensitive methods. During the last decade, urinary measurement has been largely used to study pesticide exposures but few chemical families were studied (mostly OPs and pyrethroids). The objective was to develop a multi-residue analysis to quantify different pesticides in urine and to assess their determinants of exposure.

2 METHODS

2.1 Study population and data collection: The population is issued from the mother-child PELAGIE cohort, Brittany, France. 244 urine samples were collected in 2004 at the beginning of pregnancy. Sociodemographic characteristics, home pesticide uses and dietary habits were collected by questionnaires. Urban and rural areas, and presence of and proximity to agricultural activities were determined from location and geographical information systems.

2.2 Multi-residue analyses: Pesticides were selected according to available data on agricultural practices, uses recommendations, and analytical feasibility. Pesticides were analyzed by UHPLC/HRMS after enzymatic hydrolysis followed by solid phase extraction (SPE) (Mercier et al. 2019).

2.3 Statistical analyses: Pesticide metabolites were grouped according to a same parent compound or family. Missing data were replaced by simple imputations with the QRILC method (Wei et al. 2018). Bayesian statistic was used to introduce uncertainty on the parameters (Monte Carlo Markov Chain, R software). Well detected compounds (>60%) were analyzed with a linear regression, whereas less well detected compounds (>10-50%) were analyzed with a logistic regression with a binary variable detected/ non-detected.

3 RESULTS

3.1 Pesticides quantification: 27 pesticides or metabolites were detected in urine, and 18 were sufficiently detected (>10%) to be used in statistical analyses. The most frequently detected pesticides are OP compounds, pyrethroids and aryloxyphenoxypropionates (detected >70%). Prochloraz, bromoxynil, cyfluthrin, diazinon and procymidone were less detected (10-30%). Other specific compounds were only detected to a very limited extent (0.3<10%): chlorprophame, imidacloprid, carbendazime, quizalofop-p-ethyl, parent compounds of certain OPs, and 2-phenylphenol. Lastly, acetochlor and its metabolite 2-methyl-6-ethylaniline, dimethoate, linuron and isoproturon metabolites, iprodione, a pyrimicarbe metabolite, and carbofuran phenol were never detected.

3.2 Determinants of exposure: Diet: Cereal and dairy products intake may be considered as determinants of OP pesticides. Surprisingly, shellfish consumers have urinary concentrations of aryloxyphenoxypropionates about twice as low as those who do not. **Urbanization and proximity to crops:** women living in rural areas have higher urinary concentrations of bromoxynil as those living in urban areas. The presence of vegetable crops in a 500m radius of the residence or cereal crops in the town of residence may also be considered as determinants of OP pesticides. An inverse association between the presence of potatoes and peas crops in the town of residence and urinary metabolites of pyrethroids was found. **Smoking** status has been identified as a determinant of diazinon exposure.

4 DISCUSSION AND CONCLUSION

Pesticide metabolites that are not routinely measured in urine were characterized. For proximity to crops, the results were consistent with other already described (Gunier et al. 2011, Chevrier et al. 2014). For diet, fruits and vegetables have not been found as a determinant of OP pesticides, contrary to the literature (van den Dries et al. 2018). The surprising result for pyrethroids may be explained by the multitude of existing uses other than for agriculture (biocides). Finally, smoking status might be consistent with the presence of diazinon in tobacco leaves (Rahman et al. 2012). Strength of this study is the multiresidue analysis including an enzymatic hydrolysis allowing to measure more pesticide forms. The limitation concerns the use of a single-spot urine sample, although dietary habits are captured on a longer period and agricultural activities may concern different temporality.

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