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The added value of a surveillance human biomonitoring program: The case of FLEHS in Flanders (Belgium)

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ABSTRACT

Since 2002, the Flemish Government decided to carry out the Flemish Environment and Health Survey (FLEHS), an extended human biomonitoring (HBM) program, which is integrated in the environmental health policy.

Through the FLEHS studies, a vast amount of data such as biomarkers of exposure and effect, exposure-effect associations, time trends and geographical differences, became available to the Flemish policy makers. In order to facilitate the policy interpretation, a phased action-plan was developed collaboratively by FLEHS researchers and policy makers.

In this article we look back on more than 15 years of investments of the Flemish government in HBM and reflect on how this large scaled and challenging HBM-initiative contributed to shaping the environmental health policy in Flanders. We used the FLEHS I (2002–2006) and II (2007–2011) results on persistent organic pollutants (POPs) and the resulting policy actions as an example to illustrate the added value of HBM for policy making. Policy measures for POPs, including source-related regulation (e.g. further optimization and tightening of existing Flemish legislation on open fires), investment in monitoring networks and communication and awareness campaigns, are presented and the added value for environmental health policy is discussed.

We also reflect on how HBM can support science and innovation in the environmental monitoring context. Finally, we describe what society can gain from HBM in terms of opportunities for (1) feeding the political and societal debate, (2) stimulating community involvement and (3) empowering participants and citizens.

All together, the gained insights and phased action plan showed that next to compliance with high scientific standards, results of the Flemish human biomonitoring campaign could be translated in targeted policy actions even for chemicals that have since long been regulated.

1. Introduction

In 2002 the Flemish Government decided to initiate the Flemish Environment and Health Survey (FLEHS), an extended human biomonitoring (HBM) program to assess and monitor human exposure of the Flemish population to environmental pollution and its impact on public health. Flanders is a densely populated area in the North of Belgium with intense traffic and widespread industrial and agricultural activities, which have a measurable impact on environmental quality and human health. It has been estimated

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that 6.3% of the total burden of disease in Belgium, *assessed using Disability-adjusted life years (DALYs),* is associated with a range of well characterized environmental stressors (i.e. particulate matter (PM2.5), secondhand smoke, traffic noise, radon, lead, ozone, dioxins, benzene and formaldehyde) (Hänninen et al., 2014). DALYs were estimated using primarily World Health Organization data on burden of disease, national environmental exposure data and epidemiological or toxicological risk estimates. However, for many other chemicals, the exposure levels and associated health effects are not well assessed or poorly understood.

Within this scope, human biomonitoring (HBM) adds value to environmental monitoring programs by assessing internal human exposure to chemicals with potential health impact. HBM integrates exposure through inhalation, ingestion and dermal uptake from a variety of sources taking into account personal characteristics and individual life styles. The FLEHS HBM program provides information on the distribution of chemicals in the general population allowing to identify high exposure groups. It provides reference values for selected chemicals in a representative population and allows to study time trends, spatial comparisons and exposure of vulnerable population groups such as pregnant women and adolescents (Baeyens et al., 2014; Croes et al., 2014; Den Hond et al., 2013; Koppen et al., 2009; Morrens et al., 2012; Schoeters et al., 2012). Relationships between exposure and biological and health effects are studied to support environmental risk assessment and health impact assessment (Choi et al., 2014; Croes et al., 2015, 2009; Den Hond et al., 2015; Dhooge et al., 2011; Franken et al., 2014; Lagerqvist et al., 2015; van Larebeke et al., 2006; WHO Regional Office for Europe, 2015). To assure the policy relevance of FLEHS, the Flemish government included specific requirements in the project call. FLEHS had to be implemented as a surveillance program to produce reference values of selected exposure biomarkers for the general population of Flanders. These reference values could then be used to compare with so-called 'hot spots', e.g. cities, industrial areas or regions with extensive fruit cultivation, and later on to study time trends in Flanders. The multidisciplinary composition of the research consortium (with all relevant scientific disciplines represented, including social scientists) and the establishment of structures for interaction with policy makers were other requests. Extension to relevant scientific research projects was encouraged for optimal use of the information of the surveillance program and its logistic framework. In addition, a special program had to be launched to use FLEHS data for policy making.

Since 2003 HBM is also specifically mentioned as a legal instrument for evidence-based environmental health policy making in the Flemish Decree on Preventive Health Care. Moreover, since 2004, the translation of HBM results into policy is mentioned in every yearly policy declaration of the Flemish Minister of Environment. Accordingly, a dozen of additional projects were launched building on the FLEHS results (additional research, participatory processes to evaluate FLEHS results and develop targeted policy interventions and specific action plans). These initiatives clearly indicate the political support for HBM in Flanders and the engagement to use HBM results for policy making.

So far, three successive FLEHS studies (FLEHS I: 2002–2006, FLEHS II: 2007–2011, FLEHS III: 2012–2015) were commissioned, steered and funded by the Flemish government and were designed and carried out scientifically by the Flemish Centre of Expertise on Environment and Health (CEH) (Fig. 1). A fourth survey is now ongoing (FLEHS IV: 2016–2019). The FLEHS studies cover now 15 years of HBM in Flanders, in three age groups of the general population (newborns and their mothers, adolescents and adults) and in several hot spots using a combination of cross sectional and prospective cohort studies. In total more than 5500 participants were included within the first three FLEHS studies, Flemish reference values were obtained for more than 50 biomarkers of exposure and effect, including classical pollutants such as toxic metals, dioxins, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and dichlorodiphenyltrichloroethane (DDT), as well as new emerging pollutants which appeared in the environment on a larger scale mainly during the last decade such as phthalates, musks, parabens and organo phosphate pesticides (Schoeters, et al., 2011). Biological effect markers and health effects studied in FLEHS were genotoxicity markers (micronucleus assay, comet assay), hormone levels (e.g. testosterone, FSH), puberty stadia in adolescents, inflammation and oxidative stress markers in e.g. breath condensate, self-reported information on fertility and asthma and allergy (Baeyens et al., 2014; Croes et al., 2015, 2014; Dhooge et al., 2011; Franken et al., 2014; Kiciński et al., 2012; Sioen et al., 2013). Remaining biological samples are stored in a biobank, currently containing about 10.000 samples.

Through these FLEHS studies, a vast amount of HBM data became available for the Flemish policy makers. The evaluation of these research results in terms of public health impact, priorities for policy action and possibilities for policy intervention is, however, not always as straightforward as it might seem. This process of interpretation is most often complicated by scientific complexity, uncertainty and discussion. Also a plurality of societal perspectives on environmental health risks, its acceptability and support for policy interventions need to be taken into account. In order to facilitate this process, a phased action-plan was developed collaboratively by FLEHS researchers and policy makers (Keune et al., 2009), and was implemented after each FLEHS study. This phased action-plan combines scientific analysis and societal deliberation in a structured and participatory approach. In several successive phases HBM results are prioritized for policy action, explanatory factors are identified and targeted policy interventions are developed. This approach has successfully resulted in several action plans, with a diversity of policy actions in addition to existing policies and in cooperation with various national and regional actors.

In this article we look back on more than 15 years of investments of the Flemish government in HBM and reflect on how this large scaled and challenging HBM-initiative contributed to shaping the environmental health policy in Flanders. Based on our experience with HBM, we elaborate on the question why policy makers need to keep investing in HBM, even for substances which have already been regulated or banned since many years? We will use the FLEHS I and II results on persistent organic pollutants (POPs) and the resulting policy actions as an example, to illustrate the added value of HBM for policy making and the diversity of eligible policy interventions. Secondly, we reflect on how HBM can support science and innovation in the environmental monitoring context. And thirdly, we describe what society can gain from HBM.

2. Material and methods

In this methods section a brief description of the methodology of the FLEHS campaigns, in particular FLEHS I and FLEHS II, and the methodology of the phased action plan is included, as a basis for the description of the POPs case to illustrate the added value of HBM for policy making. Secondly, we also clarify the methodology used in this article to demonstrate the added value for policy, science and society in Flanders.

2.1. The cycle of the Flemish human biomonitoring programs (FLEHS I and FLEHS II) and the phased action plan

In FLEHS I participants were recruited in eight geographical areas with different environmental characteristics, while in FLEHS II all Flemish provinces were included to establish reference values,

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