Group 1 National Hub Template (HBM data for Awareness)

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Introduction:	
Background information on the evolution and status of HBM in your country.	The Netherlands can be considered as one of the early adopters of human biomonitoring (HBM) with a tradition going back to the 1970's. HBM has been applied in targeted research (Wibowo, Brunekreef et al. 1980), to direct policy in pollution hotspots (Brunekreef, Veenstra et al. 1981); Brunekreef et al. 1983; Kreis 1990, Monster and Zielhuis 1991), in occupational health (Verschoor, Herber et al. 1988), in Surveillance Programme "Man, Food and Environment" (Fiolet, Cuijpers et al. 1988, Pieters, Kok et al. 1990, Zeilmaker, Houweling et al. 2003). The Netherlands has been the first in applying HBM directly after a disaster (Enschede 2001) (Roorda, van Stiphout et al. 2004) and has developed a procedure to judge need and added value in health studies, including HBM in the aftercare of disaster victims (Scheepers et al., 2011, 2021). HBM is currently used in activities for WHO and in a number of research projects, such as the exposure and risk assessment of PFOA (perfluorooctanoic acid) and GenX in residents in Dordrecht (Gebbink and van Leeuwen, 2020).
Main text - Results and Discussion ENSURE YOUR NARRATIVES ARE REFERENCED AS FAR AS POSSIBLE	
• Description of issue(s) which have resulted in the raising of awareness. • Include brief description of sample population, substances of concern and whether local/regional/national.	Historically, HBM has been regularly applied in the previous century in the context of local concerns about environmental health, e.g. by environmental physicians. These involve metals (Pb, Cd), cleaning agents around dry cleaning facilities and soil pollution sites. More recently, concern about possible health effects due to exposure to (groups of) specific chemicals like PFOA has resulted in increased awareness of the utility of HBM as a tool to obtain insight into exposure to environmental chemicals and potential health effects. For PFOA, the concern specifically related to PFOA emission by the Dupont/Chemours factory in Dordrecht, where PFOA was used up to 2012 for the production of Teflon. The National Institute for Public Health and the Environment in the

	Netherlands (RIVM) has measured PFOA blood values in residents in two zones around the chemical factory DuPont/Chemours. Primary aim was to verify, also to the general public, earlier model results that indicated high exposures in the past. Blood samples were collected from a total of 382 local residents in the autumn of 2016. The results overall supported the model results and showed that it is likely that residents around Dupont/Chemours have been chronically exposed to high values of PFOA (van Poll et al., 2017; Gebbink and van Leeuwen, 2020). Another example is pesticide exposure of residents of areas near agricultural fields. Upon advice from the Health Council of the Netherlands (2014), the Dutch parliament commissioned RIVM to coordinate a large exposure survey assessing pesticide exposure of residents living close (<250 m) to agricultural fields. The survey was conducted between 2016 and 2019, and involved residents living in the vicinity of flower bulb cultivation as well as residents living more than 500 m away from any agricultural fields (control subjects). Samples collected included urine and hand wipes, as well as air, dust and soil. Urine samples and hand wipes were analyzed for biomarkers of five applied pesticides: asulam, carbendazim (applied as thiophanate-methyl), chlorpropham, prochloraz and tebuconazole (Figueiredo et al, 2021; Oerlemans et al, 2021).
• Description of HBM programme **if it exists** e.g. implementation of a HBM module into HES	In the Netherlands, HBM was covered in the Surveillance Programme "Man, Food and Environment" in which periodically pesticides, PCB's and dioxines were measured in mother's milk. This programme run by the State Health Inspectorate and commissioned to RIVM was terminated late 20th century. HBM is now mainly applied in dedicated studies directed to determinants of health and chronic or infectious diseases. Examples include the Doetinchem Cohort Study (Picavet et al, 2017), a prospective longitudinal study that started in 1987, and Lifelines, a multigenerational cohort study focused on the northern population of the Netherlands (Stolk et al, 2008). Although these studies are not primarily aimed at exposure to environmental chemicals and health, they may facilitate risk assessment of chemicals because an enormous amount of valuable data on e.g. lifestyle factors and health (physical and psycho-social) is generated. Also, the samples collected in these studies may be used for environmental health purposes. In fact, in the context of HBM4EU samples from the Doetinchem Cohort Study have been used for the assessment of exposure to toxic metals and associated health risks. More recently the use of HBM for environmental health monitoring re-gained some interest in

	the Netherlands, because of the abovementioned concerns related to e.g. PFOA and pesticides.
• Describe which ministries (Environment, Health etc.)/policy makers and stakeholders involved/steering/financing the HBM programme. • Give examples - specific chemicals or outcomes.	In the Netherlands, HBM was covered in the Surveillance Programme "Man, Food and Environment" in which periodically pesticides, PCB's and dioxines were measured in mother's milk. This programme run by the State Health Inspectorate and commissioned to RIVM was terminated late 20th century. HBM is now mainly applied in dedicated studies directed to determinants of health and chronic or infectious diseases. Examples include the Doetinchem Cohort Study (Picavet et al, 2017), a prospective longitudinal study that started in 1987, and Lifelines, a multigenerational cohort study focused on the northern population of the Netherlands (Stolk et al, 2008). Although these studies are not primarily aimed at exposure to environmental chemicals and health, they may facilitate risk assessment of chemicals because an enormous amount of valuable data on e.g. lifestyle factors and health (physical and psycho-social) is generated. Also, the samples collected in these studies may be used for environmental health purposes. In fact, in the context of HBM4EU samples from the Doetinchem Cohort Study have been used for the assessment of exposure to toxic metals and associated health risks. More recently the use of HBM for environmental health monitoring re-gained some interest in the Netherlands, because of the abovementioned concerns related to e.g. PFOA and pesticides.
• Steps/processes needed or used to get the attention of policy makers.	Recent efforts to increase awareness of the utility of HBM for monitoring exposure to environmental chemicals and possible health effects mainly involved interactions between experts and policy makers. Overall, the Dutch Ministries appear hesitant to make use of human biomonitoring as a tool for monitoring environmental health, despite its added value demonstrated in the past in the Surveillance Programme "Man, Food and Environment. In more recent years, HBM studies were only initiated upon explicit advice from the Dutch Health Council and/or questions asked in the Dutch parliament. This tendency not to measure is not restricted to HBM, but extends environmental measurement in general; the monitoring programme of the Coordinating Committee for the Monitoring of Radioactive and Xenobiotic Substances (CCRX) has also been terminated in the previous century.
• Describe barriers e.g funding; challenges e.g. participant recruitment; opportunities e.g.	Barriers may include the perception that HBM studies are very costly and challenging to set up, while generating only a limited dataset. Additionally, there may be concerns how to act upon the findings obtained. The joint survey on pesticides 'SPECIMEn' (Survey on PEstiCIde Mixtures in Europe) carried out in the context of HBM4EU may help to

enhancing cross government working and linking of env data with exposure measurements currently at play in your country with regards to HBM. • Have any of these barriers been addressed by HBM4EU? If yes - describe.	break down these barriers, by demonstrating a proof-of-concept of suspect screening analyses for generating new exposure data across Europe on a broad combination of pesticides and to assess possible local contributions and within-person variation. Successful recruitment of participants does not seem to be a major hurdle, based on the outcomes of focus groups held in November 2020 in the context of HBM4EU. Participants particularly expressed interest in HBM to gain insight into sources of exposure to hazardous substances that can be used by citizens to make informed choices.
• Other players who would be beneficial in raising awareness and working together to promote HBM	Besides continuing the dialogue between experts and policy makers, case studies from across Europe would be highly valuable for demonstrating the added value of HBM for policy making on environmental chemicals. A nice example of such a study is the HBM4EU chromates study, in which also the Netherlands participated. This study was conducted to provide EU relevant data on hexavalent chromium exposure in workers to support the regulatory risk assessment and decision-making (Santonen et al. 2021). It is to be expected that also results from the SPECIMEn study will contribute to promoting HBM.
Future plans - • Are there plans to use HBM data in the future for policy or awareness - give clear examples. Will the data from HBM4EU be used?	HBM will have an important role in the Partnership for the Assessment of Risks from Chemicals (PARC), funded via the Horizon Europe programme of the European Commission. In this partnership, exposure to emerging chemicals as well as legacy chemicals, e.g. per- and polyfluoroalkyl substances, and possible associated health effects will be addressed. We envision that this will further enhance awareness of HBM and its possible use for policy making.

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