

Assessing PBDE and PFC Exposures in Pregnant Women: Development of a Detailed Exposure Assessment Questionnaire

Glenys M. Webster¹, Cristina M. Cotea², Kay Teschke^{1,3}

¹School of Occupational and Environmental Hygiene, University of British Columbia, 2206 East Mall, Vancouver BC Canada V6T 1Z3

²Department of Biochemistry and Molecular Biology, University of British Columbia, 2350 Health Sciences Mall Vancouver BC Canada V6T 1Z3

³Department of Health Care and Epidemiology, University of British Columbia, 5804 Fairview Ave Vancouver BC Canada V6T 1Z3

Introduction.

Polybrominated diphenyl ethers (PBDEs) and perfluorinated compounds (PFCs) are used as flame retardants (PBDEs) and stain, grease and water repellents (PFCs) in a wide range of consumer products. Both sets of chemicals leach out of products, and certain congeners accumulate in human tissues (Olsen et al. 2003; Kubwabo et al. 2004; Schechter et al. 2005). Within regions, the levels of PBDEs and certain PFCs vary widely across people (Environmental Working Group 2003; Kubwabo et al. 2004), suggesting differences in individual-level exposures. While the diet and dust ingestion are thought to be important exposure routes (Kubwabo et al. 2005; Wilford et al. 2005), the *specific determinants* of PBDE and PFC levels in human tissues (e.g. extent of home carpeting, sleeping on a foam mattress or pillow, high consumption of microwave popcorn) are not well understood. This information is needed to design effective control strategies to reduce on-going exposures to these chemicals. Bans on *new* uses of PBDEs and PFCs may have little effect on exposures in the short term, because large reservoirs of chemicals are already present in many homes and workplaces.

The main goal of this work was to develop a detailed exposure assessment questionnaire to assess PBDE and PFC exposures in pregnant women. The questionnaire will be administered to 150 pregnant subjects in the ongoing Chemicals, Health and Pregnancy study (CHirP) in Vancouver, Canada (www.cher.ubc.ca/chirp). PBDEs and PFCs will also be measured in serum collected from the same subjects at 15 weeks of pregnancy. In later analyses, multiple linear regression will be used to identify the main determinants of PBDE and PFC exposure in this population, using the questionnaire data as independent variables and chemical levels measured in maternal serum as dependent variables. Data from the questionnaire will also be used in other studies in the same cohort to investigate the influence of PBDEs and PFCs on thyroid hormones during pregnancy, and to identify the determinants of PBDE and PFC levels in dust, air and dryer lint samples collected from the same subjects' homes.

Materials and Methods.

Current and historical uses of PBDEs and PFCs in North America were identified by literature review, including peer-reviewed publications, government reports, industry documents and other resources. When possible, local uses of PBDE- and PFC-containing products were verified by personal communication with local users (e.g. home improvement, construction material and furniture retailers, house cleaning services). Two PBDE questionnaires developed at Boston University (Webster 2005; Webster & Wu 2005) were combined and expanded to include a more detailed assessment of PBDE exposures (e.g. air travel, detailed vehicle use, detailed occupational history) as well as PFC exposures (e.g. fast food consumption, use of non-stick pans, use of stain repellents on carpets, furniture and clothing). Exposure

sources specifically relevant to the Vancouver population were also added (e.g. extent of sushi consumption, use of GoreTex clothing). When relevant, questions were designed to assess both the intensity and duration of exposure to PBDE- and PFC- containing materials. For most variables, the questionnaire was designed to collect exposure information over the past 3 years. This time frame was selected to balance the need for detailed exposure information related to the kinetics of PBDEs and PFCs, while minimizing difficulties with recall. Demographic, health and pregnancy-specific questions were also included for use in future analyses. An initial draft of the questionnaire (Phase 1) was tested on non-pregnant female volunteers (n=10). This version was administered in person by study personnel. Substantial revisions were made and the revised version (Phase 2) was tested on another group of pregnant volunteers (n=12).

Results and Discussion.

Following initial pilot testing, the questionnaire was split into 3 sections: 1) An online questionnaire using SurveyMonkey software (<http://www.surveymonkey.com>, SurveyMonkey.com, Portland, OR) (25-30 minutes), 2) An in-person interview conducted in each subject's home (60 minutes), and 3) A home walk-through conducted at the time of the home interview (15-30 minutes). Simple and familiar questions (e.g. type of home, vehicle use patterns) were included in the online questionnaire, and pictures were added to many questions to improve understanding (e.g. to identify types of home insulation). The "skip logic" (conditional logic) feature of SurveyMonkey was used to allow subjects to skip non-relevant questions. Sensitive questions (e.g. drinking, smoking and drug habits) were also included in the online questionnaire to encourage honest reporting. The online questionnaire reduced the time and cost of administering the whole questionnaire in person, reduced the burden on study subjects by shortening the time spent in their homes, reduced data transcription errors and made the questionnaire more enjoyable for subjects to complete. More complex questions were retained in the in-person questionnaire. Worksheets for certain sections (e.g. air travel, occupational history) were emailed to subjects in advance of the home visit to shorten the length of the home interview. Pictures of typical portion sizes were also used to improve the accuracy of the collected dietary data. An occupational exposure list and a hobby exposure list were developed to help subjects identify potential exposures at work or during hobbies. Following the in-person interview, specific home characteristics (e.g. type of flooring, number and type of foam furniture items) were recorded during a home walk-through. A laser distance measurer was also used to measure the dimensions of each room. To minimize the invasiveness of the home walk-through, the type of data to be collected was first explained to each subject, and permission was asked to enter each room. The types of data collected in each part of the finalized questionnaire are summarized in **Table 1**.

Conclusions.

We have developed a detailed three-part exposure assessment questionnaire to assess the determinants of exposure to PBDEs and PFCs in pregnant women. Questionnaire data and chemical levels in maternal serum will ultimately be used to identify the most important determinants of PBDE and PFC exposure in a group of 150 pregnant Vancouver women. This questionnaire may be adapted and tailored for future studies in other populations and regions.

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Table 1. Main categories of data to be collected in the PBDE and PFC exposure assessment questionnaire. The questionnaire will be administered in 3 sections: 1) An online questionnaire, 2) An in-home interview, and 3) A home walk-through (at the time of the home interview).

1. Online Questionnaire		2. In-home Interview		3. Home Walk-Through	
Your Home	<ul style="list-style-type: none"> Age and type of home Type of heating, ventilation system and insulation Home renovations 	Your Diet*	1 year before pregnancy: <ul style="list-style-type: none"> Detailed consumption of beef, pork, poultry, sushi, other fish, dairy, eggs Consumption of fast food / foods served in paper or cardboard containers; Lifetime: Consumption of microwave popcorn	For each room:	
Your Bedroom & Kitchen	<ul style="list-style-type: none"> Type and age of mattress Time spent on mattress Presence and age of foam pillows and mattress pads Use of non-stick cookware Use of self-cleaning oven 			Dimensions	<ul style="list-style-type: none"> Floor area (m²); Room volume (m³)
Home Cleaning	<ul style="list-style-type: none"> Frequency of vacuuming, dusting and carpet cleaning Use of cleaning products and stain repellents 	Your Typical Day†	<ul style="list-style-type: none"> Time spent at home, in another building, in a vehicle, and outside Time spent sitting on foam furniture, watching TV, on a computer, on the phone 	Flooring	<ul style="list-style-type: none"> Type of flooring; % of floor covered
Laundry & Clothing	<ul style="list-style-type: none"> Location of laundry facilities Use of dryer sheets and fabric softener Use of Gore-Tex or stain-repellent clothing 	Air Travel†			
Transportation & Fire History	<ul style="list-style-type: none"> Make, year and use of vehicles Presence of exposed foam in vehicles Use of public transit Personal experience of house, office or car fires Use of fire extinguishers 	Occupational Exposure†	<ul style="list-style-type: none"> Job title; Industry, Location, Start / end dates, Hours worked per week, Typical job tasks, Hours per week on computer (past 3 yrs) Contact with materials on the "Occupational Exposure List" (past 3 yrs & lifetime) 	Home Electronics	All items: <ul style="list-style-type: none"> Number Type TVs & computers: <ul style="list-style-type: none"> Brand Age Typical use
Care & Other	<ul style="list-style-type: none"> Use of cosmetics, antistatic sprays, waterproof casts Use of indoor pesticides, waterproof sprays, shoe polish, stain removers, car wax & polish 	Hobbies†	<ul style="list-style-type: none"> Type, frequency and duration of hobbies (past 3 yrs) Contact with materials on the "Hobby Exposure List" (past 3 yrs) 		
Demographics	<ul style="list-style-type: none"> Education, Income, Ethnicity, Happiness index, Stress index Use of tobacco, alcohol and illicit drug use (1 yr before pregnancy, & since the beginning of pregnancy) 	Demographics	<ul style="list-style-type: none"> Number of prior births and Total months of prior breastfeeding Height, Current and pre-pregnancy weight, Current medications, Recent illnesses 	Other	<ul style="list-style-type: none"> Presence of visible foam Presence & size of curtains

* Pictures of typical portion sizes were shown to each subject

† Worksheets were emailed to subjects in advance of the home interview

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