Contamination: the next generation

Results of the family chemical contamination survey

A WWF-UK Chemicals and Health campaign report in conjunction with The Cooperative Bank

October 2004

WWF 'S CHEMICALS AND HEALTH CAMPAIGN

Along with wildlife around the world, we are being subjected to an uncontrolled and dangerous global experiment. Exposure to hazardous man-made chemicals is putting us all at risk. Our children and wildlife are especially vulnerable. These chemicals are found in everyday products like televisions and sofas. WWF's Chemicals and Health campaign is seizing a once in a generation opportunity to put an end to this threat, by asking people to help us ensure forthcoming European chemicals legislation brings chemicals under control.

WWF is calling for hazardous man-made chemicals to be properly regulated – replaced where safe alternatives exist, or banned where necessary.

Note

14 October 2004 - This report has been revised due to minor errata in the previous version. These do not change the findings and overall conclusions of the report.

Contents

Executive Summary

WWF has shown in its past surveys in the UK and Europe that every adult tested has been contaminated by a cocktail of hazardous man-made chemicals. Now, this survey breaks new ground. It set out to explore whether children were similarly contaminated, whether there was any relationship between the types and levels of contamination found in three generations of families, and to examine possible links between contamination and a family's lifestyle, consumption patterns and everyday products.

The survey was conducted in the summer of 2004 with The Co-operative Bank. This report summarises the findings of the analysis of 104 different chemicals in the blood of 33 volunteers from seven families living in England, Scotland and Wales.

The volunteers in each family spanned three generations, generally comprising the grandmother, mother and two children. The volunteers comprised 14 children, 13 adults and six grandmothers. The ages of the volunteers ranged from nine years to 88 years.

All three generations tested, including the children, are contaminated by a cocktail of hazardous man-made chemicals. The results reveal that every child, from as young as nine years (we did not look at younger children), was contaminated by the same range of hazardous chemicals: organochlorine pesticides, PCBs, brominated flame-retardants, phthalates and perfluorinated ("non-stick") chemicals. Five chemicals found in each parent and grandparent were also found in every child (see table below).

While it might be expected that chemical burden increases with age, this study has shown that this conventional assumption is not always true: children can be more contaminated by higher numbers and levels of certain "newer" chemicals than their parents or even their grandparents, despite being exposed to these chemicals for only a fraction of the time. These "newer" chemicals include brominated flame retardants (used in sofas, textiles and electrical appliances) and perfluorinated chemicals (used in the manufacture of non-stick pans, coatings for takeaway food packaging and treatments for carpets, furniture, clothing and footwear).

The results also show that chemicals in everyday products around the home are contaminating the blood of all the families tested in the survey, including the children.
For example:

- Fifty seven per cent of the seven people found to be contaminated by deca-BDE, a brominated flame retardant, were children. Even so, the UK government has decided that such human contamination by deca-BDE is not enough of a risk to introduce risk reduction measures for the chemical.
- Of the volunteers tested, 82 per cent were contaminated by one or more perfluorinated chemical.
- The perfluorinated chemical PFOA (perfluorooctanoic acid) was found in more than a third of the children tested. A related chemical PFOS (perfluorooctane sulphonate) was found in five of the family members tested. The UK government is belatedly pressing for this

chemical to be phased out due to concerns over its health and environmental impacts. We believe that waiting until large proportions of the population are contaminated by hazardous chemicals before deciding to phase them out is too little too late. There should be an assumption against the use of such persistent and bioaccumulative chemicals.

Frequency of detection of the most commonly found chemicals in three generations

Chemical	All (n=33)	Grandmothers (n=6)	Parents (n=13)	Children (n=14)
BDE 153 (penta and octa)	100%	100%	100%	100%
p,p' DDE	100	100	100	100
PCB congener 118	100	100	100	100
PCB congener 170	100	100	100	100
PCB congener 99	100	100	100	100
Hexachlorobenzene	85	83	92	79
DEHP	79	83	10	79
β-HCH	52	83	77	36
Perfluorooctanoic acid (PFOA)	36	50	31	36
BDE 209 (deca)	21	17	15	29
Perfluorooctane sulphonate (PFOS)	15	0	23	14

FAMILY LIFESTYLE CHOICES AND CHEMICAL CONTAMINATION

There seems to be little relationship between the location of each family (urban, suburban or rural) and their chemical profile.

Without our knowing about it and sanctioning it, the indisciriminate use of hazardous chemicals in our modern way of life is contaminating the present generation and the next. Man-made chemicals can contaminate our bodies regardless of where we are or what we do. Dietary choices, lifestyle activities and the presence of certain products in the home may influence the types and absolute levels of chemicals to which people are exposed, but exposure to man-made chemicals is a fact of life, irrespective of how old a person is, what they do or where they live.

The continuing contamination of the youngest members of families with hazardous man-made chemicals clearly illustrates that industry and government have failed to regulate hazardous chemicals. Regulators are repeating the mistakes of the past as chemicals with similar properties to DDT and PCBs are now contaminating future generations.

THE SOLUTION

This survey highlights the fact that there is very little, if anything, individuals can do to prevent contamination of themselves or their family by the insidious and ubiquitous threat of hazardous man-made chemicals. WWF’s view is that we need strong chemicals regulation now, to stop the contamination of today’s children and future generations. Public education and awareness is required to highlight the extent of contamination and to give people the choice to avoid hazardous man-made chemicals. People have the right to know what is in the products they use and what they are potentially exposing themselves to in their everyday lives. Industry needs to provide this information, to be more responsible and to phase out persistent, bioaccumulative and endocrine disrupting chemicals. Governments should force industry to do so.

Everyone – not least children and future generations – should have the right to a clean, healthy and uncontaminated body so that they achieve their maximum potential without the ever-present worry of their lives being blighted through exposure to hazardous man-made chemicals. Phasing out the use of very persistent and very bioaccumulative chemicals and of endocrine disrupting chemicals, and their substitution with safer alternatives, is the only way to stop the insidious threat of such chemicals and the contamination of future generations of humans and wildlife.

Introduction

Contamination of the environment by hazardous man-made chemicals will not come as a surprise to most people. Over the years, in pursuit of its mission to stop the environmental degradation of the planet, WWF has highlighted the global nature of chemical contamination. Now, from polar bears in the once pristine Arctic to seals and dolphins, wildlife throughout the world is contaminated. But chemical contamination is not restricted to wildlife – people around the world are also contaminated.

Chemical contamination is not only a global or even a local issue: it is a personal issue, affecting people from all walks of life. Everyone – not least the next generation – should have the right to a clean, healthy and uncontaminated body so that they achieve their maximum potential without the ever-present worry of their lives being blighted through exposure to hazardous man-made chemicals.

This report presents data from a WWF study into the types and levels of contaminants in three generations of UK families. It investigates for the first time the kinds of chemicals to which they are exposed in their everyday lives.

OUR CHEMICAL ENVIRONMENT

The environment is being exposed to, and contaminated by, increasingly large numbers of industrial chemicals, the vast majority of which have not been tested for their effects on human health. The global production of chemicals has increased from 1 million tonnes in 1930 to 400 million tonnes today. Some 100,000 different substances are registered in the EU, 10,000 of which are marketed in volumes of more than 10 tonnes and a further 20,000 at 1-10 tonnes.

Industrial chemicals can escape from and leak out of the products in which they are used. They then contaminate the environment as they make their way into the air we breathe, the food we eat and the water we drink. We are exposed to chemicals released directly into the environment from industry, agriculture and other sources of environmental pollution such as vehicle and diesel exhaust, incinerators and tobacco smoke. In addition, many commercial products used in and around the home contain chemicals that pose a potential risk to humans, as they can escape from these products into air and dust, and end up in our bodies.

Chemicals can also enter our bodies through more direct routes. For example, those used in cosmetics and toiletries can enter our bodies through the skin, those used in food packaging can leach into food, and chemicals used in items such as children's toys can leach into saliva if those toys are chewed. Due to inadequate chemical regulations, very few of such chemicals have had their risks to human health, wildlife or the environment assessed sufficiently. The EU has admitted that 99 per cent of the volume of chemicals on the market are inadequately regulated. Only 14 per cent of EU high production volume chemicals have even the minimum "base-set" amount of data – and 21 per cent have no data at all (Allanou *et al*., 1999).

UK government surveys show that up to 30 per cent of our food is contaminated by pesticides (DEFRA, 2000). Others show that the indoor and outdoor air we breathe (e.g. Harrad *et al*., 2004, Wilford *et al*., 2004) and the dust in our homes (Greenpeace, 2003) are also contaminated. The presence of chemicals in these environmental "compartments" is a clear indication that humans could be exposed through these routes. The next logical step is therefore investigating the contamination of our own bodies. Biomonitoring is a way of doing this and has been used by WWF in its campaign work for safer chemicals, see www.wwf.org.uk/chemicals.

BIOMONITORING

Biomonitoring is the term given to the analysis of biological samples – for example human blood – to identify the presence and levels of specific substances in the body. The results provide an interesting record of the chemicals to which a person has been exposed and which have been retained in the body. Policy-makers can use such information to help determine whether current regulations are adequately protecting the public from chemical risks – and if they are found not to be, to help identify priority chemicals for better control. The results of our biomonitoring surveys clearly show that current regulations are not protecting the public from exposure to chemicals, as every person we tested was contaminated (see below).

In its first biomonitoring study in 2003, WWF tested the blood of 155 volunteers for the presence and levels of a range of 78 hazardous man-made chemicals, including organochlorine pesticides (OCPs), polychlorinated biphenyls (PCBs) and brominated flame-retardants (BFRs). The study revealed the startling extent of chemical contamination in the bodies of people from across the UK: every person in the survey was contaminated by chemicals from each of the chemical groups tested.

WWF, with The Co-operative Bank, continued this line of research by investigating contamination of the blood of 47 volunteers from 17 countries across Europe. They included 39 Members of the European Parliament and four observers from EU accession countries. In addition to the chemicals looked for in the UK survey, this study also analysed blood samples for a further 23 chemicals including phthalates (chemicals widely used in plastics), perfluorinated chemicals (used in greaseproof, stain repellent and non-stick products) and two additional brominated flame retardants (used in printed circuit boards and polystyrene foam). Again it was found that every person tested was contaminated and had chemicals from every group investigated in their blood.

This survey also produced some shocking results about levels of human contamination by man-made chemicals. In particular, deca-BDE, a suspected neurotoxic chemical used as a flame retardant, was found at what we believe to be the highest concentration yet detected in human blood serum anywhere in the world. Even more alarming was that this level was almost 10 times higher than that found in occupationally exposed people.

Detection of two other brominated flame retardants (TBBP-A and HBCD) also caused concern. As far as WWF is aware, TBBP-A (tetrabromobisphenol A) was found in the highest concentration so far detected in Europe and HBCD (hexabromocyclododecane) was found for the first time in human blood. The phthalate DEHP (di-ethylhexyl phthalate) and seven different perfluorinated chemicals were also detected in every person tested. These findings were very significant, as they illustrated that chemicals in widespread use today are contaminating people in the same way as banned chemicals such as DDT and PCBs. WWF showed that the chemicals that industry insists are safe are in fact accumulating in our bodies in the same way that hazardous chemicals did in the past.

MULTI-GENERATIONAL BIOMONITORING

Our previous surveys, while highlighting the extent of contamination of adults across Europe by persistent, man-made chemicals, investigated only individual and unrelated volunteers. A number of questions therefore arose – how contaminated are children and is there any relationship between levels of contamination in the members of the same family and especially between mothers and their children? It is known that chemicals are passed from mother to foetus during gestation (pregnancy) and from mother to baby during breast-feeding. We also noted in our previous surveys that older people tended to be more contaminated, presumably due to being exposed for longer to the chemicals investigated. So to what extent might children be contaminated by chemicals that were banned before they were born? Are they contaminated in the same way as our adult volunteers? How do different generations differ in their chemical burdens, particularly of chemicals still in use? And do people's lifestyles affect the level and nature of their contamination? The present study was carried out to investigate the contamination of different generations of UK families and to attempt to uncover any links between this and their lifestyles.

CHEMICALS IN EVERYDAY PRODUCTS

Exposure to hazardous man-made chemicals is not an occupational phenomenon, restricted to people working in a chemical manufacturing plant or spraying crops with pesticides. It is something that affects us all, as man-made chemicals are found in everything we use in our daily lives. From flame retardants in sofas, textiles and electrical appliances, non-stick coatings on pans, synthetic fragrances in toiletries, ingredients in cosmetics and pesticides in the food we eat, it is impossible to avoid exposure to man-made chemicals. The most worrying aspect of this is that since there is insufficient safety data for a large number of such chemicals to which we are unwittingly exposed, we do not know whether or to what extent we – and foetuses – are being adversely affected by these exposures.

Although little is known about the relationship between exposure to most chemicals and the risks they pose, there are exceptions which should serve as cautionary tales. It is known that many organochlorines (chlorine-containing compounds) including polychlorinated biphenyls (PCBs) and certain pesticides such as DDT, persist in the environment and become concentrated in animal tissues. Despite assurances at the time that such chemicals were "safe", it has emerged that many were toxic, having the ability to disrupt the endocrine system (the body's hormonal signalling system, crucially important for regulating reproduction and development), the reproductive system and the immune system. The developing foetus, infant and child are particularly vulnerable to many of these compounds. Birth defects and developmental disabilities are increasingly common, and chemicals are considered to play a role in the development of some of these conditions.

WWF is particularly concerned that very persistent (vP) chemicals (those that aren't broken down in the environment and therefore linger for long periods of time) and very bioaccumulative (vB) chemicals (those that build up in the tissues of living organisms) are not adequately addressed in the new EU Chemical Regulation (see below). These types of chemicals are of particular concern because once released into the environment, they cannot be recalled like products on a supermarket shelf. Instead, they will persist and build up in people, wildlife and the environment, and may reach levels that cause adverse effects. For example:

- Some wildlife, including polar bears, are suffering decreased immune system function due to the immunotoxic effects of accumulated PCBs.
- Dog-whelk populations crashed in coastal waters around the UK, other parts of Europe and elsewhere in the world due to tributyltin (TBT) which masculinised female dog-whelks, making them unable to reproduce. TBT was widely used in anti-fouling paints on ship hulls to prevent organisms from growing on the bottom of boats.
- Populations of many birds of prey crashed in the UK as a result of their contamination by DDT, which caused the birds' eggshells to thin so much that they broke during incubation.

Despite such ruinous outcomes, governments and industry have not learned from these historical examples – chemicals with very similar physical properties to DDT and PCBs are still in widespread use. For example, brominated flame retardants and perfluorinated chemicals are contaminating wildlife and humans across the planet. These chemicals are widely used in our daily lives (see above), but once released into the environment they can contaminate the whole food chain. Consequently, even polar bears in the Arctic have these chemicals in their bodies and perfluorinated "non-stick" chemicals have been found in wildlife (including porpoises, sea birds and otters) and humans around the world.

WWF is not alone in wanting urgent action to stop our exposure to such hazardous man-made chemicals:

- In May 2003, 60 European environmental and human health scientists signed a declaration highlighting the urgent need to reduce human exposure to persistent and bioaccumulative chemicals and endocrine disrupting chemicals; and
- in June 2003, the Royal Commission on Environmental Pollution in the UK published a report which recommended that "*where chemicals are found in elevated concentrations in biological fluids such as breast milk, they should be removed from the market immediately*".

HEALTH EFFECTS OF CHEMICALS

The available health and safety data is inadequate to assess the potential impacts of the vast majority of chemicals on the market, including many of the chemicals we are testing for – for example, certain brominated flame retardants and the perfluorinated chemicals. However, data is available for some of the chemicals in this survey. PCBs, for instance, are known carcinogens and reproductive and neurological toxicants.

In addition to the toxicity data already available on some of these chemicals, new studies are frequently being published in scientific literature which show that chemicals are able to produce subtle adverse effects at lower levels than previously ever thought.

Furthermore, continuing developments in understanding how chemicals exert their toxic effects show that the present approach to chemical risk assessment, whereby substances are assessed individually, does not adequately predict their risks. For instance, chemical risk assessments do not take account of the fact that:

- chemicals are never present alone as single contaminants – we are all exposed to a cocktail of chemicals, and there is therefore a potential for interaction between chemicals; and
- foetuses and young children are particularly sensitive to chemicals, so that exposure in the womb can produce adverse effects at lower concentrations than would affect adults.

Taken together, there are great uncertainties surrounding what might be considered a safe level of exposure to hazardous chemicals, especially when they persist in the body for long periods. While WWF does not claim that exposure to a certain chemical at a certain concentration will cause a particular adverse effect in a particular individual, neither do we accept that continuing exposure, especially of developing foetuses, infants and young children, to a cocktail of hazardous chemicals can be considered "safe".

POLICY CONTEXT

Current chemical regulations

The current system in Europe for regulating chemicals is widely acknowledged to be failing to protect human health and the environment and is in urgent need of a radical overhaul. Among the tens of thousands of industrial chemicals registered in Europe prior to 1981 ("Existing Substances"), 140 have been prioritised by EU member states for evaluation to determine whether measures are needed to reduce the risks they pose to humans or the environment because of their hazardous nature. Nevertheless, in the 10 years since this process was started, fewer than half of the substances have had their evaluations completed and fewer still have been the subject of regulatory action to limit their known threat. Chemicals introduced after 1981 (approximately 2 per cent of chemicals currently registered) are subject to much tighter safety testing requirements.

Several chemicals investigated in this survey were phased out in an uncoordinated manner, country by country and year by year, before they were finally subjected to widespread international bans through international agreements such as the Stockholm Convention on Persistent Organic Pollutants. Persistent Organic Pollutants (POPs) are defined as being persistent, bioaccumulative and able to travel great distances. Four chemicals, or groups of chemicals, classified as POPs (DDT, PCBs, HCB and chlordane) were analysed in this study and have been found in WWF's previous biomonitoring surveys. After years of painfully slow negotiation, the Stockholm Convention finally came into force in 2004. Experience of the POPs "Dirty Dozen", which includes the chemicals listed above, serves to highlight the often inadequate protection against known toxic chemicals from international chemical regulations.

This illustrates the unacceptably slow pace of regulation currently in place to protect our lives and the environment from some of the world's most hazardous chemicals. It usually takes many years, if not decades, from the first warning signs of a chemical's hazardous nature to it being regulated (adequately or otherwise).

The proposed new EU Chemical Regulation (REACH)

The EU is currently developing and negotiating a new chemical regulation, known as REACH (Registration, Evaluation and Authorisation of Chemicals). This was initially developed to address widely perceived legislative failures and inadequacies of current chemicals regulations. Under the proposals, the chemical industry will have to provide safety data on chemicals for the first time, which will then need to be evaluated to determine their safety for use in different applications. This is a reversal of the required burden of proof. Previously, regulators needed to provide evidence of harm in order to regulate a chemical, rather than industry having to provide evidence of the safety of their chemical before it could be marketed.

The development of this EU legislation presents a once in a generation opportunity to regulate chemicals of very high concern while amalgamating 40 separate pieces of existing legislation. The last major overhaul of chemical legislation was in 1981 – a generation ago. The proposals could help establish a robust system of regulation that protects present and future generations from toxic chemicals. However, the proposals aren't tough enough as they stand, as the authorisation process will fail to ensure that chemicals of very high concern are phased out even when safer alternatives are available.

If the EU strengthens the proposals as we outline at the end of this report, the new legislation will yield a more progressive, precautionary and science-based chemicals policy. This will encourage industry to innovate in order to produce greener and safer products and give them competitive advantage over other manufacturing regions. If the EU supports new, strengthened legislation, WWF hopes that the REACH standard becomes the global norm.

AIMS OF THE STUDY

WWF has previously revealed the extent to which people in the UK and Europe are contaminated by a cocktail of hazardous man-made chemicals. However, these studies did not look at the chemical contamination of different generations of the same family, which is of importance in light of what is known about the nature of chemical transfer in the womb and via breast milk. Nor did the previous studies examine in detail the possible sources of chemical exposure in their volunteers. This is important since the chemicals we are looking for in the blood can be found in everyday consumer products and food and this may have a role in influencing people's levels of contamination.

In light of this, the aims of the study are:

1. to examine potential generational differences in the levels and types of contamination of UK families, by testing the blood of children, parents and grandparents in the same family for a range of persistent and bioaccumulative chemicals; and
2. to examine possible links between contamination and a family's lifestyle, consumption patterns and everyday products.

Generational differences

The aim of analysing three generations is to investigate potential differences in chemical burden and chemical profile between the generations, possible differences in firstborn and second children and possible "fingerprinting" of trans-generational contaminant burden (where a child's chemical profile might resemble that of the mother).

Lifestyle

Do members of a family who live in the same house, eat together, use the same products and lead similar lives, have a comparable chemical "profile"? By gathering information on a family's lifestyle and the products they use, the aim is to qualitatively investigate whether links exist between a family's contaminant burden and what they eat, use, apply to themselves, surround themselves with and do in their lives.

When particularly interesting results are found, we investigate links between the chemical data and potential exposure routes by a more in-depth study of the lifestyle data.

METHODS

Recruitment of volunteer families

Seven families from around England, Scotland and Wales were sampled for blood during June and July 2004. A total of 33 people were sampled. Families were selected subject to having at least three generations available for testing, agreeing to be tested in their homes and agreeing to spend some time completing lifestyle and product inventory questionnaires before being tested.

Each family sampled comprised three generations, including the mother, the grandmother and at least one child. Ages ranged from nine years to 88 years.

Table 1. Individual family members tested in the survey.

Family No.	Grandmother	Mother	Father	Child 1	Child 2	Child 3
1	✔	✔	✔	✔ F	✔ M	-
2	✔	✔	✔	✔ M	✔ M	-
3	✔ *	✔	✔	✔ M	✔ F	-
4	✔	✔	✔	✔ F	✔ M	-
5	✔	✔	-	✔ F	✔ F	-
6	✔ *	✔	✔	✔ M	✔ F	✔ F
7	✔	✔	✔	✔ F	-	-

* The grandmother in family 3 is also grandmother to family 6.

Blood sampling

Approximately 40-50ml of blood was taken from each family member by vein puncture, using the vacutainer system. In certain cases, volumes less than 40-50ml were collected, due to vein collapse or difficulty in locating suitable veins.

Blood samples were immediately centrifuged (3,000 rpm for 10 minutes) after collection, to separate the blood cells and platelets from the serum. Samples were then frozen and kept frozen for transport to the laboratory for analysis. Blanks (ultra-pure water) were also taken at the time of sampling to ascertain the contribution of background levels of analytes at each sampling location.

Chemical analysis of blood

Blood samples were analysed for 108 individual chemicals in seven different groups, by SAL (Scientific Analysis Laboratories Ltd), Manchester, UK.

- 12 organochlorine pesticides (including DDT, DDE, Chlordane, HCH, lindane, HCB)
- 44 PCBs
- 33 brominated flame retardants (31 PBDEs plus HBCD and TBBP-A)
- 8 phthalates (including DEHP)
- 7 perfluorinated chemicals (including PFOS and PFOA)
- 2 artificial musks
- 2 antibacterials (triclosan and its breakdown product, methyl triclosan)

Organochlorine Pesticides (OCPs)

Many pesticides developed and in widespread use in the 1950s, ’60s and ’70s were OCPs. Many have now been banned in the UK after they were belatedly found to be highly persistent in the environment and cause long-term toxic effects in wildlife. For example, populations of raptors were devastated due to DDT causing their eggshells to thin and break. DDT has been found in wildlife and people all over the world and WWF’s previous biomonitoring reports have found p,p’ DDE , a breakdown product of DDT, in the blood of every person tested.

PCBs (polychlorinated biphenyls)

This group of industrial chemicals were used in electrical equipment in the 1970s but banned in the UK after they were found to be toxic and to be building up in animals and people across the world. Adverse behavioural and neurological effects that some babies were born with are now associated with elevated levels of PCBs in their mothers’ bodies.

BFRs – brominated flame retardants (PBDEs, TBBP-A and HBCD)

This is a group of brominated chemicals, used as flame retardants in numerous consumer products, that can be sub-divided into PBDEs (Poly Brominated Diphenyl Ethers) and two other compounds, TBBP-A and HBCD. The PBDEs are a group of BFRs, some of which are suspected hormone disrupters, used as flame retardants in many everyday items such as plastics, textiles, furniture and electrical appliances. They are contaminating humans and wildlife throughout Europe, the Arctic and North America, and the levels of contamination are increasing. TBBP-A and HBCD, used as flame retardants in plastics, insulation foams and electrical goods, are also accumulating in the environment, wildlife and humans.

Phthalates

Phthalates are a group of man-made chemicals widely used as additives in many plastics and consumer products. Di-ethylhexyl phthalate (DEHP) is the most commonly used phthalate and is a ubiquitous environmental contaminant. Phthalates are relatively persistent in the environment and have been detected in drinking water, soil, household dust, fish and other wildlife. Phthalates have also been detected in fatty foods (meat and dairy products), human blood and breast milk, and phthalate metabolites have been detected in the urine of adults and children.

Perfluorinated chemicals

Perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) are members of a chemical group known as perfluorinated chemicals (PFCs). PFCs are heat stable, extremely resistant to degradation and environmental breakdown, and repel both water and oil. It is these properties that are exploited in their various applications, ranging from the manufacture of non-stick pans, stain/water repellents for clothing and furniture to floor waxes and paper coatings. These chemicals are accumulating in the environment and have been found in a wide range of wildlife, as well as in humans.

Artificial musks

HHCB and AHTN are two artificial musks – a group of man-made chemicals used to fragrance a wide variety of toiletries, cosmetics and cleaning products. Artificial musks, being persistent and bioaccumulative, are widespread environmental contaminants. HHCB and AHTN have been measured in rain and river water, lakes, sediment, sewage sludge and wastewater treatment plant effluent in Canada, the United States and Europe, including the UK.

Triclosan

Triclosan is a man-made chemical used as an antibacterial/antimicrobial agent incorporated into numerous everyday products where there is a perceived need for such properties – for example in kitchenware, soap and personal care products. It has been shown to be accumulating in the environment and wildlife, and has been detected in human breast milk.

Lifestyle data collection

All family members were asked to complete a detailed questionnaire about their diet and lifestyle. In addition, one member of each family was also asked to fill in a product inventory for the family home. The aim of the questionnaire and inventory was to discover the kinds of products the family use in their home and workplace, and the kind of lifestyle they lead.

In the product inventory, the family home was broken down into various rooms. Listed within those rooms were the typical products that might contain chemicals of concern. The garden/shed/workshop areas of the home were also included, as well as questions about cars belonging to the household. For each product listed in the inventory, the families were asked to state whether or not they had the product, in what numbers and (where applicable) the age of the product. The brand and a brief description of the product were also requested as this information can be useful in identifying whether it contains chemicals of concern. Similarly, the lifestyle questionnaire was designed to discover what kind of chemicals the family might come into contact with through their diet, work and leisure activities. It is also designed to reveal more general information about the family that might be useful in explaining aspects of any contamination in their blood.

ROUTES OF EXPOSURE

There are many exposure routes by which people can be contaminated by the chemicals for which we were searching. Exposure can occur during application – for example, exposure to DDT is possible in countries where it is or has been used to control malarial mosquitoes. But chemicals can also escape or leach from the products in which they are found, and contaminate both indoor and outdoor environments. We can then become exposed to these chemicals through the air we breathe, the water we drink and the food we eat. The studies quoted below offer some explanation as to how family members can become exposed to certain chemicals or groups of chemicals.

Diet

For many persistent chemicals such as PCBs and dioxins, food accounts for more than 95 per cent of human exposure. Oily fish is a particularly important route of exposure to PCBs and organochlorines such as DDT (Hites *et al*., 2004a). Recent studies have shown that PBDEs can also be found in fish such as tuna (Ueno *et al*., 2004) and salmon (Hites *et al*., 2004b). Cod liver oil has also been shown to contain chemicals such as PCBs and organochlorines (Storelli *et al*., 2004).

Another recent study has shown that foods other than fish can be sources of exposure to PBDEs (Schecter *et al*., 2004). Researchers found that the PBDE levels in tested foods varied widely, with the highest average levels in fish, followed by meat and dairy products. PBDEs were even found in soy infant formula.

Air

In addition to the dietary route discussed above, research has shown that products in the home and office may be a major source of people's exposure to PBDEs. A recent study provides strong new evidence that indoor air can be a significant source of exposure to PBDEs in the home (Wilford *et al*., 2004). Products found in the home – including upholstered sofas, chairs, curtains, carpet underlay and mattresses – can contain high levels of brominated flame retardants such as the penta-BDE formulation recently banned in the EU, and these chemicals can then escape from these products into the air and be inhaled. This is reflected in the fact that researchers found detectable levels in air in all the homes sampled in the survey: higher levels in air could be the reason why some people had elevated levels of PBDEs in their blood. Other studies (e.g. Greenpeace, 2003) have shown that PBDEs such as penta- and deca-BDE can be found in house dust and that this can be a significant exposure route to these chemicals. Additionally, concentrations of PBDEs in office air have been correlated with the number of electrical appliances and chairs containing polyurethane (Harrad *et al*., 2004).

A study has shown that the phthalate DEHP can escape from PVC flooring into air and dust (Clausen *et al*., 2004), creating an inhalation exposure route.

The perfluorinated ("non-stick") group of chemicals can be found in people and wildlife all over the world (Kannan *et al*., 2004, Martin *et al*., 2004, Taniyasu *et al*., 2004), but the information on the routes of exposure to these chemicals is limited. More work needs to be done on the environmental fate and behaviour of these chemicals if we are to discover how they are contaminating the globe to such an extent.

RESULTS AND DISCUSSION

Family Profiles

The following family profiles are general interpretations of the lifestyle questionnaires completed by the families. They are a guide, not a comprehensive insight. However, they may help identify potential sources of contamination by the chemicals in question.

Family 1

Family 1 live in the centre of a large city. They regularly eat organic produce – fruit and vegetables daily, and meat and dairy products less often. Apart from the mother, family members exercise or play sport at least two hours a week. The parents are active around the home, spending up to four hours a week on DIY or working in the garden. They also spend anything from two to six hours in front of a computer screen or a television at work and home each day.

There is potential for the mother to have been exposed to DDT and lindane through various incidences in her childhood. Their home has numerous electrical appliances, such as televisions, videos, a computer, a games console and kitchen gadgets. The family uses a range of popular toiletries, perfumes and cosmetic products, but they also use antibacterial soap and toothpaste. They use non-stick cookware in the kitchen.

Family 2

Family 2 live in a suburb of a large city and are less active than some other families in the survey. They eat some organic food once a month but consume processed foods more often. The mother takes cod liver oil. The family watch around two to four hours of television a day, and the children play on games consoles for several hours. The father works up to eight hours a day in front of computer, and the children one or two hours. Their household contains recently purchased products treated with flame retardants.

Family 3

Family 3 live on the outskirts of a rural town. They are an active family: with the exception of the grandmother, who does up to four hours organised exercise a week, they do more than four hours of exercise or sport a week, as well as DIY and gardening. The family eats organic food such as fruit, vegetables and dairy products every day, but the mother and children can eat up to four ready made/microwave or takeaway meals a week. The father works between four and six hours a day on a computer, while other family members spend between one or two hours daily. The family don’t own a television but are regular cinemagoers, and the children can spend up to two hours a day playing computer games.

Family 4

Family 4 are a farming family in a fairly isolated rural community. They eat minimal processed foods and an abundance of home-grown vegetables. In addition to the family living and working on the farm, the children also do up to two hours exercise a week and the whole family watch several hours of television a week. The youngest child also plays on a game console for a few hours a day. Their home has a few electronic gadgets and appliances. The father spends much time working in vehicles during the day. As well as farming, he works in the garden and does DIY. The main family home is insulated by expanded polyurethane foam and has one television, video machine and computer. Family members make little use of toiletries, cosmetics and personal care products, but do use antibacterial soap and toothpaste.

Family 5

Family 5 live in a country village. Apart from the grandmother, they do not eat organic food. The mother takes more than four hours regular exercise per week as well as doing DIY and gardening. It is not apparent what exercise the grown-up children take. The grandmother's home has a lot of new electrical and white goods purchased in the last few years, and her sofa is flame retarded. The grandmother is a keen overseas traveller and the mother spends between four and six hours in front of a computer every day.

Family 6

Family 6 live in a small rural town. They regularly participate in organised sport, do DIY and tend their vegetable garden as well as spending time in front of a computer or the television. The family diet includes daily organic fruit and vegetables as well as other organic foods less frequently. The parents and grandmother take fish liver oil supplements. The grandmother has visited a malarial country and the mother has worked with DDT. Both the family and the grandmother have goods which could be flame-retarded and the family home has PVC flooring in the kitchen, bathroom and utility room. The grandmother's house contains several new electrical appliances and white goods – a washing machine, drier, oven, extractor and fridge freezer all bought within the last two years, and several electrical kitchen appliances and non-stick cookware bought within the last six months.

Family 7

Family 7 live on a farm in the countryside and eat a diet containing fresh vegetables, occasional oily fish and minimal convenience foods or takeaways. With the exception of the grandmother, who eats organic fruit and vegetables three times a week, the family never eats organic. The family regularly exercise each week but also watch several hours of television a day. The grandmother has visited a malarial country and the father has worked in sheep dipping. The adults are keen gardeners. Both the family's and the grandmother's homes have PVC flooring in the kitchen. Both the family and the grandmother use non-stick cookware.

RESULTS OVERVIEW

As in previous surveys, the results of this survey revealed that every family member tested was contaminated by man-made chemicals. The results are summarised in the tables below and are expressed in different ways for the different chemical groups.

Levels of OCPs, PCBs and PBDEs are reported in "ng/g lipid" – i.e. the amount of the chemical (ng = nanogram) is expressed with respect to the amount of lipid (fat) in the serum. Levels of phthalates, artificial musks and perfluorinated chemicals are expressed in "ng/g whole blood". This means the concentration of the chemical found in the blood as a whole, not just the serum. (NB: ng/g = parts per billion).

Minimum (which includes zero values i.e. not detected) and maximum concentrations for the survey are presented as well as the median concentration in the survey. A median value is similar to an average value, but is technically a more accurate term with the spread of data found in this kind of survey. A median is the middle value in a set of values when they are arranged in order of size. The median is calculated using all values in a data set, not just the positive values (i.e. detected levels), which therefore includes zeros ("non-detects").

Due to the above differences, the concentrations of all chemicals detected in the blood cannot be combined to give an overall chemical burden for each family member. Instead, there are two types of totals quoted here – the total concentration of OCPs, PCBs and PBDEs in the serum (ng/g lipid) and the total concentration of phthalates, artificial musks and perfluorinated chemicals in whole blood (ng/g whole blood).

Results for the antibacterial chemical triclosan (and its breakdown product methyl triclosan) and the flame-retardants HBCD and TBBP-A are not included in the tables below as the analysis employed was not sufficiently sensitive for them to be reported with a satisfactory degree of confidence.

Contamination of three generations by persistent and endocrine disrupting chemicals

Table 2. Table showing selected chemicals and the number of grandmothers, parents and children in which they are found in this survey.

Chemical	For whole survey (n=33)	Grandmothers (n=6)	Parents (n=13)	Children (n=14)
β-HCH	17	5	7	5
Hexachlorobenzene	28	5	12	11
p,p' DDE	33	6	13	14
PCB congener 99	33	6	13	14
PCB congener 118	33	6	13	14
PCB congener 170	33	6	13	14
DEHP	26	5	10	11
BDE 153 (penta and octa)	33	6	13	14
BDE 209 (deca)	7	1	2	4
Perfluorooctanoic acid (PFOA)	12	3	4	5
Perfluorooctane sulphonate (PFOS)	5	0	3	2

Table 2 above shows a selection of chemicals, the number of people in total and the three generations found with this chemical in their blood. Despite having been banned in the 1970s, organochlorines such as PCBs and DDT (represented by its ubiquitous breakdown product p, p' DDE) are found in every person in this study, from the youngest to the oldest. Newer chemicals still in use today are also contaminating three generations of the families tested. For example, the brominated flame retardant deca-BDE, despite having undergone a recent risk assessment in the EU and been deemed "safe", is found in seven people in the survey, the majority (57 per cent) of whom are children. Of particular note is that the highest level of this chemical found (33.9ng/g lipid), is higher than levels found in occupationally exposed workers (Jakobsson *et al*., 2003).

WWF believes that the continued use of such a chemical is putting future generations at unacceptable risk, particularly as the long-term health impacts are still unclear. While the precautionary principle has been ignored for deca-BDE in the EU risk assessment, other persistent, bioaccumulative chemicals found in the blood of children, parents and grandparents are subject to regulatory legislation.

For example, the UK government is pressing for the perfluorinated chemical PFOS (perfluorooctane sulphonate), a chemical closely related to PFOA (found in more than a third of the children in this survey), to be phased out due to concerns over its health and environmental impacts. The phthalate chemical DEHP, used as a plasticiser in numerous plastic products, is found in 79 per cent of the survey and more than three-quarters of the children tested.

Phthalates, including DEHP, in house dust have been correlated with increased incidence of asthma, eczema and rhinitis in children (Bornehag *et al*., 2004). For several years DEHP, together with a number of other phthalates, has been subject to a temporary EU ban on its use in toys for children under three years and intended to be put in the mouth. This ban became permanent in September 2004 and is extended to all children's toys.

If such legislation is planned for phthalates and perfluorinated chemicals, WWF believes that deca-BDE, used in large amounts to flame retard electrical appliances and computers, should be restricted and/or phased out too. Additionally, WWF believes the UK government's action on phasing out PFOS should be extended to PFOA, a related perfluorinated chemical, since there are concerns about its carcinogenicity and toxic effects. Recent studies have shown that it is contaminating people and wildlife around the world and there is data to suggest that it may be a developmental toxicant. The US chemical company DuPont, which manufactures perfluorinated chemicals, was recently forced to pay a $100 million settlement to residents close to its plant in West Virginia who have been exposed to these chemicals, including PFOA, through their drinking water (ENDS report 356, September 2004).

PFOA is found in 12 people surveyed, including five children.

Table 3. Minimum, maximum and median levels of organochlorine pesticides in the blood of all 33 family members.

Organochlorine pesticides (ng/g serum lipid)	Min	Max	Median	**Detected in (of 33)**
Alpha HCH	0	8.9	0	**1**
Beta HCH	0	130.0	5.5	**17**
Gamma HCH	0	15.2	0	**3**
Hexachlorobenzene	0	85.0	10.2	**28**
cis Chlordane	0	39.2	0	**1**
trans Chlordane	0	119.0	0	**2**
o,p' DDE	-	-	-	**0**
o,p' DDD	-	-	-	**0**
o,p' DDT	-	-	-	**0**
p,p' DDE	5.7	1500.0	54.5	**33**
p,p' DDD	0	58.2	0	**3**
p,p' DDT	0	17.7	0	**1**
Total OCPs	**14.9**	**1715.0**	**79.7**	
Number of OCPs detected	**1**	**8**	**3**	

Table 4. Minimum, maximum and median levels of PCBs in the blood of all family members.

PCBs (ng/g serum lipid)	Min	Max	Median	**Detected in (of 33)**
18	0	12.3	0	**2**
28/31	0	62.5	0	**11**
22	0	9.8	0	**4**
41	-	-	-	**0**
44	0	10.5	0	**10**
49	0	11.6	0	**5**
52	0	9.5	0	**13**
54	0	9.5	0	**7**
56/60	-	-	-	**0**
64	-	-	-	**0**
70	0	15.5	0	**7**
74	0.7	64.3	4.4	**33**
87	0	11.3	0	**9**
90	-	-	-	**0**
99	0.8	50.0	4.6	**33**
101	0	12.3	0	**7**
104	0	14.5	0	**5**
105	0	19.0	1.0	**20**
110	0	11.3	0	**3**
114	0	10.7	0	**11**
118	1.0	100.0	5.4	**33**
123	0	10.0	0	**6**
138/158	3.0	215.0	22.5	**33**
141	0	0.3	0	**1**
149	0	9.8	0	**15**
151	0	9.8	0	**9**
153/168	4.2	357.1	42.7	**33**
156	0	44.6	4.0	**32**
157	0	13.0	1.2	**19**
167	0	13.4	2.0	**24**
170	1.3	196.4	13.8	**33**
177	0	16.5	3.4	**27**
180	2.7	607.1	33.9	**33**
183	0	27.5	3.6	**30**
187	0.9	92.9	7.2	**33**
188	0	11.1	0	**3**
189	0	10.9	0	**15**
194	0	96.4	6.1	**29**
199	0	101.8	4.5	**32**
203	0	78.6	4.9	**28**
Total PCBs	**17.7**	**1946.4**	**163.0**	
Number of PCBs detected	**11**	**38**	**21**	

Table 5. Minimum, maximum and median levels of PBDE flame retardants in the blood of all family members.

PBDEs (ng/g serum lipid)	Min	Max	Median	**Detected in (of 33)**
17	0	17.9	0	**1**
28	0	5.2	0	**2**
32	-	-	-	**0**
35	-	-	-	**0**
37	-	-	-	**0**
47	0	24.1	4.2	**25**
49/71	-	-	-	**0**
66	0	2.2	0	**1**
75	-	-	-	**0**
77	0	6.3	0	**2**
85	0	6.3	0	**2**
99	0	12.6	0	**4**
100	0	8.5	2.9	**26**
119	0	6.1	0	**2**
126	-	-	-	**0**
138	-	-	-	**0**
153	0.7	21.4	3.3	**33**
154	0	10.2	0	**2**
156	-	-	-	**0**
166	-	-	-	**0**
181	-	-	-	**0**
183	0	10.4	0	**3**
184	0	9.3	0	**2**
190	-	-	-	**0**
191	0	8.8	0	**2**
196		21.4		**3**
197	0	15.5	0	**9**
206	-	-	-	**0**
207	-	-	-	**0**
209	0	33.9	0	**7**
Total PBDEs	**0.7**	**163.9**	**14.9**	
Number of PBDEs detected	**1**	**15**	**3**	

Table 6. Minimum, maximum and median levels of phthalates in the blood of all family members.

Phthalates (ng/g whole blood)	Min	Max	Median	**Detected in (of 33)**
DMP	-	-	-	**0**
DEP	0	30.0	0	**9**
DisoBP	0	150.0	0	**13**
DBP	0	43.0	0	**8**
BBP	0	33.0	0	**12**
DEHP	0	1400.0	180	**26**
DiNP	0	280.0	0	**2**
DiDP	0	80.0	0	**2**
Total phthalates	**0**	**1666.0**	**213.0**	
Number of phthalates detected	**0**	**5**	**1**	

Table 7. Minimum, maximum and median levels of artificial musks in the blood of all family members.

Artificial musks (ng/g whole blood)	Min	Max	Median	**Detected in (of 33)**
HHCB	0	2.0	0	**1**
AHTN	-	-	-	**0**
Total musks	**0**	**2.0**	**0**	
Number of musks detected	**0**	**1**	**0**	

Table 8. Minimum, maximum and median levels of perfluorinated chemicals in the blood of all family members.

Perfluorinated chemicals (PFCs) (ng/g whole blood)	Min	Max	Median	**Detected in (of 33)**
Perfluorooctanoic acid (PFOA)	0	28.68	0	**12**
Perfluorooctane sulphonate (PFOS)	0	19.16	0	**5**
Perfluorononanoic acid (PFNA)	0	7.29	0	**7**
Perfluorodecanoic acid (PFDA)	0	1.72	0	**4**
Perfluoroundecanoic acid (PFUnA)	0	31.83	0	**4**
Perfluorododecanoic acid (PFDoA)	0	9.68	0	**14**
Perfluorotetradecanoic acid (PFTrDA)	0	17.72	0	**12**
Total PFCs	**0**	**45.19**	**2.40**	
Number of PFCs detected	**0**	**5**	**2**	

Table 9. Minimum, maximum and median total levels of all chemicals in the blood of the family members.

Totals	Min	Max	Median
Total number of chemicals detected	17	62	31
Total burden (ng/g lipid)	48.3	3056.5	299.7
Total burden (ng/g whole blood)	0	1684.3	213.5

FAMILY RESULTS OVERVIEW

Family 1

	Grandmother	Mother	Father	Daughter (1)*	Son (2)*
Total OCPs (ng/g lipid)	288.7	132.1	124.7	329.1	23.2
Number of OCPs detected	6	5	3	8	2
Total PCB (ng/g lipid)	699.6	852.0	318.3	136.2	97.5
Number of PCBs detected	26	38	20	34	17
Total PBDE (ng/g lipid)	9.1	163.9	5.6	63.8	41.4
Number of PBDEs detected	3	15	2	14	4
Total phthalates (ng/g whole blood)	Not found	Not found	Not found	Not found	560.0
Number of phthalates detected	0	0	0	0	5
Total musks (ng/g whole blood)	Not found	2.0	Not found	Not found	Not found
Number of musks detected	0	1	0	0	0
Total PFCs (ng/g whole blood)	0.5	5.7	14.3	Not found	2.3
Number of PFCs detected	1	3	2	0	2

Total number of chemicals detected	36	62	27	56	30
Total burden (ng/g lipid)	997.4	1148.0	448.6	529.1	162.2
Total burden (ng/g whole blood)	0.5	7.7	14.3	0.0	562.3

* The numbers in parentheses denote if the child is the first, second or third born in the family (where applicable).

The mother and daughter of this family have the survey's highest and second highest number (62 and 56 respectively) of chemicals in their blood. The daughter therefore has higher numbers of chemicals in her blood than her father and grandmother. The daughter's blood contains the highest number of OCPs (8) the second highest number of PCBs (34) and the second highest number of PBDEs (14) detected in the whole survey. The mother's blood contains 38 different PCBs which is the joint highest number of PCBs detected in an individual in the survey. Her blood also contains 15 PBDE flame retardant chemicals – the highest number of PBDEs detected in the survey. As a result, her total blood burden of PBDEs is the highest of the survey and is more than twice the second highest level in the survey.

By comparison the grandmother, father and son have fewer chemicals in their blood. The mother's total ng/g lipid burden is the highest of her family, followed by the grandmother (her mother), the daughter, the father and then the son. The youngest member of the family, the son, has the highest ng/g whole blood total burden in the family, due principally to his higher levels of phthalates. All the family members apart from the daughter have perfluorinated chemicals in their blood.

Lindane

There are only three people in the survey whose blood contains lindane (γ-HCH) and they are all in this family. They are the grandmother, mother and daughter. Before being banned for agricultural uses in the EU, lindane was widely used as an insecticide. It can still be found in lotions, creams and shampoos used to control head lice and scabies.

PBDE flame retardants

Every person in this family has PBDE flame retardants in their blood. PBDEs are commonly found in carpets, textiles, furniture and electrical appliances. The PBDEs detected in the family's blood are constituents of the flame retardant formulations known as penta- and octa-BDE. These PBDEs have recently been banned in the EU, due to concerns about their effects and the fact that they have been shown to be persistent (they don't easily break down) and bioaccumulative (they build up in the environment, wildlife and people).

The mother, daughter and son also have deca-BDE in their blood. Deca-BDE, found in plastic used in casings for electrical appliances and computers, is a PBDE flame retardant still used in the EU but there are similar concerns regarding its tendency to bioaccumulate and its potential neurological effects. Recent research has shown that these chemicals can escape from the products in which they are used and contaminate indoor air and dust, and that this can be a significant source of exposure in the home (Wilford *et al*., 2004).

A common route of exposure to PCBs and organochlorines is through the diet, especially through consumption of oily fish. Recent studies have also shown that PBDEs can be found in fish such as tuna and salmon. Therefore, the family's contamination by these kinds of chemicals could partly be a result of their consumption of such food. The daughter's high number of OCPs, PCBs and PBDEs could be influenced by the fact that she eats oily fish more frequently (two or three times a week) than the rest of her family.

When the chemical profiles for the different members of the family are compared, there are clear similarities with respect to PCBs and PBDEs between the mother and daughter. While human exposure to PCBs and PBDEs generally follow similar patterns, the number and overall proportions of these chemicals in the mother and daughter have more similarities than the rest of the family. The types of OCPs found in the blood of the grandmother, mother and daughter are also more similar to each other than they are to the father and son.

The disparity between the family members could be a result of similarities in dietary/leisure and lifestyle choices of the mother and daughter. Since chemicals can be passed from mother to child during pregnancy and breast-feeding, this could explain how the daughter has accumulated such a similarly wide range of chemicals despite her relatively young age (see "Inheriting a toxic burden?"). In contrast to the rest of her family, the grandmother has one of the lowest levels of PBDEs in the survey, which might reflect the fact that she lives in a different house.

Deca-BDE

The mother, daughter and son have comparable levels of deca-BDE in their blood. Deca-BDE is used in plastics for electrical appliances, of which there are several in the family home. However, the father's blood does not contain this chemical, so there may be a specific route of exposure exclusive to these three family members.

Phthalates

The son also has elevated levels of phthalates in his blood, whereas the other family members do not. This suggests there could be a specific source of phthalates in the son's life or diet to which the rest of the family is not exposed.

The mother is the only person in the family (and in the survey) to have artificial musks in her blood and in contrast to the other chemical groups, the daughter is the only person in her family not to have perfluorinated ("non-stick") type chemicals in her blood.

Family 2

	Grandmother	Mother	Father	Son (1)*	Son (2)*
Total OCPs (ng/g lipid)	1715.0	303.0	79.7	73.6	54.4
Number of OCPs detected	3	3	3	3	3
Total PCB (ng/g lipid)	1325.5	276.7	485.8	163.0	94.2
Number of PCBs detected	32	18	25	24	21
Total PBDE (ng/g lipid)	16.0	21.5	3.9	36.0	46.3
Number of PBDEs detected	3	2	1	4	4
Total phthalates (ng/g whole blood)	120.0	213.0	815.0	Not found	237.0
Number of phthalates detected	1	3	5	0	2
Total musks (ng/g whole blood)	Not found	Not found	Not found	Not found	Not found
Number of musks detected	0	0	0	0	0
Total PFCs (ng/g whole blood)	1.6	0.5	1.1	28.7	0.7
Number of PFCs detected	2	1	1	1	1
Total number of chemicals detected	41	27	35	32	31
Total burden (ng/g lipid)	3056.5	601.2	569.4	272.7	194.9
Total burden (ng/g whole blood)	121.6	213.5	816.1	28.7	237.7

* The numbers in parentheses denote if the child is the first, second or third born in the family (where applicable).

In general, the adults in this family have higher numbers and levels of chemicals in their blood, which is understandable as they have had longer to accumulate chemicals through their lifetime. The grandmother has the highest total ng/g lipid burden, the highest level of p, p'-DDE and as a consequence the highest OCP total burden of the whole survey. She also has the family's highest number of different chemicals in her blood.

Organochlorine pesticides

The family have exactly the same number and types of organochlorine pesticides in their blood (p, p'-DDE, β-HCH and hexachlorobenzene).

PCBs

The types of PCBs in their blood are broadly similar, with the older members of the family again having higher levels. The number of PCBs in the eldest son's blood is only one fewer than his father, but the father's total concentration of PCBs is higher because he has had more time to accumulate these chemicals.

PBDE flame retardants

Every person in this family has PBDE flame retardants in their blood. The PBDEs detected in the family's blood are constituents of the flame retardant formulations known as penta- and octa-BDE (see above). PBDEs are commonly used in carpets, textiles, furniture and electrical appliances and have been shown to contaminate indoor air and dust (see above), which can be a significant source of exposure to these chemicals. The two sons of the family have higher levels of PBDEs in their blood than their parents or grandmother. The eldest son also has deca-BDE in his blood, a flame retardant found in plastics used for electrical appliances such as televisions, computers and game consoles which are found in this family's home. The youngest son has the highest level of PBDEs in his family and the eldest son's total level of perfluorinated chemicals is an order of magnitude higher than that of his parents and grandmother.

These results suggest that the third generation of this family, even in their shorter lifetimes, have accumulated higher levels of certain "newer" chemicals such as brominated flame retardants and perfluorinated chemicals. Compare this with their parents, whose chemical burdens consist of greater contributions from "historical" banned compounds such as DDT and PCBs. It is important to remember, however, that older generations are also exposed to "newer" chemicals in the same way as younger generations. This can lead to results such as the father having the family's highest level of phthalates, used in flexible plastics such as PVC, in his blood.

Family 3

	Grandmother	Mother	Father	Son (1)*	Daughter (2)*
Total OCPs (ng/g lipid)	101.4	50.3	126.1	91.1	14.9
Number of OCPs detected	3	2	3	3	2
Total PCB (ng/g lipid)	512.4	66.2	332.7	188.5	17.7
Number of PCBs detected	21	22	20	19	13
Total PBDE (ng/g lipid)	2.6	3.2	7.6	16.4	21.4
Number of PBDEs detected	1	3	2	3	4
Total phthalates (ng/g whole blood)	781.0	230.0	40.0	150.0	70.0
Number of phthalates detected	4	1	1	1	1
Total musks (ng/g whole blood)	Not found	Not found	Not found	Not found	Not found
Number of musks detected	0	0	0	0	0
Total PFCs (ng/g whole blood)	23.2	32.3	21.5	17.5	45.2
Number of PFCs detected	2	2	2	3	2

Total number of chemicals detected	31	30	28	29	22
Total burden (ng/g lipid)	616.4	119.7	466.4	296.0	54.0
Total burden (ng/g whole blood)	804.2	262.3	61.5	167.5	115.2

* The numbers in parentheses denote if the child is the first, second or third born in the family (where applicable).

N.B: The grandmother in this family is also grandmother to family 6 (her daughters are the mothers of families 3 and 6). She lives near to, and was tested with, family 6.

This family, with the exception of the grandmother, are one of the least contaminated of the survey. The total numbers of chemicals in their blood are broadly similar (with the exception of the daughter, who has fewer) and the mother and children's levels of OCPs and PCBs are around the median or lower for the survey. The grandmother has the highest overall total chemical burdens of the family. Of the remainder of the family, who live in the same house, the father and mother have the highest total ng/g lipid and ng/g whole blood burdens respectively.

The daughter has the survey's lowest total burden of OCPs and the lowest number of PCBs in her blood. The mother has the family's greatest number of PCBs in her blood, and the grandmother the highest total PCB burden, followed by the father, then the son (whose PCB level is almost three times that of his mother).

Phthalates

The whole family have the phthalate DEHP in their blood, which is a chemical found in flexible plastics such as PVC and in toiletries and cosmetics. The grandmother has the family's highest DEHP level, the father's and daughter's levels are relatively low and the mother's and son's levels, while higher, are still around and below the median respectively.

Perfluoroundecanoic acid (PFUnA)

Only four people in the survey – members of this family – have the perfluorinated chemical perfluoroundecanoic acid (PFUnA) in their blood. The mother has the highest level, followed by her daughter. It is difficult to explain why they are the only ones in the survey to have this chemical in their blood, but there could be a source of exposure that is unique to this family.

PBDE flame retardants

The family has a broadly similar profile with respect to the PBDE flame-retardants, but the children have much higher levels of these chemicals than their parents and even their grandmother. When compared with the rest of the family, the daughter (the youngest member of the family) has the highest number of different PBDEs and the highest total PBDE burden in her blood, which is in marked contrast to her OCP and PCB contamination profile. Her blood also has the highest concentration of perfluorinated chemicals of the whole family.

As is the case with family 2, this shows that the youngest generation of this family have accumulated higher levels of certain brominated flame-retardants and perfluorinated chemicals than their parents, while having lower levels of "older" chemicals that have been phased out, such as organochlorine pesticides and PCBs. As the diet and lifestyle of all the family members are very similar, it is difficult to suggest reasons for these differences.

Family 4

	Grandmother	Mother	Father	Daughter (1)*	Son (2)*
Total OCPs (ng/g lipid)	44.0	24.1	122.5	22.4	225.0
Number of OCPs detected	3	2	3	2	3
Total PCB (ng/g lipid)	125.7	78.6	154.3	30.9	776.1
Number of PCBs detected	17	18	20	11	20
Total PBDE (ng/g lipid)	15.8	0.7	23.0	10.3	17.3
Number of PBDEs detected	3	1	3	3	3
Total phthalates (ng/g whole blood)	337.0	Not found	1666.0	100.0	60.0
Number of phthalates detected	5	0	4	1	1
Total musks (ng/g whole blood)	Not found	Not found	Not found	Not found	Not found
Number of musks detected	0	0	0	0	0
Total PFCs (ng/g whole blood)	0.4	Not found	18.3	Not found	21.3
Number of PFCs detected	1	0	2	0	2

Total number of chemicals detected	29	21	32	17	29
Total burden (ng/g lipid)	185.5	103.4	299.7	63.6	1018.4
Total burden (ng/g whole blood)	337.4	0.0	1684.3	100.0	81.3

* The numbers in parentheses denote if the child is the first, second or third born in the family (where applicable).

With a few notable exceptions, this family have relatively low or median levels of chemical contaminants in their blood and their chemical profiles are broadly similar. The whole family have organochlorine pesticides in their blood – all have p, p'-DDE and hexachlorobenzene, while the grandmother, father and son have β-HCH. Despite the grandmother, father and mother working with sheep dip in the past, no member of the family has lindane (γ-HCH) – previously an active ingredient in sheep dip – in their blood. Although he is the youngest member, the son has the family's highest concentration of OCPs and PCBs in his blood. His father has the next highest total burden of these chemicals, followed by the grandmother, mother and daughter. The family's PCB profiles are similar and the total levels of PCBs follow the same pattern as the OCPs (i.e. Son>Father>Grandmother>Mother>Daughter).

PBDE flame retardants

The family members' profiles of PBDEs are broadly similar, with the father having the highest total PBDE burden. He is followed by the son, then the grandmother, who is the only member of the family with deca-BDE in her blood. Deca-BDE is a flame retardant found in plastics used for electrical appliances such as televisions, computers and game consoles.

Phthalates

The father has the highest burden of phthalates in the family and in the survey, but these chemicals are not detected in the mother's blood and are found at much lower levels in the rest of the family. This suggests something in the father's lifestyle, unique to him, that exposes him to higher levels of phthalates such as DEHP. The lifestyle data provides no clues as to what this might be.

Perfluorinated chemicals

In addition to the son having his family's highest level of OCPs, PCBs and second highest level of PBDEs, he also has the highest concentration of perfluorinated ("non-stick") chemicals in his blood. It therefore appears that the youngest member of this family is more contaminated (with respect to the above chemicals) than the older generations. Scientists are still unsure as to how people are exposed to perfluorinated chemicals, but they may be released by the products in which they are used – stain-resistant coatings for carpets and furniture, coatings for takeaway food packaging and water-repellent treatments for clothing and footwear.

In stark contrast to her brother, the daughter's total number of chemicals are the lowest in the survey and her total chemical burdens (both ng/g lipid and ng/g whole blood) are the lowest in the family.

Family 5

	Grandmother	Mother	Daughter (1)*	Daughter (2)*
Total OCPs (ng/g lipid)	21.2	15.8	31.8	342.5
Number of OCPs detected	1	1	1	3
Total PCB (ng/g lipid)	57.8	32.8	107.7	498.2
Number of PCBs detected	12	13	15	23
Total PBDE (ng/g lipid)	14.0	53.6	13.6	24.1
Number of PBDEs detected	3	7	3	4
Total phthalates (ng/g whole blood)	1334.0	1136.0	410.0	1171.0
Number of phthalates detected	5	5	1	4
Total musks (ng/g whole blood)	Not found	Not found	Not found	Not found
Number of musks detected	0	0	0	0
Total PFCs (ng/g whole blood)	2.4	0.7	Not found	Not found
Number of PFCs detected	1	2	0	0
Total number of chemicals detected	22	28	20	34
Total burden (ng/g lipid)	93.0	102.2	153.2	864.8
Total burden (ng/g whole blood)	1336.4	1136.7	410.0	1171.0

* The numbers in parentheses denote if the child is the first, second or third born in the family (where applicable).

As a whole, this family has the some of the lowest numbers of chemicals in their blood, and their chemical totals with respect to OCPs and PCBs are below the median for the survey, with the exception of the youngest member of the family (the second daughter). In this family this daughter has the highest number of chemicals, the highest ng/g lipid burden and the highest number and total burden of OCPs and PCBs in her blood. These numbers and levels are above the survey medians. This is another example of the younger generation being more contaminated than older generations.

PBDE flame retardants

The mother's chemical profile is similar to her mother's (the grandmother) with respect to both levels and numbers of chemicals, with the exception of the PBDE flame retardants. The mother and her youngest daughter have a PBDE burden which is above the median, whilst the grandmother and eldest daughter's levels are below the median. The flame retardant deca-BDE is found in the mother and youngest daughter and at similar levels.

Phthalates and perfluorinated chemicals

Overall, the family has comparable levels of phthalates in their blood, which are higher than the median for the survey. Perfluorinated chemicals are not detected in the daughter's blood, but are found in the mother and grandmother, with the grandmother having higher levels.

Family 6

	Grandmother	Mother	Father	Son (1)*	Daughter (2)*	Daughter (3)*
Total OCPs (ng/g lipid)	101.4	209.4	176.8	50.0	24.6	28.7
Number of OCPs detected	3	2	2	1	1	2
Total PCB (ng/g lipid)	512.4	230.0	1946.4	256.1	84.8	72.2
Number of PCBs detected	21	23	22	17	20	21
Total PBDE (ng/g lipid)	2.6	9.8	55.7	30.3	13.9	9.3
Number of PBDEs detected	1	3	4	4	4	4
Total phthalates (ng/g whole blood)	781.0	1456.0	660.0	651.0	1041.0	242.0
Number of phthalates detected	4	4	1	4	5	4
Total musks (ng/g whole blood)	Not found	Not found	Not found	Not found	Not found	Not found
Number of musks detected	0	0	0	0	0	0
Total PFCs (ng/g whole blood)	23.2	0.4	2.1	Not found	10.7	10.2
Number of PFCs detected	2	1	1	0	2	4

Total number of chemicals detected	31	33	30	26	32	35
Total burden (ng/g lipid)	616.4	449.2	2178.9	336.3	123.3	110.2
Total burden (ng/g whole blood)	804.2	1456.4	662.1	651.0	1051.7	252.2

* The numbers in parentheses denote if the child is the first, second or third born in the family (where applicable).

The adults of this family have higher total burdens than the children, although the person with the highest number of different chemicals detected in the blood is the youngest daughter. The highest ng/g lipid total belongs to the father with the mother having the highest ng/g whole blood burden. The children have much lower levels than their parents and grandmother, apart from the eldest daughter's ng/g whole blood burden, which is higher than her father's. The father has the highest total PCB burden of his family – his level is an order of magnitude higher than the rest of his family – and of the whole survey.

PBDE flame retardants

Every person in this family has PBDE flame retardants in their blood. PBDEs are commonly used in carpets, textiles, furniture, computers and electrical appliances. The PBDEs detected in the family's blood are constituents of the flame-retardant formulations known as penta- and octa-BDE (see above). The father has the highest level of PBDEs in the family and his lifestyle data revealed that he has spent most of his working life in front of a computer. Electrical appliances, including computers, contain flame retardant chemicals and studies have shown that there is a correlation between the number of electrical appliances in an office and the levels of these chemicals in office air (Harrad *et al.*, 2004). This may play some part in explaining his higher level of contamination. The son and the first daughter have the family's next highest total levels of these chemicals and these levels are higher than the mother and grandmother.

Phthalates

The whole family have phthalates, including DEHP, in their blood and their total levels of these phthalates are higher than the median for the survey.

In terms of chemical profile, on average the adults in the survey have higher levels of OCPs and PCBs than the children. However, the first and second children, despite having had a shorter time to accumulate persistent chemicals, have higher levels of brominated flame retardants (PBDEs) than their mother and grandmother. The youngest daughter already has a higher total PBDE burden than her grandmother and this burden is almost as high as her mother's. The second and third children also have higher levels of perfluorinated chemicals than their parents. Results such as these again highlight the fact that younger generations are contaminated – and in some cases with higher levels of "newer" chemicals than their parents. In an interesting contrast, the grandmother's level of perfluorinated chemicals is the highest in the family and is almost ten times the median level for the whole survey.

Family 7

	Grandmother	Mother	Father	Daughter (1)*
Total OCPs (ng/g lipid)	1266.9	68.7	138.7	21.2
Number of OCPs detected	4	2	2	2
Total PCB (ng/g lipid)	328.8	158.2	188.8	21.5
Number of PCBs detected	31	38	32	21
Total PBDE (ng/g lipid)	4.1	14.9	6.6	5.6
Number of PBDEs detected	2	4	3	3
Total phthalates (ng/g whole blood)	30.0	80.0	155.0	Not found
Number of phthalates detected	1	1	2	0
Total musks (ng/g whole blood)	Not found	Not found	Not found	Not found
Number of musks detected	0	0	0	0
Total PFCs (ng/g whole blood)	5.7	37.2	16.9	33.1
Number of PFCs detected	4	4	4	5

Total number of chemicals detected	42	49	43	31
Total burden (ng/g lipid)	1599.9	241.7	334.0	48.3
Total burden (ng/g whole blood)	35.7	117.2	171.9	33.1

* The numbers in parentheses denote if the child is the first, second or third born in the family (where applicable).

Organochlorine pesticides and PCBs

The adults in this family have some of the highest numbers of chemicals in their blood recorded by the survey, and the daughter's total number is the same as the survey median. This is because, compared with the other families, this one has higher numbers of PCBs in their blood. Within the family, the grandmother has the highest total ng/g lipid burden and the highest OCPs and PCBs total burdens, with the parents having intermediate levels and the daughter having the lowest levels of these chemicals.

The lifestyle data reveals that the grandmother eats oily fish most frequently (two or three times a week), followed by the parents (once a week), then the daughter (once a month). This may have influenced the family's burdens of these chemicals, as dietary intake of oily fish is an important exposure route for organochlorines (PCBs and DDT). The grandmother's high OCP burden is due primarily to her having one of the highest p, p'-DDE levels in the survey (p, p'-DDE is a breakdown product of DDT). The grandmother has visited a malarial country in the past, so it is likely that this has also contributed to her burden, as DDT has been widely used to control malarial mosquitoes.

PBDE flame retardants

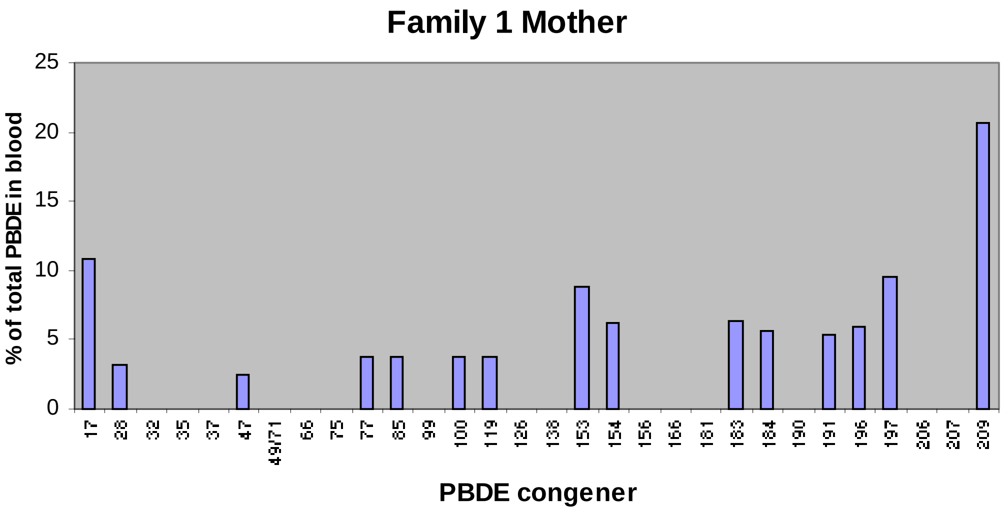
With the exception of the mother, the total levels of PBDEs in the family are broadly similar and are below the median for the survey. The mother has the highest PBDE burden of the family (14.9 ng/g lipid), which is the same as the survey median.

Perfluorinated chemicals

The whole family has higher than median levels of perfluorinated chemicals and has a greater numbers of perfluorinated chemicals than any other family. The daughter and the mother have similar levels of these chemicals.

Inheriting a toxic burden?

It is well established that a child can inherit a toxic burden from its mother during pregnancy and/or by breast-feeding (Lackmann *et al*., 2004). However, drawing definite conclusions about transfer of contaminant burden is not possible in this report, as testing this phenomenon was beyond the scope of the survey. The analysis of three generations does, however, provide an opportunity to see if similarities exist between a mother's chemical burden and those of her children. For example, in family 1, both mother and daughter have comparable numbers of OCPs, PCBs and PBDEs in their blood. When the contribution of individual PCBs and PBDEs to their respective totals are compared (see figures) their profiles closely resemble each other.



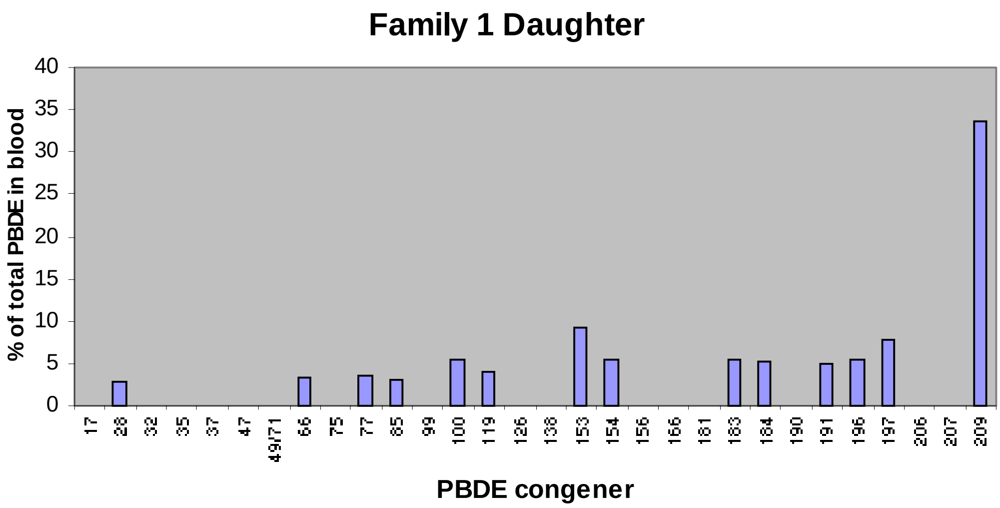
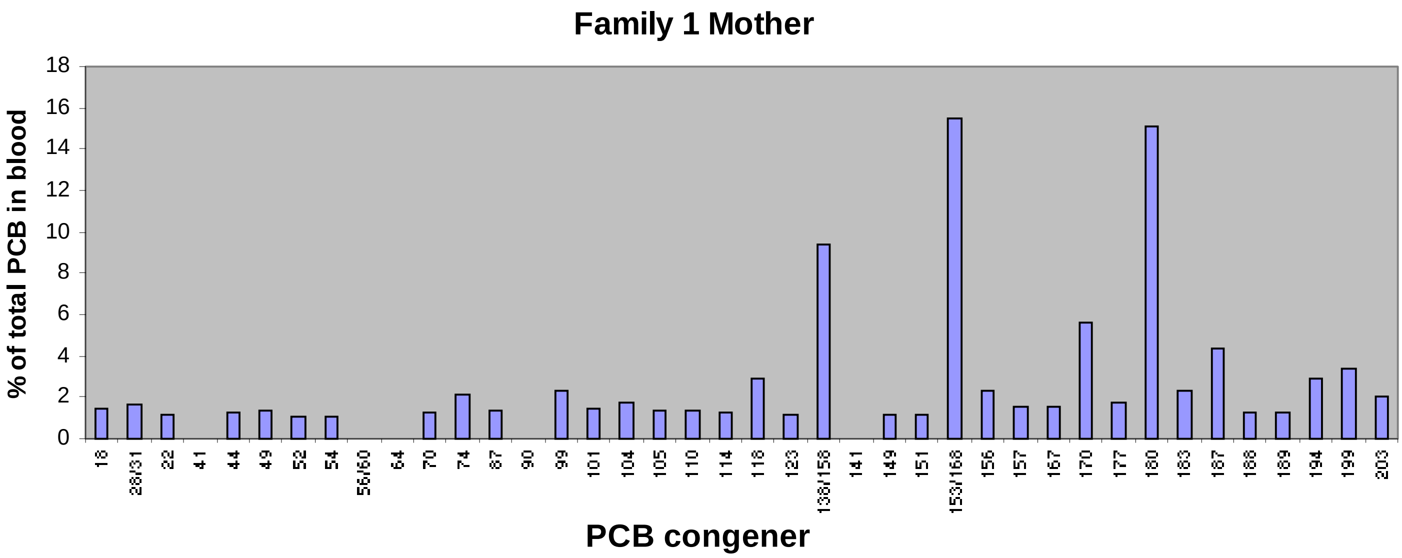


Figure 1: Comparison of PBDE profile (percentage contribution of individual congeners) in mother and daughter of Family 1.



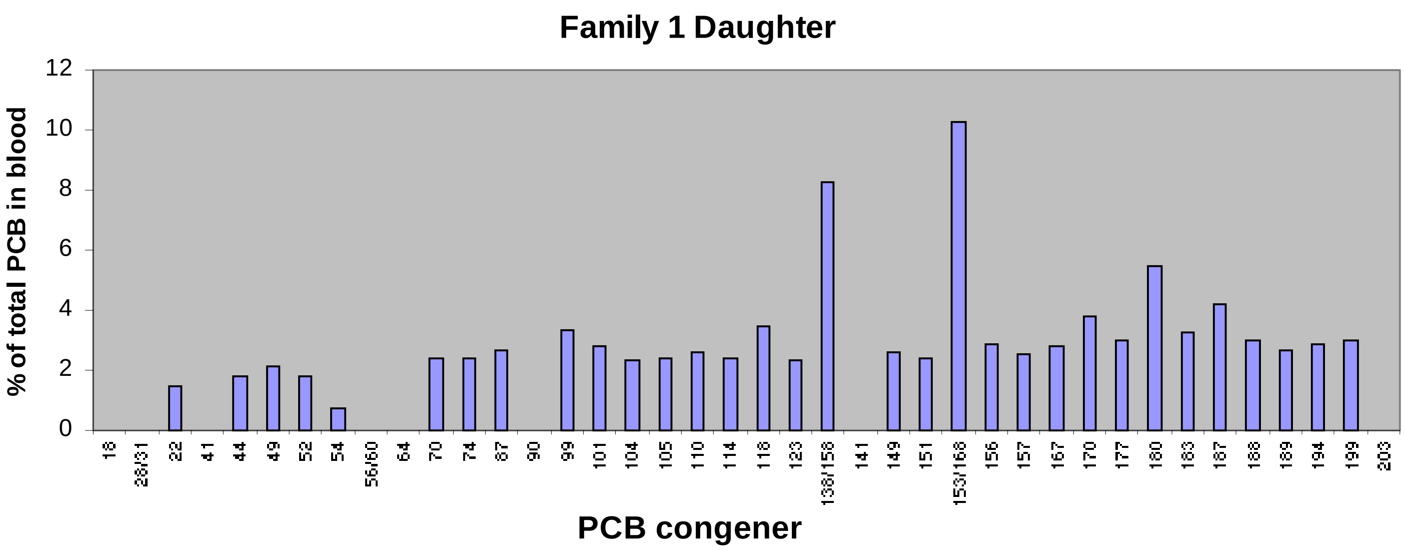


Figure 2: Comparison of PCB profile (percentage contribution of individual congeners) in mother and daughter of Family 1.

The mother's and daughter's results show they have been exposed to similar kinds of PCBs and PBDEs in similar proportions, but due to her age, and hence greater time spent accumulating these chemicals, the mother's levels are higher than her daughter's. Although it is established that a mother can pass on a proportion of her chemical burden to her children (e.g. Lackmann *et al.*, 2004), it is not possible to conclude that this has occurred here, despite the compelling results.

The daughter's age means that chemical exposure picked up during her life is likely to have obscured the burden she may have inherited from her mother during pregnancy and breast-feeding. Nonetheless, inheritance of a chemical burden is known to occur and this is one interpretation suggested by the results. Lifestyle choices may also be a factor here, as both mother and daughter eat more oily fish than the rest of the family. The source of contamination aside, the daughter's results highlight a worrying trend, which is that even at her young age, she has a comparable number of chemicals in her blood to older generations. Although at this stage the levels of these chemicals are not as high, there is potential for her, and her generation, to become increasingly contaminated as they go through life.

With respect to certain chemicals, the children's results in Family 6 illustrates how the firstborn can be more contaminated than the second and third children. For example, the firstborn of this family has higher levels of PCBs and PBDEs than the second, who has higher levels than the third child. With respect to OCPs, the firstborn has higher levels than the second, but the third child has higher levels than the second. Although lifestyle and exposure throughout a child's life can obscure levels inherited from the mother, in this family there is a clear case of the firstborn being more contaminated than the younger siblings. However, it must be remembered that another reason why older children have higher levels of chemical contamination is because they have had longer to accumulate these chemicals, even in their relatively short lives.

Family comparisons

Every member of every family in this survey is contaminated by man-made chemicals. There is a large degree of variation in the results from within and between the different families. While there seems to be little correlation between the location of each family – for example urban, suburban or rural – and their differing chemical profiles, the small number of families in the survey prevents any meaningful statistical analysis of any trends.

In this survey, a rural farming family have higher numbers of chemicals in their blood than a family living in the suburbs of a large city. Members of a family living in the centre of a large city have the highest numbers of certain chemicals in their blood, but the concentrations of these chemicals are lower than for other families who live in rural farming communities or small towns in the countryside. A child living in an isolated farming area has been shown to have higher levels of certain chemicals in the blood than a child of comparable age living in the suburbs or in a city centre. Equally, a person from an urban-living family may have a higher level of a particular chemical than a person living in the countryside, but that same person may have lower levels of other chemicals.

It is clear that man-made chemicals can invade our bodies by the simple process of our living a modern life, regardless of where we are or what we do. Dietary choices, lifestyle activities and the presence of certain products in the home may influence the types and levels of chemicals to which people are exposed, but exposure to man-made chemicals is a fact of life, no matter what a person does or where they live.

CONCLUSIONS

There are several findings in this survey which highlight the need for tighter regulations to protect future generations from hazardous man-made chemicals.

Contamination of children

While it might be expected that chemical burden increases with age, this study has shown that this conventional assumption is not always true. The results show that children can be more contaminated by higher numbers and levels of certain chemicals than their parents or even their grandparents, despite being exposed to these chemicals for only a fraction of the time. This is worrying, particularly if the chemicals are of unknown toxicity, with unknown long-term health effects and are not subject to any regulation with respect to consumer exposure.

As the long-term effects of present levels of exposure are unknown, it is alarming that future generations may be subject to even higher levels than preceding generations. Also, as future generations become more contaminated by unregulated persistent, bioaccumulative chemicals, they will pass on greater burdens to their children than before. If the contamination of the environment as whole continues unchecked, then the threat from man-made chemicals will only increase for future generations.

Influence of lifestyle

The results have also shown that chemicals in everyday products used in the home – whether in urban, suburban or rural areas – can be found in the blood of all the families tested in the survey.

For example, PBDE flame-retardants used in electrical appliances, plastics, textiles, furniture and carpets are found in all the family members tested. While it is impossible to pinpoint the exact way in which each child, parent or grandparent has become contaminated by PBDEs, their presence in blood illustrates that they are escaping from the products in which they are used and making their way into the environment and into humans (see "routes of exposure"). Deca-BDE, a flame retardant used in plastic housings for electrical appliances is found in several people in this study and these kinds of products were found in all the family homes. Are these findings unrelated or is there weight to the argument that using products containing a certain chemical can expose you to that chemical? Similarly, the phthalate DEHP, used in numerous plastic products, PVC flooring, toiletries, cosmetics and food packaging, is found in 79 per cent of the family members tested. Is it a coincidence that a chemical used in so many everyday products ends up contaminating the vast majority of people in this survey?

Organochlorine pesticides and PCBs, which are found in elevated levels in oily fish, are at higher levels in family members whose lifestyle questionnaires reveal that they eat this kind of food more regularly than members of their family who have lower levels.

Perfluorinated chemicals are found in or used in the manufacture of numerous everyday products such as non-stick pans, stain resistant coatings for carpets and furniture, coatings for takeaway food packaging and water-repellent treatments for clothing and footwear. Eighty two per cent of family members tested had one or more of these chemicals in their blood and previous WWF biomonitoring surveys found these kinds of chemicals in all people tested. While it is not known exactly how people are becoming exposed, these chemicals are clearly escaping from the products in which they are used and making their way into the environment, wildlife and people, including children as young as 10.

Urban vs rural?

Every member of every family in the survey, regardless of where they live or what they do, is contaminated by man-made chemicals. There is little association between whether a family lived in a rural or urban location and their chemical burdens. There is an assumption that living a rural life is "healthier" and "cleaner" and somehow protects us from chemical pollution. The results of this study have shown that this is not the case.

This survey shows that whether we live in the centre of a large city or an isolated rural village, our modern way of life, including our diet and the use of products in our daily lives, contaminates us with detectable levels of chemicals. For example, a child living in a rural family in this study was found to have blood levels of organochlorine pesticides and PCBs greater than some urban adults. Lifestyle factors, and the kinds of products a family use, are invariably more important in influencing chemical burdens. For example, the two people with the highest number of chemicals in their blood (family 1) live in the centre of a large city, but their questionnaire responses suggest that dietary choices (a preference for oily fish) have more influence on their chemical burdens than where they live.

The need for regulation

This survey has shown that chemicals declared by industry as safe are in fact contaminating not only adults but also young children. This demonstrates the nonsense of industry's insistence that their chemicals are under "adequate control" (despite the fact that the vast majority of which have no safety data). WWF believes that historic data, reinforced by the findings in this survey, shows that current national and EU chemical regulations have failed to protect present and future generations from hazardous chemicals, particularly endocrine disrupting chemicals and persistent and bioaccumulative chemicals.

Persistent and bioaccumulative chemicals that have been banned for decades are contaminating British families, and they are now accompanied by other chemicals with similar properties which are still being produced and released into the environment – for example perfluorinated chemicals and brominated flame retardants. Regulators have clearly not learned the lessons from past experiences of the adverse effect that persistent chemicals have on people and wildlife.

We need strong chemicals regulation now, to stop the contamination of children and future generations. Public education and awareness is required to highlight the extent of contamination and to give people the choice to avoid hazardous man-made chemicals. People have the right to know what is in the products they use and what they are potentially exposing themselves to in their everyday lives. Industry needs to provide this information, to be more responsible and to phase out persistent, bioaccumulative and endocrine disrupting chemicals. Governments should force industry to do so.

WWF believes that the best way to stop this continuing chemical contamination, and the threat to future generations, is to prevent the manufacture and use of chemicals that are found in elevated concentrations in biological fluids such as blood and breast milk. This opinion has also been expressed recently by the Royal Commission for Environmental Pollution.

The current EU regulatory opportunity – REACH

The proposed new EU chemicals regulation known as REACH – the Registration, Evaluation and Authorisation of Chemicals – provides a once in a generation opportunity to secure long overdue and essential controls on hazardous man-made chemicals. The proposals could help establish a robust system of regulation that protects present and future generations from exposure to toxic chemicals.

However, the proposals are not tough enough as they stand, as the authorisation process will fail to ensure that chemicals of very high concern – such as very persistent, very bioaccumulative (vPvB) and endocrine disrupting chemicals (EDCs) – are phased out even when safer alternatives are available.

If Members of the European Parliament and European governments strengthen the proposals as we outline below, the new legislation will yield a more progressive, precautionary and science-based chemicals policy, helping to reduce further contamination of people and wildlife and encouraging industry to innovate and produce greener and safer products.

RECOMMENDATIONS

The number, types and concentrations of chemicals found in this survey, and by extrapolation the population in general, are unacceptable. More needs to be done to protect children and future generations of people and wildlife from the insidious threat of chemical contamination. WWF recommends that:

1. The government of the UK and governments of the EU should do all in their power to protect future generations of humans and wildlife. Their responsibility now is to ensure that REACH requires persistent, bioaccumulative and other hazardous chemicals to be removed from the market. Such measures would reduce the continuing exposure of children, adults and the environment. In particular, governments should support strict conditions for authorising chemicals under REACH. This must include:

a) supporting the inclusion of very persistent and very bioaccumulative (vPvB) chemicals (those likely to be found in biological fluids such as blood and breast milk) and EDCs into the prior authorisation scheme of REACH; and

b) phasing out the use of these chemicals of very high concern, such as vPvBs and EDCs, and their substitution with safer alternatives. Phasing out is the best way effectively to reduce and eventually stop our exposure to hazardous chemicals.

c) the authorisation to use hazardous chemicals should only be granted when there is no safer alternative, an overwhelming societal need for them and measures to minimise exposure are put in place. All authorisations should be time-limited and reviewed after an agreed period to determine whether safer alternatives are then available.

d) The best route of protection is to introduce better control of hazardous chemicals so that humans and wildlife are not contaminated in the first place. Chemicals with undesirable properties should be taken off the market. Where this “gatekeeper” approach fails, there should be adequate monitoring to determine the levels of chemicals in the environment and their effects. European governments should therefore set up coordinated biomonitoring programmes to determine trends in the levels of hazardous chemicals in humans, wildlife and the environment. These programmes should be integrated into the risk assessment process so that the detection of chemicals in monitoring surveys should be considered unacceptable and would initiate rapid investigation and the phase-out of a chemical, if appropriate.

Everyone – not least children and future generations – should have the right to a clean, healthy and uncontaminated body so that they achieve their maximum potential without the ever-present worry of their lives being blighted through exposure to hazardous man-made chemicals. Phasing out the use of very persistent and very bioaccumulative chemicals and of endocrine disrupting chemicals, and their substitution with safer alternatives, is the only way to stop the insidious threat of such chemicals and the contamination of future generations of humans and wildlife.

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