WWF

DETOX

CAMPAIGN

GENERATIONS X

WWF 2005

Results of WWF's

European Family Biomonitoring Survey

WWF DETOX CAMPAIGN

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The Generations X report has been produced by the WWF DetoX Campaign

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WWF would like to record its thanks to:

- The EEN (EPHA Environment Network) and Eurocoop (European Community of Consumer Cooperatives) for giving their support to the bloodtesting project.

een epha environment network euro coop

http://www.env-health.org http://www.eurocoop.org

- The many families and doctors involved in the project, for their enthusiasm and cooperation.
- Ruud Peters and TNO Built Environment and Geosciences, Apeldoorn, The Netherlands.

I think that getting this **knowledge acts as education** for me and my children on **how to avoid harmful substances and how to thrive for cleaner environment.**

family - FINLAND

Let's unite our voices and cry out loud
We want a **better and safer future** for our children. Free from the fear of "suspected" chemical substances and their thoughtless use. Because, **we DO worry about the existence of dangerous chemicals in our blood!**

VOGIATZIS family - GREECE

The accumulation of chemicals in our blood **is not our choice.** No governmental mechanism has informed us of **the risk** we run through the consumption of products that contain chemicals. **It is high time** we saw at what degree various chemicals have influenced us and think their side effects. **I DO want to know** what is inside **my blood!**

PAVLOUDIS family - GREECE

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We are concerned about the **build up of chemicals** in wildlife and people. **We should all have the right to know which toxics chemicals we are being exposed to.**

Loretta GUERCI - ITALY

I am **very much concerned** about the over-use of toxic chemicals and their **effects** on our **planet**, its fauna and flora. I am even more upset to learn that most of them **can be replaced by safer ones. Now is the time to prove** that **our health** and the health of **our children** are **really becoming threatened.**

Anne-Marie SZEWCZYK - BELGIUM

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WWF DETOX CAMPAIGN

Executive summary

WWF's biomonitoring surveys have revealed the extent to which people across Europe are contaminated by a cocktail of hazardous man-made chemicals. The present survey, carried out with the support of EEN (EPHA Environment Network) and the European Community of Consumer Co-operatives (Eurocoop), investigates the types and levels of chemical contamination in three generations (grandmothers, mothers and children, aged from 12 to 92 years) from families across Europe.

Blood samples from members of thirteen families from twelve EU countries - Belgium (2 families), Denmark, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Poland, Sweden, Luxembourg - were analysed for a range of persistent, bioaccumulative and/or endocrine disrupting chemicals, many of which are found in everyday consumer products.

107 different man-made chemicals were analysed in the families' blood: 12 organochlorine pesticides (including DDT), 44 polychlorinated biphenyls (PCBs), 33 brominated flame retardants including 31 polybrominated diphenyl ethers (PBDEs), hexabromocyclododecane (HBCD) and tetrabromobisphenol-A (TBBP-A), 8 "non-stick" perfluorinated chemicals (PFCs), 7 artificial musks, 2 antimicrobials (triclosan and its breakdown product, methyl triclosan) and the polycarbonate plastic monomer, bisphenol-A.

The results of these survey show that every family member, from grandmothers to children, is contaminated by a cocktail of at least 18 different man-made chemicals, many of which can be found in everyday consumer items. Some of the identified chemicals such as PCBs and DDT, have been banned for decades but persist in the environment and continue to contaminate new generations with every passing year. Some key findings are:

- Of the 107 chemicals analysed, 73 in total were detected in the whole survey. 63 were found in the grandmother's generation, 49 in mothers and 59 in children. The higher number in the grandmother's generation is due largely to higher numbers of PCBs. The lowest number of chemicals detected in a family member is 18 (a mother) and the highest is 39 (a grandmother).
- Brominated flame retardants, organochlorine pesticides, PCBs, perfluorinated chemicals and artificial musks were found in the blood of just about every family member tested, including children as young as 12. The only exceptions were two grandmothers (one with no brominated flame retardants in her blood and another with no perfluorinated chemicals).
- The median number of chemicals detected in the survey is 28. The median numbers of chemicals found in the different generations are 32 for grandmothers, 29 for mothers and 24 for children.

Moreover, the results of this survey show that for certain chemicals the extent of contamination in younger generations can equal or exceed that of their elders. The grandmothers are the generation most contaminated with older, banned chemicals such as organochlorine pesticides and PCBs, but "newer" chemicals in widespread use such as the brominated flame retardants, perfluorinated chemicals and artificial musks can be found more frequently and at higher levels in the younger generations. Some key findings are:

- The children's generation has the highest median level of PBDE flame retardants, PFCs and artificial musks in the survey. Of the 31 different PBDEs flame retardants analysed in the survey, 17 were found in the children's generation compared to 10 in the grandmothers and 8 in the mothers.
- The flame retardant deca-BDE, the only PBDE still in use in the EU, was found in only two family members (both children) with a higher level being found in the younger one.
- The flame retardant TBBP-A, used in printed circuit boards in electronic appliances, was found in 18 family members (3 grandmothers, 7 mothers and 8 children). The young generation has the highest median level of this chemical and the highest level was found in a child.
- The artificial musk HHCB (galaxolide) chemical was found in every family member tested, and the highest level detected was found in a child.
- Bisphenol-A, an oestrogenic (hormone mimicking) chemical e.g. used for the manufacture of certain plastic bottles and CDs was found in three family members from each generation, with the highest level found in a child.

These results are especially worrying as most of the chemicals found only break down very slowly, persist in the environment and accumulate in our bodies to ever increasing levels during the life span. The study therefore raises the question of whether future generations will be more exposed to potentially carcinogenic or endocrine disrupting chemicals that may lead to negative long term health effects.

The continuing contamination of the youngest family members with hazardous man-made chemicals clearly illustrates the failures of the current regulatory system. The mistakes of the past are being repeated, as chemicals with similar properties to DDT and PCBs, such as the brominated flame retardants, are contaminating young children. This highlights the importance of regulating persistent and bioaccumulative chemicals, as they cannot simply be recalled like faulty goods on a supermarket shelf when it becomes clear they pose risks to the environment, wildlife and human health.

It is vital that that the currently debated new EU legislation on chemicals, REACH, is significantly strengthened to ensure that persistent, bioaccumulative and/or endocrine disrupting chemicals are brought under strict control and consequently phased out in order to protect future generations of wildlife and people. WWF urges European legislators to ensure that REACH delivers sufficient safety data on chemicals in order to identify the most hazardous ones – especially those with long term consequences resulting from low dose exposure. Chemicals of very high concern should be replaced with safer alternatives whenever possible.

Introduction

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. From polar bears in the once pristine Arctic to seals and dolphins, wildlife throughout the world is contaminated with hazardous man-made chemicals. But this contamination is not restricted to wildlife – people from all walks of life around the world are also affected. 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 thirteen different families from twelve different EU countries. It is an investigation into the kinds of chemicals to which they are exposed in their everyday lives.

Our chemical environment

Chemicals are an integral part of modern life and are found in everything from air fresheners to electrical appliances. From plastics to paints, toiletries to toys, chemicals bring great benefits to society, improving our quality of life in innumerable different ways. The chemicals industry also provides employment for thousands of people and generates considerable revenue for Europe's economy. However, despite these undeniable benefits, there is another side to the chemicals story. Many chemicals have hazardous properties and the risks associated with them need to be properly managed to ensure humans, wildlife and the wider environment do not come to harm. In several cases a proper management, or adequate control, has proven to be impossible as e.g. the presence of chemicals in the womb show (see the WWF/Greenpeace A present for Life study http://www.panda.org/downloads/toxics/presentforlife.pdf). In the past, regulatory action on some chemicals was taken so late that it did not prevent environmental damage and toxic impacts in humans and wildlife.
As a result of modern society's increasing reliance on synthetic chemicals, the global environment, as well as wildlife and humans, are being contaminated by increasingly large numbers of these chemicals, the majority of which have not been tested for their long term effects on 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 17,500 at 1-10 tonnes.
Due to inadequate chemical regulations, the majority of chemicals in use have not had their risks to human health, wildlife or the environment assessed sufficiently. The EU has admitted that 99 per cent of chemicals (by volume) on the market are inadequately regulated and 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).
Of the thousand of chemicals on the market, there are certain types of particular concern to WWF as we believe they pose unacceptable risks to future generations of wildlife and people, and threaten to undermine our important global conservation efforts. These are chemicals which are persistent, bioaccumulative and/or endocrine disrupting. Persistent chemicals are those that stick around in the environment for long periods of time (many years or even decades), and are not readily broken down. Examples of persistent chemicals include the organochlorine insecticide DDT (and its metabolites) and polychlorinated biphenyls (PCBs) - which still persist in the environment several decades after they were banned in the EU - as well as most perfluorinated chemicals. Bioaccumulative chemicals are those that build up in the bodies' of wildlife species and humans. For example, PCBs and brominated flame retardants (another group of persistent chemicals) have accumulated in polar bears in the Arctic, seals in the North Sea and humans from all over Europe. Endocrine disrupting chemicals are those that are capable of interfering with the body's natural hormone (endocrine) messaging system, which

is crucial for growth, development, reproduction and numerous other important biological functions. An example of a group of endocrine disrupting chemicals are the phthalates (used in plastics, cosmetics and toiletries), which can mimic hormones. There are concerns that phthalates are capable of disrupting the normal progression of sexual development in baby boys in the womb, leading to genital abnormalities and other problems such as undescended testicles and increase risk of testicular cancer.

Such man-made chemicals can be released directly into the environment from industrial and/or agricultural activities and can also escape from the applications in which they are used, to contaminate food chains and make their way into the air we breathe, the food we eat and the water we drink. Many consumer products used in and around the home also contain chemicals which can escape from these products into air and dust, be inhaled and end up in our bodies. Chemicals can also enter our bodies through more direct routes e.g. chemicals in cosmetics and toiletries can enter our bodies through the skin.

Contamination of soil, water, food, indoor and outdoor air, and the dust in our homes, along with the presence of certain chemicals in everyday products is a clear indication that humans can be exposed, either directly or indirectly, through these routes. The next logical step is therefore to investigate the contamination of our own bodies. “Biomonitoring” is a way of doing this and has been used by WWF in its highly successful campaigning work for safer chemicals (see http://www.panda.org/campaign/detox/index.cfm).

Biomonitoring

Biomonitoring is the term given to the analysis of biological samples – for example urine, adipose (fat) tissue or 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 or metabolised by 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 tested has been contaminated (see below).

In its first biomonitoring study in 2003, WWF-UK tested the blood of 155 volunteers from around the UK 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 work 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 surprising 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 industry insists are safe are in fact accumulating in our bodies in the same way that hazardous chemicals have in the past.

Contamination through GENERATIONS

The surveys described above, 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 do different generations compare in their chemical burdens and their contamination profiles? How contaminated are children? Are they contaminated in the same way as our adult volunteers? It is known that chemicals are passed from mother to foetus during pregnancy and from mother to baby during breast-feeding. So to what extent might children be contaminated by chemicals, some of which were banned before they were born?
Can they be more contaminated than their parents or even grandparents? The normal assumption is that older people have higher levels as they have had longer to accumulate persistent, bioacumulative chemicals. For many contaminants, such as PCBs, age does appear to be correlated with an increase in body burden i.e. the older a person is, the higher their levels of contamination. But is this always the case and does it apply to "newer" chemicals, such as brominated flame retardants and perfluorinated "non-stick" chemicals?
The 2004 WWF-UK biomonitoring survey "Contamination: The next Generation" aimed to find answers to these questions. This survey took blood from three generations of seven families from around the UK and analysed these samples for 104 different man-made chemicals.
The results were shocking: All three generations, including the children, were contaminated by a cocktail of hazardous man-made chemicals, many of which are used in everyday products around the home and many of which were banned before the children were even born.
The results revealed that every child, including those as young as nine years old, 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 (a banned flame retardant, 3 PCBs and a breakdown product of the banned pesticide DDT).

Even more alarming was that some children were more contaminated with certain chemicals than their parents or grand-parents generations. The study showed that the conventional assumption of increased age equating to greater chemical burden does not always hold true: children can be more contaminated, with higher numbers and levels of certain chemicals despite being exposed to these chemicals for only a fraction of the time. Children can be more contaminated with "newer" kinds of chemicals, such as 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).

There also seemed to be little relationship between the location of each family (urban, suburban or rural) and their chemical profile. Without our knowledge, the widespread use of hazardous chemicals in our modern way of life is contaminating the present generation and the next. Dietary choices, lifestyle activities and the presence of certain products in the home may have an influence on the types and levels of chemicals to which people are exposed, but the reality is that 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 these 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 present survey of families across the EU is a continuation of this UK work and is an attempt to investigate the contamination of thirteen typical European families by a cocktail of different man-made chemicals.

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 our unborn children – 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 (bioaccumulate) 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 abnormalities are becoming increasingly common, and chemicals are considered to play a role in the development of some of these conditions.

As mentioned previously, 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 a proposed 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.

Despite the well documented impacts for example of DDT on bird of prey populations or of PCBs on the immune systems of wildlife (seals, polar bears), 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 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.

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.

Some of the chemicals in widespread use for the production of daily consumer items are structurally similar to the infamous PCBs, which some years ago were found to have bio-accumulated to levels high enough to affect the brain development of EU children exposed in the womb. As a report published by the WHO notes,

"data from human and experimental animal studies clearly indicate that exposure (particularly prenatal exposure) to certain EDCs (eg.,PCBs) can have adverse effects on neurological development, neuroendocrine function and behaviour." (Damstra et al. 2002)

Unfortunately, with the PCBs, regulatory action was taken too late to prevent effects in many children across the EU. WWF considers that it is now time to learn from such experience and implement a more precautionary approach (that is a 'better safe than sorry approach') to controlling chemicals that can build up in our bodies and potentially affect the unborn child. Many scientists throughout the EU also echo our concerns.

In addition to toxicity data already available on some of these chemicals, new studies are frequently being published in the scientific journals which show that chemicals are able to produce subtle adverse effects at lower levels than previously ever thought. There is a worry that because endocrine disrupting chemicals (EDCs) act on a biochemical system that is already active, some chemicals may not have a threshold for certain effects, particularly in susceptible members of the population. The concern is therefore that long-term low-level exposure during early life, may result in unexpected effects, which manifest only many years later.

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, such 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".

Many scientists with international reputations are now becoming increasingly concerned as evidence about EDCs and bioaccumulating chemicals is increasing. Many well-known scientists have signed a WWF declaration saying that it would be prudent to eliminate or minimise exposure to EDCs, and that if safer alternatives are judged to be available for either EDCs or vPvBs (very persistent and very bioaccumulating substances), then there should be a requirement to use such alternatives.
(see http://www.wwf.org.uk/chemicals/declaration.asp)

Similarly, scores of scientists have signed up to a detailed declaration on EDCs called the Prague Declaration.
This highlights the serious concerns about endocrine disrupting chemicals and presses for precautionary action. It states,

"In view of the magnitude of the potential risks associated with endocrine disrupters, we strongly believe that scientific uncertainty should not delay precautionary action on reducing the exposures to and the risks from endocrine disrupters".
(see http://www.edenresearch.info/declaration.html).

This shows that even though scientists recognise there is as yet no absolute proof that currently traded chemicals are responsible for harmful effects, many agree with WWF that it is necessary to eliminate or reduce exposure to chemicals with certain undesirable properties, like endocrine disruption or the ability to bioaccumulate to a great extent.

It is for such reasons that WWF is campaigning to ensure that proposed EU legislation (see below), which aims to adequately regulate chemicals on the market in the EU, is strengthened to ensure a high level of protection for future generations of people and wildlife. WWF recognises that during the REACH negotiations we have a once in a lifetime opportunity to get better legal controls over chemicals, particularly those that may, without stricter controls, build up to harmful levels in future, or be found to cause effects later in life.

For more information on WWF publications about potential health effects of chemicals and their threat to wildlife and people please see www.panda.org/detox.

Chemicals Regulation in Europe

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"), just 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. PCBs, DDT, HCB and chlordane are classified as POPs and were analysed in this survey 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. REACH is designed to be an integrated approach to the control of the production, import and use of chemicals in Europe. It intends to create a system which is based on information about chemicals, rather than ignorance, and which ensures that useful safety information gets to those using chemicals. Under the proposal, the chemical industry will have to provide safety data on all chemicals produced above 1 tonne (principle of "no data, no market").

The REACH system is quite complex, but so is the network of 40 or so regulations that it is replacing. Crucially, in REACH the main responsibility for chemical safety is clearly placed on the chemical producer, not on public authorities or downstream users ("principle of reversed burden of proof").

The development of this EU legislation presents a once in a generation opportunity to regulate chemicals of very high concern by the introduction of an authorisation procedure. Chemicals deemed to be of very high concern will be submitted to authorisation, which first identifies and prioritises the chemicals, and then allows industry to submit a case for their continued use. Chemicals of very high concern are defined as those that are carcinogens; mutagens; reproductive toxins; are persistent, bio-accumulative and toxic (PBT); very persistent and very bio-accumulative (vPvB); and of similar concern when showing "serious and irreversible" effects (also see chapter "Recommendations").

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.

GENERATIONS X

Aim of the study

In its previous biomonitoring surveys, WWF has revealed the extent to which people across Europe are contaminated by a cocktail of hazardous man-made chemicals. The present study is a continuation of this. Its aim is to examine potential generational differences (and/or similarities) in the types and levels of contamination of families from across Europe, by testing the blood of the grandmother, mother and child of thirteen EU families for a range of persistent and bioaccumulative and/or endocrine disrupting chemicals.

Methods

Sampling of volunteer families

Thirteen families from twelve countries around Europe – Belgium (2 families), Denmark, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Poland, Sweden, Luxembourg – were sampled for blood during June of 2005. Each family sampled comprised three generations (the grandmother, the mother and one child) with a total of 39 family members sampled. The ages of the family members ranged from 12 years to 92 years. The children's generation ranged in age from 12 to 28 (with a median age of 16), the mother's generation from 38 to 59 (median age 45) and the grandmothers from 58 to 92 (median age 70). NB: "Children" within the context of this report are the youngest participants of each family and have no children of their own.

Due to the small sample size (i.e. only three members of one family from each country), and the lack of any lifestyle data for the families, no attempt has been made to associate the types and levels of chemicals detected in the individuals with their country of origin or their specific lifestyles choices. Confidentiality requirements mean that the families' countries of origin are not divulged in this report. Families were instead assigned a code number (family 1 to 13) to which they are referred when their results are reported or discussed e.g. the grand mother of family 10 had the highest level of p,p'-DDE detected in the survey.

Blood sampling

In total, approximately 40-50ml of blood was taken from each family member by vein puncture, using the Vacutainer system. Six vacutainer tubes were used to collect the volume of blood. Three tubes (half the volume of blood) were immediately centrifuged (3,000 rpm for 10 minutes) after collection, to separate the blood cells and platelets from the serum. The second half of the blood sample (in the three remaining vacutainer tubes) was not centrifuged. All tubes were then frozen and kept frozen (using dry ice) for transport to the laboratory for analysis.

Chemical analysis of blood

Blood samples were analysed for 107 different man-made chemicals by TNO Environmental Analysis laboratory, TNO Built Environment and Geosciences, Apeldoorn, The Netherlands. The chemicals analysed in this survey were chosen on the basis of their potential to persist and bioaccumulate in the environment and in human samples, their detection in previous biomonitoring surveys and information on their properties which are of concern to WWF (e.g. bisphenol-A, triclosan). The chemicals tested were -

- 12 organochlorine pesticides (OCPs) incl. DDT, chlordane, lindane, hexachlorobenzene
- 44 polychlorinated biphenyls (PCBs)
- 33 brominated flame retardants incl. 31 polybrominated diphenyl ethers (PBDEs), plus hexabromocyclododecane (HBCD) and tetrabromobisphenol-A (TBBP-A)
- 8 “non-stick” perfluorinated chemicals (PFCs) incl. perfluorooctane sulphonate (PFOS) and perflurooctanoic acid (PFOA)
- 7 artificial musks
- 2 antimicrobials (triclosan and its breakdown product, methyl triclosan)
- The polycarbonate plastic monomer Bisphenol-A

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 EU after they were belatedly found to be highly persistent in the environment and cause long-term toxic effects in wildlife. For example, populations of birds of prey were devastated due to exposure to DDT in the food chain. The DDT caused their eggshells to thin and break, meaning the chicks did not survive. 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.

Polychlorinated biphenyls (PCBs)
This group of industrial chemicals were used in electrical equipment in the 1970s but banned in the EU after they were found to be toxic and to be building up in animals and people across the world. Research has shown that exposure to PCBs in the womb (due to elevated levels of PCBs in the mother’s body) can be associated with adverse behavioural and neurological effects in babies. PCBs have also had impacts on wildlife species, such as seals in the North Sea, whose immune systems were compromised by high levels of accumulated PCBs, which made them more susceptible to infection e.g. by viruses such as the phocine distemper virus.

Brominated flame retardants (including PBDEs, TBBP-A and HBCD)
This is a group of chemicals used as flame retardants in numerous consumer products. The group can be sub-divided into polybrominated diphenyl ethers (PBDEs) and two other compounds, TBBP-A (tetrabromobisphenol-A) and HBCD (hexabromocyclododecane).
The PBDEs, some of which are suspected hormone disrupters, are used to flame retard numerous consumer products such as plastics, textiles, furniture and electrical appliances. They are contaminating humans (blood, fat and breast milk) and wildlife throughout Europe, North America and the Arctic and levels of contamination are increasing. Several PBDEs have now been banned in the EU, due to concerns over their toxicity and persistence in the environment. Particularly worrying was the fact that levels of these chemicals were shown to be increasing in human breast milk. The remaining PBDE flame retardant “deca-BDE” is still in widespread use however. Although it can be found in wildlife and humans throughout the world, industry refuses to acknowledge there are concerns about the persistence and neurological toxicity in animals and about the fact that deca-BDE breaks down into hazardous chemicals that are already banned in the EU. TBBP-A and HBCD, used as flame retardants in plastics, insulation foams and electrical goods, are also accumulating in the environment, wildlife and humans.

Perfluorinated chemicals (PFCs)
PFOS (perfluorooctane sulfonate), PFOA (perfluorooctanoic acid) and PFOSA (perfluorooctane sulphonamide) 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. Chemicals such as PFOS and PFOA, which are two breakdown products of the chemicals used in these applications, are accumulating in the environment and have been found in a wide range of wildlife, as well as in humans.

For example, the half-life (the time taken for half the amount of a chemical to be metabolised or eliminated) of PFOS in humans is in the region of 8-9 years. However, at present it is not fully clear how such chemicals escape from these products into the environment, wildlife and people. The US EPA also considers both PFOS and PFOA to be carcinogenic and occupational exposure to PFOS has been correlated with increased incidence of bladder cancer.

Artificial musks

Artificial musks are 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. Musks such as HHCB (galaxolide) and AHTN (tonalide) have been measured in rain and river water, lakes, sediment, sewage sludge and wastewater treatment plant effluent in Canada, the United States and Europe. Synthetic musks have also been detected in air. Studies in Europe, North America and Japan have shown that synthetic musk compounds bioaccumulate in aquatic environments, and they have been detected in a wide range of wildlife species. HHCB, AHTN, and other musks have been found in human adipose (fat) tissue, blood and breast milk. There is research to suggest that musks can inhibit the mechanisms by which the body's cells eliminate other environmental pollutants.

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. Triclosan has been detected in human breast milk and its breakdown product, methyl triclosan, has been shown to be accumulating in the environment and wildlife. Research has shown that it can produce highly toxic dioxins in the presence of sunlight (UV) and chloroform when mixed with chlorinated water.

Bisphenol - A

Bisphenol - A (BPA) is the building block for polycarbonate plastic, used for making bottles and containers for food and drink (including baby bottles) and other products such as CDs and DVDs and spectacle lenses. BPA is also used in epoxy resins (used in the protective liners in metal food cans/tins) and certain dental sealants. However, BPA is a synthetic oestrogen (a chemical that can mimic the action of the hormone oestrogen in the body) and so there is concern over it use in food and drink containers and in tin cans, as it can leach from the plastic/resin into the food or beverage inside. The fact that polycarbonate is used to make baby's bottles and that this can potentially expose new-born infants to an endocrine disrupting chemical is of great concern, as developing babies are undergoing crucially important developmental changes.

Units and reporting of results

Differences in the chemical and physical properties of the chemicals necessitated they be analysed in different ways. The OCPs and PCBs were analysed in blood serum and expressed with respect to serum weight (pg/g serum)*, whereas the flame retardants (PBDEs, HBCD and TBBP-A), perfluorinated compounds, musks, triclosan, methyl triclosan and bisphenol-A were analysed in whole blood (ng/g blood)**.

* pg = picogram = one trillionth of a gram

**ng = nanogram = one billionth of a gram

The units allow comparison with previous WWF DETOX campaign biomonitoring surveys ("Chemical Check Up – An analysis of chemicals in the blood of Members of the European Parliament" and "Bad blood- A survey of chemicals in the blood of European ministers"). The only exception to this is the PBDEs and HBCD, which due to analytical difficulties with the serum extracts, are reported here in ng/g blood instead of pg/g serum (as in previous surveys).

Due to the differences in the units and the sample media (serum and whole blood), it is not possible to combine all the chemicals together to give an overall burden. Therefore, two total burdens are reported – total pg/g serum burden (comprising OCPs and PCBs) and total ng/g blood burden (comprising PBDEs, PFCs, musks, HBCD, TBBP-A, bisphenol-A, triclosan and methyl triclosan). Minimum, maximum and median values are derived from all values, which includes values below the limit of detection (assigned a value of zero).

The median is defined as "the middle value in a set of values arranged in order of size". The median value is used rather than the mean or average as it is a more statistically appropriate way to describe this kind of data.

A "0" in the results tables stands for "Not detected above limit of detection".

For detailed detection limits please look in the Appendix.

Results

Every family member, from grandmothers to children, is contaminated with a cocktail of at least 18 different man-made chemicals. With only two exceptions[1], brominated flame retardants, OCPs, PCBs, artificial musks and PFCs were found in the blood of every person, and that includes children as young as 12.

Of the 107 chemicals analysed for -

- 73 in total were detected in the whole survey
- 63 were found in the grandmother's generation
- 49 were found in the mother's generation
- 59 were found in children's generation
- The fewest number of chemicals detected in a family member was 18 (a mother) and the most detected was 39 (a grandmother).
- The median number of chemicals detected in the survey was 28.
- The median numbers of chemicals in the different generations were 32 for grandmothers, 29 for mothers and 24 for children.
- The highest number detected in a grandmother was 39; in a mother, 34 and in a child (of 12 years old), 31.
- The lowest number detected in a grandmother was 25; in a mother, 18 and in a child, 19.

The complete set of data for all the families can be found in the Appendix.

[1] A grandmother did not have brominated flame retardants in her blood, and another grandmother had no PFCs. There are no PFC results for the mother of family 12, due to a sample extract being damaged in the laboratory.

Table 1 below presents the overall results from the blood analysis of all the family members. The minimum, maximum and median total levels and minimum, maximum and median number (in brackets) of OCPs, PCBs, PBDEs, PFCs, and musks in individual family members are shown. For example, the smallest number of OCPs detected in a family member is 2, the maximum total level of PCBs found in a family member is 7057 pg/g serum and the median level of PFCs for all the family members is 3.77 ng/g blood.
The minimum, maximum and median levels for HBCD, TBBP-A, bisphenol-A and triclosan are also shown e.g. the lowest level of triclosan in a family member is zero (i.e. not detected).
NB: Methyl triclosan, a breakdown product of triclosan, was not detected in any family member tested.
Total burdens in pg/g serum and ng/g blood are shown as well as the total number of chemicals detected e.g. the highest number detected in a family member was 39, the lowest, 18.

Table 1 - Overall results from all families in the survey - Minimum, maximum and median total levels of chemicals (min, max and median numbers of chemicals in brackets). A "0" in the results tables stands for "Not detected above limit of detection". For detailed detection limits please look in the Appendix.

All families		Minimum	Maximum	Median
OCPs	Total (pg/g serum)	187 (2)	30438 (4)	1916 (4)
PCBs	Total (pg/g serum)	81 (6)	7057 (31)	1647 (16)
PBDEs	Total (ng/g blood)	0 (0)	23.9893 (7)	0.0178 (3)
HBCD	ng/g blood	0	0.1010	0
TBBP-A	ng/g blood	0	0.32	0
PFCs	Total (ng/g blood)	0 (0)	37.09 (7)	3.77 (3)
Musks	Total (ng/g blood)	0.11 (1)	2.91 (2)	0.42 (1)
BPA	ng/g blood	0	0.85	0
Triclosan	ng/g blood	0	0.85	0
Methyl triclosan*	ng/g blood	-	-	-
	Total number detected	**18**	**39**	**28**
	Total burden (pg/g serum)	**533**	**32457**	**3977**
	Total burden (ng/g blood)	**0.328**	**40.929**	**5.187**

Table 2 below shows the number of different OCPs, PCBs, PBDEs, PFCs and musks detected in the whole survey and the number of family members contaminated with chemicals from each group. For other chemicals not included in these groups (i.e. HBCD, TBBP-A, bisphenol-A, triclosan and methyl triclosan) only the number of family members contaminated is shown.

Table 2 - Numbers of chemicals detected/family members contaminated

Chemical group/ chemical	Number detected in survey	Number of family members contaminated (out of 39)
OCPs	4 (out of 12)	All
PCBs	35 (out of 44)	All
PBDEs	20 (out of 31)	38
PFCs	7 (out of 8)	37*)
Musks	3 (out of 7)	All
HBCD	1 (out of 1)	1
TBBP-A	1 (out of 1)	18
BPA	1 (out of 1)	9
Triclosan	1 (out of 1)	16
Methyl triclosan	-	0 (not detected)
All chemicals	**73**	**-**

*) one sample was damaged in the laboratory

Table 3 below shows the most frequently detected chemicals in the survey, and the number of family members in which they were detected (out of a total 39). For example, the artificial musk HHCB, the organochlorine pesticide hexachlorobenzene and the PCBs 138/158 and 153/168 were found in every family member tested, p, p'-DDE was found in every family member but one, PFOS in all but two, the PBDE flame retardants BDE-47 and BDE-153 in over half the family members and the flame retardant TBBP-A in over a third.

Table 3 - Most frequently detected chemicals in the survey

Chemical(s)	Number of "detects"/39
HCB, PCB 138/158, PCB 153/168, HHCB	39
β-HCH, p,p'-DDE, PCB 180	38
PCB 118, PFOS	37
PCB 187, PFOSA	36
p,p' DDT, PCB 99	28
PCB 52, PCB 156	27
PCB 74, PCB 170	26
BDE 47	24
BDE 153	23
PCB 22, PCB 177	22
PCB 157	20
TBBP-A	18
BDE 100, Triclosan	16
BDE 99	15
PFOA	13

The following table (Table 4) provides an overview of the numbers and levels (minimum, maximum, median) of chemicals detected in each generation, with "n=" referring to the number of different chemicals from each group found in each generation. For example (shaded cells), 35 PCBs were found in grandmothers, the highest total level of perfluorinated chemicals found in a mother was 22.58 ng/g blood and the median level of OCPs in the children's generation was 856 pg/g serum. The total number of chemicals detected in each generation is also shown (e.g. 59 for the children's generation). For chemicals not included in the larger groups (i.e. HBCD, TBBP-A, bisphenol-A, triclosan and methyl triclosan), the number of contaminated individuals in each generation is marked with an asterisk (*).

With respect to OCPs, PCBs, PBDEs, PFCs and artificial musks, the most contaminated generations (based on number detected and/or median total burden) are –

- OCPs – grandmothers (highest median, equal highest number detected)
- PCBs – grandmothers (highest median and number)
- PBDEs – children (highest median and number)
- Perfluorinated chemicals – children (highest median level, although a higher number [7] were detected in grandmothers than children [6]).
- Musks – children (highest median level, equal number detected)

With respect to HBCD, TBBP-A, bisphenol-A and triclosan (based on their frequency of detection in a generation and the median level or the highest level detected),

- TBBP A – children (highest median level and frequency of detection in this generation)
- HBCD – only detected in one family member (a grandmother)
- Bisphenol A – detected in three individuals in each generation, with the highest level found in a child.
- Triclosan – mothers (highest frequency of detection, highest median level and highest individual level)
  NB: Methyl triclosan was not detected in any family member.

Table 4 - Overall results for the three generations in the survey

For chemicals not included in the larger groups (i.e. HBCD, TBBP-A, bisphenol-A, triclosan and methyl triclosan), the number of contaminated individuals in each generation is marked with an asterisk (*). A "0" in the results tables stands for "Not detected above limit of detection". For detailed detection limits please look in the Appendix. ND means not detected in the whole survey.

		Grandmothers				Mothers				Children			
		Min	**Max**	**Median**	**n=**	**Min**	**Max**	**Median**	**n=**	**Min**	**Max**	**Median**	**n=**
OCPs	Number detected	3	4	4	**4**	3	4	4	**4**	2	4	3	**4**
	Total (pg/g serum)	1297	30438	4070		532	16794	2150		187	3495	856	
PCBs	Number detected	15	31	18	**35**	8	23	16	**26**	6	19	12	**26**
	Total (pg/g serum)	750	7057	2388		285	2506	1804		81	777	455	
PBDEs	Number detected	0	6	2	**10**	1	5	2	**9**	1	7	5	**17**
	Total (ng/g blood)	0	0.1217	0.0155		0.0035	0.2113	0.0122		0.0057	23.9893	0.0459	
HBCD	ng/g blood	0	0.101	0	**1***	0	0	0	**0***	0	0	0	**0***
TBBP-A	ng/g blood	0	0.08	0	**3***	0	0.24	0.05	**7***	0	0.32	0.08	**8***
PFCs	Number detected	0	7	3	**7**	2	4	3	**4**	2	5	3	**6**
	Total (ng/g blood)	0	37.09	3.11		1.22	22.58	4.39		0.57	15.04	6.45	
Musks	Number detected	1	2	1	**3**	1	2	1	**3**	1	2	1	**3**
	Total (ng/g blood)	0.17	1.1	0.31		0.11	0.88	0.4		0.11	2.91	0.45	
BPA	ng/g blood	0	0.52	0	**3***	0	0.14	0	**3***	0	0.85	0	**3***
Triclosan	ng/g blood	0	0.57	0	**4***	0	0.85	0.21	**7***	0	0.55	0	**5***
Methyl triclosan	ng/g blood	ND	ND	ND	**0***	ND	ND	ND	**0***	ND	ND	ND	**0***
	Total number detected	**25**	**39**	**32**	**63**	**18**	**34**	**29**	**49**	**19**	**31**	**24**	**59**
	Total burden (pg/g serum)	**3892**	**32457**	**7207**		**1035**	**19107**	**3458**		**533**	**4008**	**1422**	
	Total burden (ng/g blood)	**0.328**	**38.150**	**3.661**		**0.941**	**23.453**	**4.265**		**1.097**	**40.929**	**7.401**	

Shaded cells – examples referred to in accompanying text.

The following graphs present the results (Overall and median numbers, median total burdens and highest levels of chemicals) for the three generations and illustrate the different types of chemical contaminants that predominate in each. For example, figures 1 and 2 present the median and overall numbers of chemicals detected in each generation and clearly show that for PCBs, grandmothers have higher numbers and this influences the overall and median number of chemicals found in their generation. In contrast, the highest overall and median numbers of PBDEs are found in children. Similar contrasts are illustrated by figures 3-5, showing greater contamination by OCPs and PCBs in the grandmothers, but the opposite scenario with respect to brominated flame retardants, PFCs and musks. Figures 6-7 show where the highest detected levels of chemicals and their total burdens can be found.

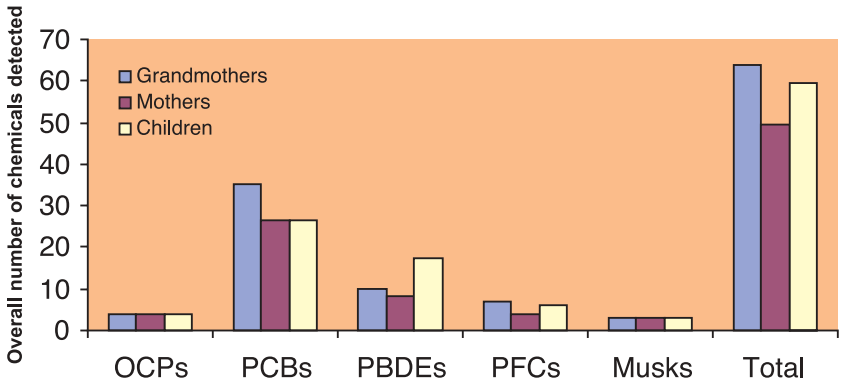

Figure 1 - Number of chemicals detected overall in each generation.
The total number also includes the detections of HBCD, TBBP-A, BPA and triclosan.

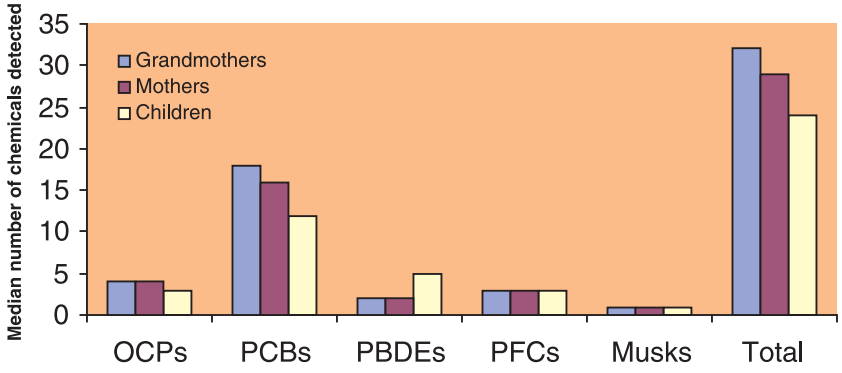

Figure 2 - Median number of chemicals detected in each generation.
The total number also includes the detected single substances HBCD, TBBP-A, BPA and triclosan.

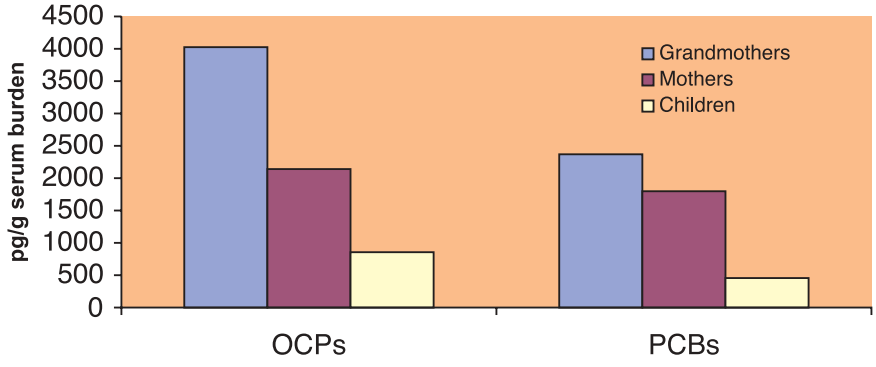

Figure 3 - Median total burden of OCPs and PCBs for each generation

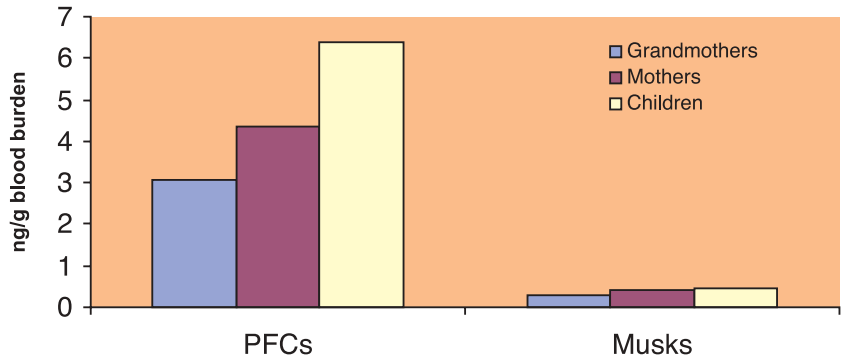

Figure 4 - Median total burden of PFCs and artificial musks for each generation

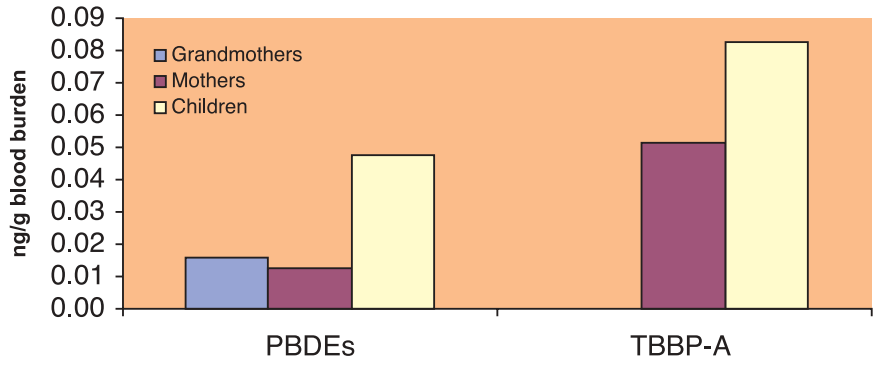

Figure 5 - Median total burden of brominated flame retardants for each generation

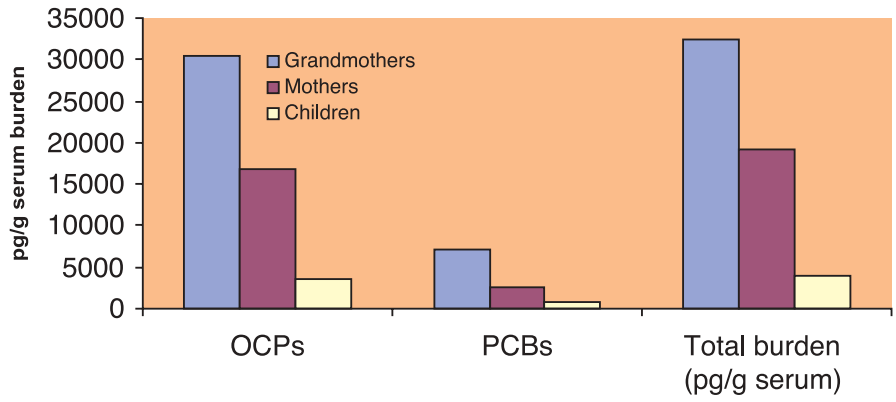

Figure 6 - Highest detected levels of OCPs, PCBs and total burden (pg/g serum) in each generation

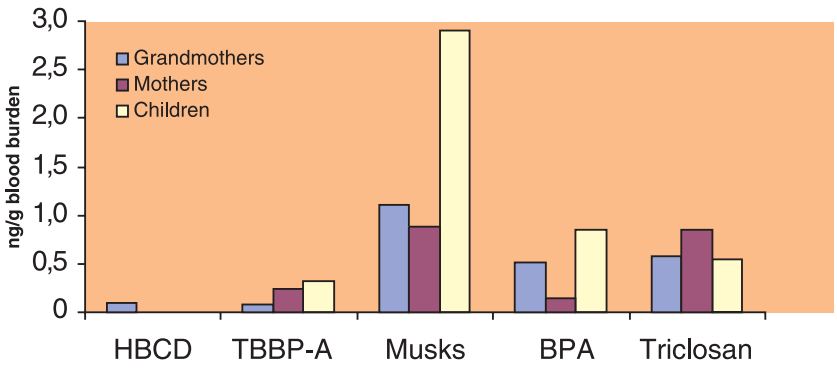

Figure 7 - Highest detected levels (ng/g blood) in each generation

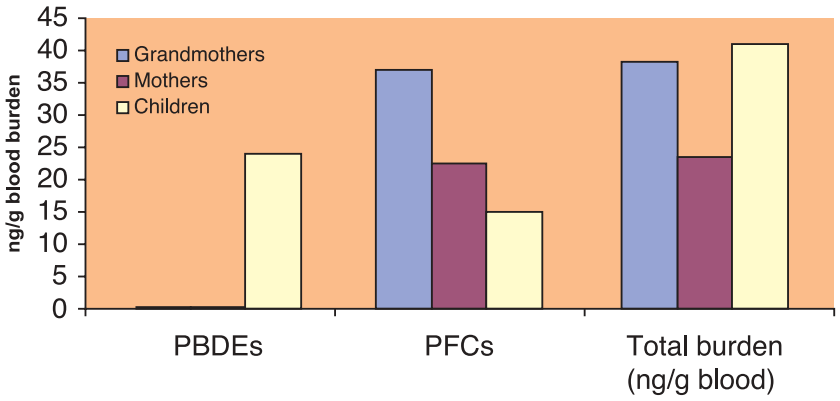

Figure 8 - Highest detected levels of PBDEs, PFCs and total burden (ng/g blood) in each generation

Highest and lowest

Table 5 below shows the highest and lowest total chemical burdens for OCPs, PCBs, PBDEs, PFCs and musks. For the other chemicals, the highest and lowest detected levels are shown - i.e. this does not include family members in which these individual chemicals were not detected (whose levels were therefore zero).

Table 5 - Highest and lowest total chemical burdens and detected levels for individual chemicals

	Highest detected		Lowest detected	
	Who?	Level	Who?	Level
Total OCP burden (pg/g serum)	GM 10	34637	CH 13	338
Total PCB burden (pg/g serum)	GM 11	7057	CH 7	81
Total PBDE burden (ng/g blood)	CH 3	23.99	GM 1	0
Total PFC burden (ng/g blood)	GM 1	37.09	GM 7	0
Total musk burden (ng/g blood)	CH 2	2.91	CH 9/M 11	0.11
HBCD (ng/g blood)	GM 2	0.101	rest of survey	0
TBBP-A (ng/g blood)	CH 9	0.32	M 10	0.05
BPA (ng/g blood)	CH 1	0.85	M 2	0.11
Triclosan (ng/g blood)	M 11	0.85	CH 1	0.17

GM=grandmother, M=mother, CH= child, followed by the number of their family.

Frequently detected chemicals and chemicals of concern

Below is information about some of the survey's most commonly detected chemicals and some of the chemicals that are of concern to WWF.

p,p'-DDE

This chemical is a breakdown product of the insecticide DDT, which was banned in the mid 1970's due to it's persistence in the environment, wildlife and people and its impacts on wildlife. Despite this, p,p'-DDE was found in all but one of the family members, including children as young as 12 years old, who were born years after DDT was banned. The highest level of p,p'-DDE (27634 pg/g serum) was found in the grandmother from family 10 and the lowest (188 pg/g serum) was found in the child from family 3.

Polychlorinated biphenyls

PCBs were found in every person tested, including children who were born years after they were banned. The highest levels were found in the grandmother's generation, and this is consistent with findings that PCB burden increases with age.

Penta- and octa-BDE

With the exception of one grandmother (family 1), BDE congeners used in the now banned penta- and octa-BDE flame retardant formulations were found in every family member tested. These chemicals were banned in Europe due to concerns over their toxicity and increasing concentrations in environmental and human samples (including breast milk). The major constituents of penta-BDE were congener numbers 47, 99, 100, 153 and 154 and of octa-BDE congeners 153 and 183.

Deca-BDE
This flame retardant chemical was found in two family members (at the concentrations of 23.3 and 4.4 ng/g blood), both from the children's generation, with the higher level being found in the younger of the two (the child of family 3). Deca-BDE is the only PBDE still in use in the EU, since formulations such as penta- and octa-BDE were banned due to concerns over their persistence, bioaccumulation and toxicity (see above). Similar concerns exist for deca-BDE and in particular over its suspected developmental neurotoxicity (Viberg et al, 2003).

TBBP-A
This flame retardant, used in printed circuit boards in electronic appliances, was more frequently found in the younger generations; it was found in 18 people, made up of 3 grandmothers, 7 mothers and 8 children. The highest level found (0.32 ng/g blood) was in the child from family 3.

HBCD
This flame retardant chemical, used in building materials such as thermal insulation foam, was only detected once, in a grandmother.

PFOS, PFOSA and PFOA
These "non-stick" perfluorinated chemicals, were found in 37, 36 and 13 family members respectively, with the highest detected levels found in the grandmother's generation. Perfluorinated chemicals are highly persistent in the environment and have been termed "eternal chemicals" since they take so long to break down. PFOS and PFOA have also been classified to be carcinogenic by the US EPA and occupational exposure to PFOA has been associated with an increased risk of bladder cancer. Such are the concerns regarding its persistence, bioaccumulation and toxicity that the UK government has taken unilateral action to phase out the use of PFOS in many applications. Many of the children's generation were contaminated with these chemicals – all were contaminated with PFOS, 12 with PFOSA and 8 with PFOA.

HHCB (galaxolide)
This artificial musk chemical was found in every family member tested. The highest level detected (2.52 ng/g blood) was found in the child from family 2.

Bisphenol A
This oestrogenic (hormone mimicking) chemical, used to make polycarbonate plastic and epoxy resins was found in three family members from each generation, with the highest (0.85 ng/g blood) being found in a child (family 1).

Triclosan
This antibacterial chemical was found in sixteen family members (4 grandmothers, 7 mothers and 5 children) and the highest level detected (0.85 ng/g blood) was in the blood of the mother from family 11.

Family profiles

Every member of every family, young and old, is contaminated with a cocktail of different man-made chemicals. Below are short overviews of the results for each family. They briefly describe the nature and extent of each family's contamination, and any noteworthy aspects of their results. The complete set of data for all the families can be found in the appendix.

Family 1

This family's blood contains 33, 32 and 30 chemicals (grandmother, mother and child respectively) including OCPs, PCBs, brominated flame retardants, PFCs, musks and bisphenol-A.

For the majority of the chemicals tested for (OCPs, PCBs, perfluorinated chemicals and musks) the grandmother has higher levels than the rest of the family. However, there are exceptions to this - for example, the youngest family member has a higher number of perfluorinated chemicals in the blood, and has the family's highest level of bisphenol-A. In contrast to the mother and child, the grandmother's blood does not contain brominated flame retardants. Of the mother and child, the mother is more contaminated with these chemicals. The total chemical burdens of all three family members are higher than the median level for all the families tested.

The grandmother's blood serum level of the organochlorine pesticide p,p' DDE is one of the highest found in the survey and the family as a whole are relatively highly contaminated – their combined levels of OCPs are higher than the family median. The grandmother has the family's highest number of different PCBs in her blood (24), followed by the mother (20) then the child (16). The grandmother's combined concentration of all these PCBs is also the highest in the family.

Two PBDEs were found in the mother and one in the child. The levels of these chemicals are lower than the median for all the families. The mother and child are also contaminated with the flame retardant TBBP-A. NB: No brominated flame retardants were detected in the grandmother's sample. All members of this family are contaminated with PFCs. The child has the highest number of these chemicals in the blood (5) and the grandmother, despite have fewer in her blood (3), has the highest level of these chemicals in this family and in the whole survey (37.09 ng/g blood).
The artificial musk HHCB (galaxolide) was found in all three family members both. Likewise, bisphenol-A was found in all the family and the child´s level is the highest level in the survey. Triclosan was found in the mother and the youngest family member.

Family 2

This family's blood contains 34, 21 and 22 chemicals (grandmother, mother and child respectively) including OCPs, PCBs, brominated flame retardants, PFCs and musks. The mother and child's samples also contain triclosan and bisphenol-A.
The grandmother has the highest level of OCPs and PCBs in her blood serum followed by the mother and then the youngest family member, whereas for the other chemicals, the mother is most highly contaminated, followed by the child and then the grandmother. The family's levels of OCPs are below the survey median, with the mother and child´s levels of PCBs and the family levels of PBDE flame retardants also being relatively low. All the family are contaminated with TBBP-A, and the grandmother is the only person in the whole survey to have another flame retardant, HBCD, in her blood.
All three family members have PFCs in their blood, and are also contaminated with artificial musks, with the child's total level of musks being the highest in the survey.

Family 3

This family's blood samples contain 31, 34 and 23 chemicals (grandmother, mother and child respectively) including OCPs, PCBs, brominated flame retardants, PFCs and musks. The mother's sample also contains triclosan.
The grandmother has the family's highest levels of PCBs and OCPs in her blood serum followed by the mother and then the child. In contrast, for chemicals such as PBDE flame retardants, PFCs and musks, the youngest family member is most highly contaminated, followed by the mother and then the grandmother. All the family members' combined burdens for these chemicals are equal to or above the survey median with the child's burden being the highest found in the whole survey.
The family are all contaminated with PBDE flame retardants and the child's total burden is the highest in the survey (23.98 ng/g blood). Deca-BDE (BDE-209), which is the only PBDE still in use in the EU, was also found in the child's sample.
The youngest family member also has the family's highest level of perfluorinated "non-stick" chemicals (despite the grandmother having a higher number in her blood), and also the family's highest level of musks in the blood.

Family 4

This family's blood contains 34, 26 and 31 chemicals (grandmother, mother and child respectively) including OCPs, PCBs, brominated flame retardants, PFCs, musks, bisphenol-A and triclosan in the grandmother's sample.
The grandmother is the most contaminated with respect to OCPs and PCBs. Next most contaminated is the mother, followed by the youngest family member. In contrast, for "newer" chemicals such as PBDE flame retardants, PFCs and musks, the mother and child are contaminated with higher numbers and/or levels than the grandmother.
This family's levels of the organochlorine pesticide p,p' DDE, and their combined total burdens for organochlorine pesticides in general, are relatively low for this survey. The grandmother is the most contaminated, followed by the mother and then the child. The grandmother is the most contaminated with PCBs – she has the highest number and total level of PCBs in her blood followed by the mother and then the child. The grandmother's total PCB burden is also the second highest level in the whole survey.
PBDE flame retardants were found in all family members, and the child is most contaminated. As well as having the family's highest number of PBDEs in the blood (6, compared to the mother's 2 and the grandmother's 5), the child's total PBDE burden is the highest in the family. The youngest family member and mother are also contaminated with another brominated flame retardant called TBBP-A.
All of this family are contaminated with "non-stick" PFC chemicals. The child has the highest number of these chemicals in the blood (4) but the mother, despite having one fewer in her blood (3), has a higher total burden.
All the members of this family are contaminated with the artificial musk HHCB (galaxolide) with the child also having musk xylene in the blood. Bisphenol-A was found in all family members and the antimicrobial triclosan was found in the grandmother's blood.

Family 5

This family's blood contains 27, 32 and 27 chemicals (grandmother, mother and child respectively) including OCPs, PCBs, brominated flame retardants, PFCs and musks, as well as triclosan in the mother and child's samples.
The grandmother has this family's highest levels of PCBs and OCPs in her blood serum with the next most contaminated family member being the mother.
The family's levels of p,p' DDE, and their combined total burdens for organochlorine pesticides in general, are relatively low. Despite being contaminated with fewer PCBs than the mother, the grandmother's combined burden of all PCBs is the highest in the family and is relatively high for the survey. The number and total burden of PCBs in the child's blood is relatively low.
The opposite is true for the PBDE flame retardants, as the child is most contaminated with having the highest number and total burden of PBDEs in the family. The child and mother are also contaminated with TBBP-A.
All members of this family are contaminated with "non-stick" PFCs such as PFOS, and although the child has a higher number in the blood, the grandmother has the family's highest level of these chemicals.
All the members of this family are contaminated with the artificial musk HHCB (galaxolide) with the youngest family member also having AHTN (tonalide) in the blood.

Family 6

This family is contaminated with OCPs, PCBs, brominated flame retardants, PFCs and artificial musks. The grandmother is contaminated with the highest number of chemicals detected in the whole survey (39), while in contrast, the mother has one of the survey's lowest numbers of chemicals in her blood (19). The number of chemicals in the child's blood is between these extremes, as it is the same as the survey median (24).

All members of this family have organochlorine pesticides in their blood serum with the grandmother most contaminated (e.g. her level of p,p' DDE is one of the highest in the survey), followed by the mother. The grandmother also has the family's highest number of different PCBs in her blood (31), and this number is also the highest found in the survey. The remaining family members have much lower numbers of PCBs in their blood and their combined levels are relatively low for the survey as a whole.

Relatively few PBDE flame retardants were found in the members of this family and at low levels, but the youngest family member has a higher total PBDE burden than the mother and grandmother.

This family are all are contaminated with "non-stick" PFCs with the child having the family's highest number and highest combined level of these chemicals in the blood. They also all have the musk HHCB (galaxolide) in their blood, with the mother and child also having AHTN (tonalide).

Family 7

The grandmother, mother and child of this family have 27, 18 and 19 different chemicals in their blood, respectively, and are therefore one of the least contaminated families (in terms of numbers of chemicals) in the survey. Their blood contains OCPs, PCBs, brominated flame retardants, PFCs and artificial musks, with the exception of the grandmother as PFCs were not detected in her blood.

With the exception of high levels of OCPs (mostly due to p,p' DDE) in the grandmother and mother, this family has some of the lowest levels and numbers of chemicals in the survey. The mother is contaminated with the fewest number of chemicals of all the family members in the survey, and the grandmother and child's numbers of chemicals are also some one of the lowest in their generations. Their total burdens (ng/g blood) are also below the median for the whole survey (and for their respective generations) and the grandmother's total burden is the lowest in the whole survey.

This family's total OCP burdens are relatively high for the survey (higher than the survey median and higher than the medians for their respective generations). This family's levels of p,p' DDE (a breakdown product of the pesticide DDT) are also relatively high and make up the majority of their total pesticide burden. In contrast, they are the least PCB contaminated family in the survey. The youngest family member has the lowest number (6) and total burden (81 pg/g serum) of PCBs in the whole survey, the mother has the lowest number and total burden of PCBs in her generation and the grandmother has the lowest total burden of all the grandmothers.

PBDEs were found in all family members and the child is the most contaminated in the family (the highest number and total burden of PBDEs in the blood). "Non-stick" perfluorinated chemicals (PFCs) were found in the mother and child's blood (but not in the grandmother's), with the mother having a higher number and total burden. The mother's level is not particularly high however and is the lowest level in her generation.

This family are all contaminated with the artificial musk HHCB (galaxolide) and the child also has AHTN (tonalide) in the blood.

Family 8

This family is contaminated with OCPs, PCBs, brominated flame retardants, PFCs and artificial musks. The grandmother, mother and child's blood samples contain 32, 30 and 24 chemicals respectively. By comparison, the median number of chemicals found in each of the generations is 32 for grandmothers, 29 for mothers and 24 for children, so in terms of numbers of chemicals this family is about "average" for the survey.

All members of this family have OCPs in their blood serum, and their levels of p,p' DDE, are relatively high. The mother is the most contaminated with this group of chemicals, followed by the grandmother. The grandmother and mother have comparable numbers and total burdens of PCBs which are higher than the child's.

PBDE flame retardants were found in all the family members. The mother's total PBDE burden is the highest in the family, followed by the grandmother and then the child. In contrast to the rest of the family, the child's PBDE contamination is relatively low and is also the lowest total PBDE burden of this generation. The child and grandmother also have TBBP-A in their blood.
This family are all contaminated with "non-stick" PFCs (the mother has the highest total PFC burden followed by the child and then the grandmother) but their levels are relatively low for the survey overall. The family are also all contaminated with the artificial musk HHCB (galaxolide) and the mother and child have musk xylene in their blood. The grandmother and child's blood also contains triclosan.

Family 9

In this family, the grandmother, mother and child's blood samples contain 27, 22 and 24 different chemicals respectively. These cocktails of chemicals include OCPs, PCBs, brominated flame retardants, PFCs and artificial musks, as well as bisphenol-A in the grandmother.
The grandmother's total serum burden (compromising OCPs and PCBs) is one of the highest in her generation and in the survey, and is largely due to her high levels of OCPs, in particular p,p' DDE. In contrast, for the other chemicals (such as PBDE flame retardants, PFCs, triclosan and bisphenol-A), the mother and child have higher total burdens than the grandmother.
All members of this family have organochlorine pesticides in their blood serum. The grandmother is the most contaminated with this group of chemicals and her total burden is one of the highest in the survey. The grandmother is also the most PCB contaminated member of the family (with respect to both number and total burden) and is one of the more contaminated people in the survey. In contrast, the mother and child are less contaminated than many in this survey, as their numbers and total burdens of PCBs are below the median for their generations.

PBDE flame retardants were found in all members of this family with the youngest family member being the most contaminated – the highest number of PBDEs of the whole survey was found in the blood and the total burden of PBDEs is the second highest of all the family members tested. The child is also contaminated with deca-BDE, the only PBDE still in widespread use. Another brominated flame retardant (TBBP-A) was also found in the child's blood sample and the level of this chemical is the highest in the whole survey. The grandmother and mother's flame retardant burdens are, however, relatively low in comparison.

The family are all contaminated with "non-stick" PFCs. The mother has the family's highest total burden of these chemicals while the grandmother and child's are relatively low in comparison. The family are also all contaminated with the artificial musk HHCB (galaxolide). Bisphenol-A was detected in the grandmother's blood at the second highest level in the survey.

Family 10

The members of this family have some of the lowest numbers of chemicals found in the survey. The grandmother, mother and child's blood samples contain 25, 28 and 19 chemicals respectively – the grandmother's number is the lowest in her generation, the child's is the equal lowest in its generation and the mother's is below the median for her generation. Their blood samples contain OCPs, PCBs, brominated flame retardants, PFCs and artificial musks.
Despite their low numbers, the family's total burdens of chemicals in their blood serum are the highest in the survey, and this is due primarily to their burdens of OCPs which are also the highest in the survey. In contrast, for chemicals such as PBDE flame retardants, PFCs, triclosan and bisphenol-A, the family are not as contaminated.
This family's high pesticide burdens are due primarily to their high levels of p,p' DDE, which are the highest in their respective generations. All three family members are also contaminated with the related p,p'-DDT at the highest levels in their generations.
The extent of the family's contamination with polychlorinated biphenyls (PCBs) is not as great as for the OCPs. The mother is the most contaminated with PCBs followed by the grandmother. The child has the equal lowest number of PCBs in the survey.

The family's levels of PBDEs are relatively low, and the child is the most contaminated of the family, followed by the grandmother and mother. The mother and child are also contaminated with TBBP-A. All the family are contaminated with PFCs, and the child is the most contaminated of the family, followed by the grandmother then the mother. The grandmother and mother's total PFC burdens are relatively low when compared to the survey as a whole. The family are also all contaminated with the artificial musk HHCB (galaxolide) at relatively low levels.

Family 11

The grandmother, mother and child of this family have 32, 34 and 26 chemicals in their blood respectively. These include OCPs, PCBs, brominated flame retardants, PFCs, artificial musks and triclosan. With respect to the family's total blood serum burdens (comprised of all PCBs and OCPs), the grandmother is the most contaminated followed by the mother and the child. For the burden of other chemicals such as PBDE flame retardants, PFCs and triclosan, the child's total burden is the family's highest, followed by the grandmother and mother.

The grandmother has the highest OCP burden of the family, followed by the mother. Their burdens are all relatively high and a large proportion is made up by their levels of p,p' DDE (a breakdown product of DDT). The grandmother also has the highest total burden of PCBs (7057 pg/g serum) in the whole survey, despite the mother having a higher number of PCBs in her blood (19). The child is the least contaminated.
PBDE flame retardants were found in all members of this family at relatively high numbers and levels (particular in the grandmother and mother), and all three family members are contaminated with TBBP-A.

All members of this family are also contaminated with "non-stick" PFCs and overall, their burdens are relatively high. The child is the most contaminated of the family followed by the grandmother then the mother. The family are also all contaminated with the artificial musk HHCB (galaxolide) and the grandmother has AHTN (tonalide) in her blood. The antimicrobial compound triclosan was found in all family members - the mother's and grandmother's levels are the highest and second highest in the survey respectively.

Family 12

The grandmother, mother and child of this family have 38, 29 and 25 chemicals in their blood, respectively. The grandmother's number of chemicals is the second highest number in the whole survey. Their blood contains OCPs, PCBs, brominated flame retardants, PFCs (except the mother) and artificial musks. The grandmother and mother's samples also contain triclosan.

The mother has the family's highest total blood serum burden (comprised of all PCBs and OCPs) and it is relatively high for the survey, due largely to her high levels of OCPs, particularly p,p' DDE. The grandmother's burden is the next highest in the family and the child's is the lowest.
For other chemicals such as flame retardants, PFCs and triclosan, this family (and particularly the mother), have relatively low levels of contamination.
All the family members have OCPs in their blood serum. The mother's total OCP burden is the highest in the family and is one of the highest in her generation, whereas the grandmother's levels are amongst the lowest in her generation. A large proportion of their burdens, and the mother's in particular, is made up by p,p' DDE. The grandmother has the highest number and total burden of PCBs in the family. The mother is next most contaminated and the child is the least.

PBDE flame retardants were found in all members of this family. The mother is the most contaminated of the family and levels of PBDEs in the grandmother and mother are relatively high. In contrast, the child is one of the least contaminated in the youngest generation.
Both the grandmother and child of this family are contaminated with "non-stick" PFCs such as PFOA and PFOS although their PFC levels are relatively low. All the family are contaminated with the artificial musk HHCB (galaxolide) and the grandmother also has AHTN (tonalide) in her blood. Triclosan was found in the grandmother and mother.

Family 13

The grandmother, mother and child's blood samples contain a cocktail of 32, 29 and 30 different chemicals respectively These include organochlorine pesticides, PCBs, brominated flame retardants, perfluorinated chemicals and artificial musks. The mother's sample also contains triclosan.
The grandmother has the family's highest total serum burden (PCBs and OCPs) followed by the mother and then the child, whose serum burdens are relatively low (second lowest serum burden in the survey). For chemicals such as flame retardants, PFCs and triclosan the grandmother is again the most contaminated in the family and her levels are relatively high for the survey. The mother and child however, are some of the least contaminated.

This family's levels of OCPs are not particularly high e.g. the child's burden is the lowest in the whole survey. The family's serum PCBs levels are also relatively low for the survey. The child is contaminated with the highest number of PCBs in the family, but their combined concentration (total burden) is the lowest. Conversely, the grandmother's number of PCBs is the lowest in the family, but her total burden is the highest.

PBDE flame retardants were found in all members of this family and their levels are relatively high. The grandmother is the most contaminated of the family (her total PBDE burden is also the highest in her generation), followed by the child and mother (who has TBBP-A in her blood). This family are contaminated with PFCs, and the grandmother is contaminated with the highest number of PFCs detected in the whole survey (7). However, the mother and child's PFC burdens are amongst the lowest in their generations.
The family are all contaminated with relatively low levels of the artificial musk HHCB (galaxolide). The mother also has AHTN (tonalide), as well as the antimicrobial triclosan, in her blood.

Routes of exposure

The results from this survey clearly show that people are contaminated with man-made chemicals, many of which can be found in everyday products. A logical question to ask is therefore, how do people become contaminated with these chemicals? What are the routes of exposure?

The answer is there are many different exposure routes. Exposure can occur directly – for example, chemicals 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. Exposure to pesticides is possible in countries where they might still be used to control insect pests (such as malarial mosquitoes in the case of DDT).

Chemicals can also escape or leach from the products in which they are found, contaminating the wider environment and important food chains, as well as more immediate indoor environments. We can then become exposed to these chemicals through the air/dust we breathe, the water we drink and the food we eat. The information below offers some explanation as to the possible ways in which family members have become contaminated with the chemicals that were found in their blood in this survey.

Diet

For many persistent chemicals such as PCBs, DDT and dioxins, food can account 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.

Indoor air and dust

In addition to the dietary routes discussed above, it is becoming increasingly clear that indoor air and dust can be a significant source of chemical exposure (e.g. Greenpeace, 2003), in particular to PBDE flame retardants (Wilford et al., 2004, Stapleton et al., 2005, Jones-Otazo et al., 2005). Research is showing that products in the home and office – including electrical appliances (computers), upholstered sofas, chairs, curtains, carpet underlay and mattresses – can be a major source of people's exposure to PBDEs. These products can contain high levels of flame retardants, which can volatalize and escape into the air and be inhaled. A recent study found detectable levels in air in all of the homes sampled (Wilford et al., 2004). Other studies (e.g. Greenpeace, 2003) have also shown that PBDEs such as penta- and deca-BDE can be found in house dust and have suggested 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). PCBs can also be found in indoor air and dust, and have been detected in school buildings which used PCBs in their construction materials (Herrick et al., 2004).

A study has shown that the phthalate DEHP (used in plastics to make them soft and flexible) can escape from PVC flooring into air and dust (Clausen et al., 2004), creating an inhalation exposure route. Although they are not looked for in this survey, these chemicals have been detected in human blood and breast milk and phthalate metabolites have been detected in adult and children's urine. Phthalates are suspected endocrine disrupting chemicals, and there are concerns that they might affect reproductive development in baby boys exposed in their mother's wombs.

Members of the “non-stick” perfluorinated group of chemicals, which includes PFOS and PFOA, 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 exposure routes is limited. It is still unclear how these chemicals are finding their way from the products in which they are used into the environment and into wildlife and people. It is thought they can be produced by the breakdown of fluorochemicals used in a wide variety of consumer products such as protective stain-proof coatings for carpets and clothing, non-stick cookware, personal care products and fire-fighting foams. Recent research suggests that indoor air and dust can be an exposure route (Shoieb et al., 2005).

Other routes

Bisphenol-A is used in polycarbonate plastic for water bottles, baby feeding bottles, food and beverage containers and epoxy resin linings for food cans. It has been shown that this chemical can leach from these materials into the food and liquids inside these containers (Brotons et al., 1995, vom Saal and Hughes, 2005), so ingestion is a possible exposure route. Artificial musks, used in numerous fragranced products, can be inhaled or absorbed through the skin (Hawkins et al., 2002). Dermal (skin) absorption is also an important exposure route for phthalates used in personal care products (Aldibi et al., 2003, WHO, 2003).

Discussion / Conclusions

This survey has demonstrated that chemical contamination is a threat faced by both the young and the old. Every family member in this survey, regardless of age or country of origin, is contaminated with a cocktail of persistent, bioaccumulative and hormone-disrupting chemicals, some of which have been banned decades ago but still persist in the environment and others that are still in widespread use in consumer products. 63 different chemicals were found in grandmothers, 49 in mothers and 59 in the youngest generation. The median number of chemicals is 32 for grandmothers, 29 for mothers and 24 for children.

The results of this survey demonstrate widespread contamination of EU families with chemicals that are banned and have been for decades. The organochlorine pesticides (such as DDT) and PCBs detected in every family member have been banned since decades but continue to contaminate new generations with every passing year. Their presence in every family member, some of whom were not even born when these chemicals were banned, clearly illustrates just how persistent they still are in the environment. This contamination of future generations highlights how important it is to strictly control persistent and bioaccumulative chemicals, as they cannot simply be recalled like faulty goods on a supermarket shelf when it becomes clear that they pose risks to the environment, wildlife and human health. The shortcomings of existing regulations become even more apparent when one considers the chemicals still in everyday use that have similar properties to the problematic PCBs and OCPs, such as brominated flame retardants and perfluorinated chemicals (see below). Both these classes of chemicals have now contaminated wildlife and humans all over the globe in the same way as PCBs and DDT did in decades past. This is a clear example of a failure to heed the environmental warnings regarding persistence and bioaccumulation. The mistakes of the past are being repeated with chemicals like PBDE flame retardants and it is vital that REACH ensures that this situation is not allowed to continue.

The survey also reveals some interesting results that show that the nature of chemical contamination is not always as we might expect: There is a reasonable assumption that contamination with persistent and/or bioaccumulative chemicals increases with age. That is, the older a person is, the more contaminated they are as they have been exposed to chemicals in the environment for longer and have had more time to accumulate them in their body. For certain chemicals, this is true. For example, PCBs, used in many open industrial applications before their ban in the mid-1970's, contaminate every corner of the globe and human body burdens increase with age (De Saeger et al., 2005). In this survey, the differences in total and median numbers of chemicals (see above) between the oldest and youngest generations are largely due to the higher numbers of PCBs detected in the oldest generation (the grandmothers). 35 PCBs were detected in the grandmother's generation compared to 26 in the mothers and children, and the range of PCB levels is an order of magnitude higher in the grandmothers.

However, this is not always the case. Other chemicals currently in use or only recently subject to bans can be found at equally high or even higher levels in younger people, as evidenced by the recent WWF-UK family biomonitoring survey "Contamination: the next Generation" (WWF, 2004). Research has also shown that in contrast to dioxin and PCBs, levels of PBDE flame retardants do not correlate significantly with age (Schecter et al., 2005). Similar findings can be seen in this survey. For example, PBDE flame retardants (chemicals with similar physical properties to PCBs and suspected similar effects) can be found at higher levels in the youngest family members.

Although the grandmother's are undoubtedly the most contaminated generation with respect to older chemicals such as organochlorine pesticides and PCBs, newer chemicals such as the brominated flame retardants (PBDEs and TBBP-A) and perfluorinated chemicals can be found more frequently and at higher levels in the younger generations (see the family profiles above for more details). For example, of the 31 different PBDEs analysed for in the survey, 17 were found in the youngest generation compared to 10 in the grandmothers and 8 in the mothers. The median number of PBDEs in the youngest generation (5) is also higher than for the older generations (2) and the median total burden of PBDEs for the youngest generation is almost three times higher than that of the grandmothers. Another brominated flame retardant,

TBBP-A, was detected most frequently in the youngest generation (detected in eight out of 13 in this generation), compared to three of the grandmothers and seven of the mothers. The survey's highest level of TBBP-A was also found in a child. This pattern is not restricted to flame retardants either. The highest median level of perfluorinated chemicals (PFCs) is that of the youngest generation and a higher number of these chemicals (6) were found in this generation compared to the mothers (4). The children's median total burden of artificial musks is higher than the older generations and the highest level of bisphenol-A was found in a child.

This phenomenon is not without exceptions however. It is worth noting that despite the higher median level found in children, the highest number and highest total level of PFCs are found in the members of the grandmothers' generation. HBCD was also found in only one family member, a grandmother. Triclosan was most frequently detected in the mother's generation (7 mothers out of 13 have triclosan in their blood, compared to 4 grandmothers and 5 children), and the highest level of this chemical is found in a mother. Nonetheless, the results of this survey clearly illustrate that the extent of contamination in younger generations can equal or exceed that of their elders.

These results are especially worrying as most of the chemicals found only break down very slowly, persist in the environment and accumulate in our bodies to ever increasing levels during the life span. The study therefore raises the question of whether future generations will be more exposed to potentially carcinogenic or endocrine disrupting chemicals that may lead to negative long term health effects.

The solution

This survey highlights the fact that there is little that families can do to avoid the ubiquitous threat of contamination by hazardous man-made chemicals. WWF's view is that we need strong European 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 and industry needs to provide this information.

WWF urges European legislators to ensure that the proposed REACH legislation delivers sufficient safety data on chemicals in order to identify the most hazardous ones – especially those with long term consequences resulting from low dose exposure. Chemicals of very high concern should be replaced whenever safer alternatives are available.

WWF recommends that:

1. The governments of the EU should adopt a strengthened REACH. Specifically REACH needs to be strengthened in order to

a) Phase out the use of hazardous chemicals, only allowing their continued use if no safer alternatives are available and their use is essential to society

b) Strengthen registration procedures rather than weaken them to close the existing gap in safety information for chemicals produced in 1-10 tonne per annum quantities.

c) Ensure that industry information receives an independent quality audit

d) Require chemicals used in imported articles to undergo the same information requirements as those in EU-made articles, so as to protect consumers and avoid distortion of competition

e) Make sufficient information on chemicals publicly available so that downstream users, retailers and consumers can find out which chemicals are contained in the products they purchase and make their own risk judgements.

2. In addition to restrictions on the use of hazardous chemicals, monitoring schemes ought to be set up to determine the levels and effects of chemicals in the environment. European governments should therefore set up co-ordinated biomonitoring programmes to determine trends in the levels of hazardous chemical 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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Appendix

	Chemical	a-HCH	b-HCH	g-HCH	HCB	cis-chlordane	trans-chlordane	o,p'-DDD
	Units	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum
Family	Generation							
1	grandmother	<20	465	<20	120	<20	<20	<20
1	mother	<20	86	<20	73	<20	<20	<20
1	child	<20	166	<20	200	<20	<20	<20
2	grandmother	<20	218	<20	398	<20	<20	<20
2	mother	<20	78	<20	150	<20	<20	<20
2	child	<20	<20	<20	130	<20	<20	<20
3	grandmother	<20	193	<20	400	<20	<20	<20
3	mother	<20	173	<20	152	<20	<20	<20
3	child	<20	85	<20	67	<20	<20	<20
4	grandmother	<20	1005	<20	243	<20	<20	<20
4	mother	<20	352	<20	314	<20	<20	<20
4	child	<20	131	<20	149	<20	<20	<20
5	grandmother	<20	64	<20	476	<20	<20	<20
5	mother	<20	119	<20	297	<20	<20	<20
5	child	<20	130	<20	90	<20	<20	<20
6	grandmother	<20	1821	<20	2428	<20	<20	<20
6	mother	<20	294	<20	249	<20	<20	<20
6	child	<20	131	<20	103	<20	<20	<20
7	grandmother	<20	218	<20	132	<20	<20	<20
7	mother	<20	176	<20	192	<20	<20	<20
7	child	<20	91	<20	98	<20	<20	<20
8	grandmother	<20	430	<20	565	<20	<20	<20
8	mother	<20	490	<20	773	<20	<20	<20
8	child	<20	222	<20	397	<20	<20	<20
9	grandmother	<20	1615	<20	4453	<20	<20	<20
9	mother	<20	279	<20	500	<20	<20	<20
9	child	<20	220	<20	434	<20	<20	<20
10	grandmother	<20	1363	<20	712	<20	<20	<20
10	mother	<20	624	<20	605	<20	<20	<20
10	child	<20	169	<20	329	<20	<20	<20
11	grandmother	<20	890	<20	1149	<20	<20	<20
11	mother	<20	314	<20	402	<20	<20	<20
11	child	<20	148	<20	152	<20	<20	<20
12	grandmother	<20	376	<20	379	<20	<20	<20
12	mother	<20	456	<20	567	<20	<20	<20
12	child	<20	291	<20	246	<20	<20	<20
13	grandmother	<20	300	<20	267	<20	<20	<20
13	mother	<20	112	<20	179	<20	<20	<20
13	child	<20	111	<20	75	<20	<20	<20

	Chemical	p,p'-DDD	o,p'-DDE	p,p'-DDE	o,p'-DDT	p,p'-DDT	OCPs	OCPs
	Units	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	n=	Total
Family	Generation							
1	grandmother	<20	<20	16320	<20	61	4	16965
1	mother	<20	<20	3323	<20	41	4	3523
1	child	<20	<20	2799	<20	34	4	3200
2	grandmother	<20	<20	663	<20	19	4	1297
2	mother	<20	<20	304	<20	<20	3	532
2	child	<20	<20	263	<20	<20	2	393
3	grandmother	<20	<20	1563	<20	89	4	2244
3	mother	<20	<20	623	<20	70	4	1017
3	child	<20	<20	188	<20	<20	3	340
4	grandmother	<20	<20	315	<20	<20	3	1563
4	mother	<20	<20	285	<20	<20	3	952
4	child	<20	<20	197	<20	<20	3	476
5	grandmother	<20	<20	1166	<20	56	4	1762
5	mother	<20	<20	793	<20	31	4	1241
5	child	<20	<20	379	<20	<20	3	599
6	grandmother	<20	<20	8376	<20	106	4	12730
6	mother	<20	<20	949	<20	36	4	1528
6	child	<20	<20	430	<20	<20	3	664
7	grandmother	<20	<20	7412	<20	291	4	8052
7	mother	<20	<20	4376	<20	176	4	4920
7	child	<20	<20	1672	<20	45	4	1906
8	grandmother	<20	<20	3004	<20	71	4	4070
8	mother	<20	<20	4417	<20	147	4	5827
8	child	<20	<20	1899	<20	149	4	2668
9	grandmother	<20	<20	5129	<20	76	4	11273
9	mother	<20	<20	1319	<20	51	4	2150
9	child	<20	<20	802	<20	40	4	1496
10	grandmother	<20	<20	27634	<20	730	4	30438
10	mother	<20	<20	14910	<20	654	4	16794
10	child	<20	<20	2806	<20	191	4	3495
11	grandmother	<20	<20	2167	<20	76	4	4281
11	mother	<20	<20	2227	<20	78	4	3021
11	child	<20	<20	604	<20	<20	3	904
12	grandmother	<20	<20	1131	<20	31	4	1916
12	mother	<20	<20	3882	<20	121	4	5027
12	child	<20	<20	318	<20	<20	3	856
13	grandmother	<20	<20	2652	<20	148	4	3368
13	mother	<20	<20	1195	<20	66	4	1551
13	child	<20	<20	<20	<20	<20	2	187

	Chemical	PCB-18	PCB-28/31	PCB-22	PCB-41	PCB-44	PCB-49	PCB-52	PCB-54	PCB-56/60
	Units	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum
Family	Generation									
1	grandmother	33	139	27	23	53	49	103	<5	<5
1	mother	8	23	11	<5	<5	6	33	<5	836
1	child	6	12	11	<5	<5	<5	30	<5	<5
2	grandmother	<5	15	9	<5	<5	<5	19	<5	<5
2	mother	<5	<5	<5	<5	<5	<5	<5	<5	<5
2	child	<5	<5	<5	<5	<5	<5	<5	<5	<5
3	grandmother	<5	8	9	<5	<5	<5	18	<5	<5
3	mother	8	58	13	<5	<5	14	42	<5	16
3	child	7	12	12	<5	<5	<5	21	<5	<5
4	grandmother	<5	9	9	<5	<5	<5	29	<5	<5
4	mother	<5	<5	<5	<5	<5	<5	<5	<5	<5
4	child	<5	<5	7	<5	<5	<5	11	<5	<5
5	grandmother	<5	<5	<5	<5	<5	<5	6	<5	<5
5	mother	8	18	11	<5	<5	<5	33	<5	<5
5	child	<5	<5	<5	<5	<5	<5	22	<5	<5
6	grandmother	<5	43	18	16	28	17	50	<5	10
6	mother	<5	<5	8	<5	<5	<5	8	<5	<5
6	child	17	51	16	<5	15	12	44	<5	<5
7	grandmother	15	52	19	17	23	18	53	<5	<5
7	mother	<5	<5	<5	<5	<5	<5	6	<5	<5
7	child	<5	<5	<5	<5	<5	<5	9	<5	<5
8	grandmother	<5	<5	<5	<5	<5	<5	<5	<5	<5
8	mother	<5	<5	<5	<5	<5	<5	6	<5	<5
8	child	<5	<5	<5	<5	<5	<5	<5	<5	<5
9	grandmother	<5	<5	<5	<5	<5	<5	<5	<5	<5
9	mother	<5	<5	<5	<5	<5	<5	<5	<5	<5
9	child	<5	<5	<5	<5	<5	<5	<5	<5	<5
10	grandmother	<5	<5	<5	<5	<5	<5	<5	<5	<5
10	mother	<5	<5	<5	<5	<5	<5	8	<5	<5
10	child	<5	<5	<5	<5	<5	<5	<5	<5	<5
11	grandmother	<5	<5	<5	<5	<5	<5	<5	<5	<5
11	mother	6	20	13	<5	<5	<5	30	<5	<5
11	child	<5	<5	9	<5	<5	<5	15	<5	<5
12	grandmother	19	56	16	6	21	12	55	<5	228
12	mother	13	25	8	<5	<5	<5	31	<5	<5
12	child	22	37	11	<5	<5	<5	34	<5	<5
13	grandmother	<5	<5	6	<5	<5	<5	<5	<5	<5
13	mother	<5	<5	8	<5	<5	<5	15	<5	<5
13	child	25	55	22	22	45	36	63	<5	9

	Chemical	PCB-64	PCB-70	PCB-74	PCB-87	PCB-90	PCB-99	PCB-101	PCB-104	PCB-105
	Units	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum
Family	Generation									
1	grandmother	<5	13	124	<5	<5	75	17	<5	<5
1	mother	<5	<5	14	<5	<5	23	<5	<5	<5
1	child	<5	<5	13	<5	<5	21	<5	<5	<5
2	grandmother	<5	<5	84	<5	<5	44	7	<5	<5
2	mother	<5	<5	<5	<5	<5	<5	<5	<5	<5
2	child	<5	<5	<5	<5	<5	<5	<5	<5	<5
3	grandmother	<5	<5	29	<5	<5	28	6	<5	<5
3	mother	<5	<5	75	<5	<5	52	<5	<5	35
3	child	<5	<5	<5	<5	<5	<5	<5	<5	<5
4	grandmother	<5	<5	424	<5	<5	42	7	<5	<5
4	mother	<5	<5	97	<5	<5	29	<5	<5	<5
4	child	<5	<5	8	<5	<5	11	<5	<5	<5
5	grandmother	<5	<5	47	<5	<5	28	11	<5	11
5	mother	<5	<5	12	<5	<5	22	<5	<5	13
5	child	<5	<5	<5	<5	<5	12	<5	<5	<5
6	grandmother	<5	12	55	13	<5	50	48	<5	37
6	mother	<5	<5	<5	<5	<5	<5	<5	<5	<5
6	child	<5	<5	<5	<5	<5	<5	<5	<5	<5
7	grandmother	<5	<5	7	<5	<5	<5	14	<5	<5
7	mother	<5	<5	<5	<5	<5	<5	<5	<5	<5
7	child	<5	<5	<5	<5	<5	<5	<5	<5	<5
8	grandmother	<5	<5	80	<5	<5	44	<5	<5	14
8	mother	<5	<5	75	<5	<5	41	<5	<5	24
8	child	<5	<5	12	<5	<5	24	<5	<5	11
9	grandmother	<5	<5	68	<5	<5	224	<5	<5	23
9	mother	<5	<5	<5	<5	<5	93	<5	<5	<5
9	child	<5	<5	<5	<5	<5	29	<5	<5	<5
10	grandmother	<5	<5	33	<5	<5	43	<5	<5	27
10	mother	<5	<5	33	<5	<5	63	<5	<5	15
10	child	<5	<5	<5	<5	<5	<5	<5	<5	<5
11	grandmother	<5	<5	40	<5	<5	53	<5	<5	22
11	mother	<5	<5	20	<5	<5	23	<5	<5	<5
11	child	<5	<5	<5	<5	<5	<5	<5	<5	<5
12	grandmother	<5	<5	77	<5	<5	29	<5	<5	<5
12	mother	<5	<5	26	<5	<5	41	<5	<5	<5
12	child	<5	<5	<5	<5	<5	12	<5	<5	<5
13	grandmother	<5	<5	25	<5	<5	43	<5	<5	<5
13	mother	<5	<5	12	<5	<5	38	<5	<5	<5
13	child	<5	12	22	<5	<5	<5	12	<5	<5

	Chemical	PCB-110	PCB-114	PCB-118	PCB-123	PCB-138/158	PCB-141	PCB-149	PCB-151	PCB-153/168
	Units	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum
Family	Generation									
1	grandmother	<5	<5	191	<5	397	<5	<5	<5	629
1	mother	<5	<5	50	<5	127	<5	<5	<5	198
1	child	<5	<5	55	<5	149	<5	<5	<5	236
2	grandmother	<5	13	196	<5	367	<5	<5	<5	879
2	mother	<5	<5	26	<5	79	<5	<5	<5	166
2	child	<5	<5	21	<5	78	<5	<5	<5	155
3	grandmother	<5	<5	130	<5	308	<5	<5	<5	504
3	mother	<5	<5	166	<5	270	<5	<5	<5	425
3	child	<5	<5	19	<5	34	<5	<5	<5	40
4	grandmother	<5	44	202	<5	394	<5	<5	<5	1214
4	mother	<5	15	82	<5	269	<5	<5	<5	653
4	child	<5	<5	32	<5	103	<5	<5	<5	242
5	grandmother	<5	<5	115	<5	360	<5	<5	<5	684
5	mother	<5	<5	73	<5	324	<5	<5	<5	518
5	child	<5	<5	25	<5	88	<5	<5	<5	114
6	grandmother	47	<5	124	<5	363	32	62	20	497
6	mother	<5	<5	<5	<5	94	<5	<5	<5	147
6	child	<5	<5	15	<5	46	<5	<5	<5	47
7	grandmother	<5	<5	14	<5	82	<5	<5	<5	153
7	mother	<5	<5	11	<5	68	<5	<5	<5	98
7	child	<5	<5	<5	<5	26	<5	<5	<5	30
8	grandmother	<5	12	89	<5	283	<5	<5	<5	510
8	mother	<5	11	138	<5	304	<5	<5	<5	512
8	child	<5	<5	71	<5	153	<5	<5	<5	199
9	grandmother	<5	22	147	<5	710	<5	<5	<5	1053
9	mother	<5	<5	78	<5	315	<5	<5	<5	368
9	child	<5	<5	41	<5	103	<5	<5	<5	114
10	grandmother	<5	<5	143	<5	301	<5	<5	<5	556
10	mother	<5	11	94	<5	344	<5	<5	<5	568
10	child	<5	<5	42	<5	172	<5	<5	<5	180
11	grandmother	<5	19	241	<5	926	<5	<5	<5	2037
11	mother	<5	<5	113	<5	421	<5	<5	<5	619
11	child	<5	<5	11	<5	148	<5	<5	<5	191
12	grandmother	<5	<5	106	<5	260	<5	<5	<5	496
12	mother	<5	<5	111	<5	339	<5	<5	<5	640
12	child	<5	<5	30	<5	87	<5	<5	<5	148
13	grandmother	<5	<5	113	<5	380	<5	<5	<5	613
13	mother	<5	<5	69	<5	297	<5	<5	<5	478
13	child	<5	<5	17	<5	35	<5	<5	<5	49

	Chemical	PCB-156	PCB-157	PCB-167	PCB-170	PCB-177	PCB-180	PCB-183	PCB-187	PCB-188
	Units	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum	pg/g serum
Family	Generation									
1	grandmother	61	25	<5	93	39	329	66	143	<5
1	mother	15	<5	<5	30	<5	185	32	60	<5
1	child	20	<5	<5	<5	<5	138	24	61	<5
2	grandmother	100	55	<5	185	49	799	67	274	<5
2	mother	15	<5	<5	32	<5	135	<5	50	<5
2	child	18	<5	<5	32	<5	118	<5	34	<5
3	grandmother	34	20	<5	55	36	274	50	137	<5
3	mother	45	25	<5	88	32	282	53	105	<5
3	child	<5	<5	<5	<5	<5	24	<5	24	<5
4	grandmother	217	61	<5	517	68	1843	100	363	<5
4	mother	80	24	<5	181	36	770	66	203	<5
4	child	29	<5	<5	29	<5	164	16	47	<5
5	grandmother	61	35	<5	208	41	678	77	156	<5
5	mother	32	17	<5	105	43	426	90	148	<5
5	child	11	<5	<5	31	<5	61	<5	21	<5
6	grandmother	33	20	<5	89	58	381	89	175	<5
6	mother	<5	<5	<5	28	<5	152	24	32	<5
6	child	<5	<5	<5	<5	<5	27	<5	<5	<5
7	grandmother	15	<5	<5	35	<5	157	21	57	<5
7	mother	<5	<5	<5	<5	<5	77	<5	26	<5
7	child	<5	<5	<5	<5	<5	16	<5	<5	<5
8	grandmother	34	20	<5	82	31	501	72	163	<5
8	mother	25	17	<5	<5	54	275	171	207	<5
8	child	<5	<5	<5	<5	<5	118	35	38	<5
9	grandmother	74	18	<5	63	55	385	118	262	<5
9	mother	25	<5	<5	<5	51	92	63	188	<5
9	child	<5	<5	<5	<5	<5	40	<5	40	<5
10	grandmother	24	22	<5	39	55	358	70	348	<5
10	mother	30	13	<5	57	35	383	81	284	<5
10	child	<5	<5	<5	<5	<5	<5	<5	118	<5
11	grandmother	76	32	<5	<5	323	1026	440	1823	<5
11	mother	14	27	<5	129	41	464	73	175	<5
11	child	<5	<5	<5	27	34	140	44	99	<5
12	grandmother	14	27	<5	145	23	458	37	114	<5
12	mother	<5	29	<5	56	37	365	84	196	<5
12	child	<5	<5	<5	<5	<5	71	49	63	<5
13	grandmother	11	21	<5	69	38	358	82	194	<5
13	mother	24	14	<5	78	30	365	57	111	<5
13	child	<5	<5	<5	<5	<5	22	<5	<5	<5

	Chemical	PCB-189	PCB-194	PCB-199	PCB-203	PCBs	PCBs
	Units	pg/g serum	pg/g serum	pg/g serum	pg/g serum	n=	Total
Family	Generation						
1	grandmother	<5	<5	<5	<5	24	2630
1	mother	<5	<5	<5	<5	20	1650
1	child	<5	<5	<5	<5	16	777
2	grandmother	<5	<5	<5	<5	20	3161
2	mother	<5	<5	<5	<5	9	503
2	child	<5	<5	<5	<5	9	455
3	grandmother	<5	<5	<5	<5	18	1647
3	mother	<5	<5	<5	<5	23	1804
3	child	<5	<5	<5	<5	12	193
4	grandmother	<5	100	<5	<5	21	5644
4	mother	<5	<5	<5	<5	15	2506
4	child	<5	<5	<5	<5	14	699
5	grandmother	<5	<5	<5	32	18	2550
5	mother	<5	<5	<5	<5	20	1894
5	child	<5	<5	<5	<5	11	385
6	grandmother	<5	<5	<5	<5	31	2388
6	mother	<5	<5	<5	<5	10	493
6	child	<5	<5	<5	<5	13	290
7	grandmother	<5	<5	<5	<5	20	750
7	mother	<5	<5	<5	<5	8	285
7	child	<5	<5	<5	<5	6	81
8	grandmother	<5	<5	<5	21	17	1957
8	mother	<5	<5	<5	<5	16	1862
8	child	<5	<5	<5	<5	11	661
9	grandmother	<5	<5	<5	<5	16	3222
9	mother	<5	<5	<5	<5	11	1274
9	child	<5	<5	<5	<5	8	367
10	grandmother	<5	<5	<5	<5	15	2019
10	mother	<5	84	<5	209	18	2313
10	child	<5	<5	<5	<5	6	512
11	grandmother	<5	<5	<5	<5	15	7057
11	mother	<5	<5	<5	<5	19	2189
11	child	<5	<5	<5	<5	12	718
12	grandmother	<5	<5	<5	<5	24	2199
12	mother	<5	<5	<5	<5	18	2001
12	child	<5	<5	<5	<5	14	566
13	grandmother	<5	<5	<5	<5	15	1952
13	mother	<5	<5	<5	<5	16	1596
13	child	<5	<5	<5	<5	19	445

	Chemical	BDE-17	BDE-28	BDE-32	BDE-35	BDE-37	BDE-47	BDE-49/71	BDE-66	BDE-75
	Units	ng/g blood	ng/g blood	ng/g blood	ng/g blood	ng/g blood	ng/g blood	ng/g blood	ng/g blood	ng/g blood
Family	Generation									
1	grandmother	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003	<0.003	<0.003	<0.003
1	mother	<0.001	<0.001	<0.001	<0.001	<0.001	0,0047	<0.003	<0.003	<0.003
1	child	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003	<0.003	<0.003	<0.003
2	grandmother	<0.001	<0.001	<0.001	<0.001	<0.001	0,0046	<0.003	<0.003	<0.003
2	mother	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003	<0.003	<0.003	<0.003
2	child	<0.001	<0.001	<0.001	<0.001	0,0014	<0.003	<0.003	<0.003	<0.003
3	grandmother	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003	<0.003	<0.003	<0.003
3	mother	<0.001	<0.001	<0.001	<0.001	0,0019	<0.003	<0.003	<0.003	<0.003
3	child	<0.001	<0.001	<0.001	<0.001	<0.001	0,0041	<0.003	<0.003	<0.003
4	grandmother	<0.001	<0.001	<0.001	<0.001	0,0073	<0.003	<0.003	<0.003	<0.003
4	mother	<0.001	<0.001	<0.001	<0.001	0,0017	<0.003	<0.003	<0.003	<0.003
4	child	<0.001	<0.001	<0.001	<0.001	0,0061	<0.003	<0.003	<0.003	<0.003
5	grandmother	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003	<0.003	<0.003	<0.003
5	mother	<0.001	<0.001	<0.001	<0.001	<0.001	0,0034	<0.003	<0.003	<0.003
5	child	<0.001	<0.001	<0.001	<0.001	0,0121	0,0035	<0.003	<0.003	<0.003
6	grandmother	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003	<0.003	<0.003	<0.003
6	mother	<0.001	<0.001	<0.001	<0.001	<0.001	0,0037	<0.003	<0.003	<0.003
6	child	<0.001	<0.001	<0.001	<0.001	<0.001	0,0047	<0.003	<0.003	<0.003
7	grandmother	<0.001	<0.001	<0.001	<0.001	<0.001	0,005	<0.003	<0.003	<0.003
7	mother	<0.001	<0.001	<0.001	<0.001	<0.001	0,0052	<0.003	<0.003	<0.003
7	child	<0.001	<0.001	<0.001	<0.001	<0.001	0,0062	<0.003	0,0049	<0.003
8	grandmother	<0.001	<0.001	<0.001	<0.001	<0.001	0,0034	<0.003	<0.003	<0.003
8	mother	<0.001	0,0034	<0.001	<0.001	<0.001	<0.003	<0.003	<0.003	<0.003
8	child	<0.001	<0.001	<0.001	<0.001	0,0013	0,0044	<0.003	<0.003	<0.003
9	grandmother	<0.001	<0.001	<0.001	<0.001	<0.001	0,0059	<0.003	<0.003	<0.003
9	mother	<0.001	0,001	<0.001	<0.001	<0.001	0,0057	<0.003	<0.003	<0.003
9	child	<0.001	<0.001	<0.001	<0.001	0,0017	0,0061	<0.003	0,0049	<0.003
10	grandmother	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003	<0.003	<0.003	<0.003
10	mother	<0.001	<0.001	<0.001	<0.001	<0.001	0,0035	<0.003	<0.003	<0.003
10	child	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003	<0.003	<0.003	<0.003
11	grandmother	<0.001	<0.001	<0.001	<0.001	0,0038	<0.003	<0.003	<0.003	<0.003
11	mother	<0.001	<0.001	<0.001	<0.001	<0.001	0,0099	<0.003	<0.003	<0.003
11	child	<0.001	<0.001	<0.001	<0.001	<0.001	0,0089	0,0034	<0.003	<0.003
12	grandmother	<0.001	<0.001	<0.001	<0.001	<0.001	0,0056	<0.003	<0.003	<0.003
12	mother	<0.001	<0.001	<0.001	<0.001	<0.001	0,0078	<0.003	<0.003	<0.003
12	child	<0.001	<0.001	<0.001	<0.001	<0.001	0,0089	<0.003	<0.003	<0.003
13	grandmother	<0.001	<0.001	<0.001	<0.001	0,0038	0,0087	<0.003	<0.003	<0.003
13	mother	<0.001	<0.001	<0.001	<0.001	0,0013	0,0033	<0.003	<0.003	<0.003
13	child	<0.001	<0.001	<0.001	<0.001	<0.001	0,0040	<0.003	0,0047	<0.003

	Chemical	BDE-77	BDE-85/155	BDE-99	BDE-100	BDE-119	BDE-126	BDE-138	BDE-153	BDE-154
	Units	ng/g blood	ng/g blood	ng/g blood	ng/g bbod	ng/g blood	ng/g blood	ng/g blood	ng/g blood	ng/g blood
Family	Generation									
1	grandmother	<0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1	mother	<0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0,0057	<0.005
1	child	<0.003	<0.005	0,0063	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2	grandmother	<0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0,0108	<0.005
2	mother	<0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0,0132	<0.005
2	child	<0.003	<0.005	0,0080	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
3	grandmother	<0.003	<0.005	0,0068	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
3	mother	<0.003	<0.005	0,0052	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
3	child	<0.003	<0.005	0,0050	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
4	grandmother	<0.003	<0.005	0,0082	0,0353	<0.005	<0.005	<0.005	0,0069	<0.005
4	mother	<0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0,0058	<0.005
4	child	<0.003	<0.005	0,0085	0,0372	<0.005	<0.005	<0.005	0,0085	<0.005
5	grandmother	<0.003	<0.005	0,0083	0,0072	<0.005	<0.005	<0.005	<0.005	<0.005
5	mother	<0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0,0061	<0.005
5	child	<0.003	<0.005	0,0068	0,2012	<0.005	<0.005	<0.005	<0.005	0,0057
6	grandmother	0,0030	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
6	mother	<0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
6	child	<0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0,0064	<0.005
7	grandmother	<0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0,0127	<0.005
7	mother	<0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0,0070	<0.005
7	child	<0.003	<0.005	0,0073	0,0131	<0.005	<0.005	<0.005	0,0352	<0.005
8	grandmother	0,0037	<0.005	0,0084	0,0126	<0.005	<0.005	<0.005	0,0055	<0.005
8	mother	<0.003	<0.005	<0.005	0,0280	<0.005	<0.005	<0.005	0,0062	<0.005
8	child	<0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
9	grandmother	<0.003	<0.005	0,0076	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
9	mother	<0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0,0055	<0.005
9	child	<0.003	<0.005	<0.005	0,0095	<0.005	<0.005	<0.005	<0.005	<0.005
10	grandmother	0,0038	<0.005	0,0053	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
10	mother	<0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
10	child	<0.003	<0.005	<0.005	0,0095	0,0287	<0.005	<0.005	0,0077	<0.005
11	grandmother	<0.003	<0.005	<0.005	0,0062	<0.005	<0.005	<0.005	0,0171	0,0060
11	mother	0,0034	<0.005	0,0126	0,0036	<0.005	<0.005	<0.005	0,0055	<0.005
11	child	<0.003	0,0075	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
12	grandmother	<0.003	<0.005	<0.005	0,0208	<0.005	<0.005	<0.005	0,0146	<0.005
12	mother	<0.003	<0.005	0,0207	0,0619	<0.005	<0.005	<0.005	0,0121	<0.005
12	child	<0.003	<0.005	<0.005	0,0104	<0.005	<0.005	<0.005	0,0123	<0.005
13	grandmother	<0.003	<0.005	<0.005	0,0739	<0.005	0,0225	<0.005	0,0129	<0.005
13	mother	<0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0,0149	<0.005
13	child	<0.003	<0.005	<0.005	0,0152	<0.005	<0.005	<0.005	0,0093	<0.005

	Chemical	BDE-166	BDE-181	BDE-183	BDE-184	BDE-190	BDE-191	BDE-196	BDE-197	BDE-206
	Units	ng/g blood	ng/g blood	ng/g blood	ng/g blood	ng/g blood	ng/g blood	ng/g blood	ng/g blood	ng/g blood
Family	Generation									
1	grandmother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
1	mother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
1	child	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
2	grandmother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
2	mother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
2	child	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
3	grandmother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
3	mother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
3	child	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	0,3293
4	grandmother	<0.005	0,0217	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
4	mother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
4	child	<0.005	0,0378	<0.015	0,0246	<0.01	<0.015	<0.03	<0.03	<0.04
5	grandmother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
5	mother	<0.005	0,0170	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
5	child	<0.005	0,0947	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
6	grandmother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
6	mother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
6	child	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
7	grandmother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
7	mother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
7	child	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
8	grandmother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
8	mother	<0.005	0,0251	<0.015	0,0224	<0.01	<0.015	<0.03	<0.03	<0.04
8	child	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
9	grandmother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
9	mother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
9	child	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	0,1269
10	grandmother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
10	mother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
10	child	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
11	grandmother	<0.005	0,0285	<0.015	0,0273	<0.01	<0.015	<0.03	<0.03	<0.04
11	mother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
11	child	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
12	grandmother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
12	mother	<0.005	0,1087	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
12	child	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
13	grandmother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
13	mother	<0.005	<0.01	<0.015	<0.01	<0.01	<0.015	<0.03	<0.03	<0.04
13	child	<0.005	<0.01	<0.015	0,0463	<0.01	<0.015	<0.03	<0.03	<0.04

	Chemical	BDE-207	BDE-209	PBDEs	PBDEs
	Units	ng/g blood	ng/g blood	n=	Total
Family	Generation				
1	grandmother	<0.1	<0.1	0	0
1	mother	<0.1	<0.1	2	0,0104
1	child	<0.1	<0.1	1	0,0063
2	grandmother	<0.1	<0.1	2	0,0154
2	mother	<0.1	<0.1	1	0,0132
2	child	<0.1	<0.1	2	0,0094
3	grandmother	<0.1	<0.1	1	0,0068
3	mother	<0.1	<0.1	2	0,0071
3	child	0,3748	23,276	5	23,9893
4	grandmother	<0.1	<0.1	5	0,0795
4	mother	<0.1	<0.1	2	0,0075
4	child	<0.1	<0.1	6	0,1228
5	grandmother	<0.1	<0.1	2	0,0155
5	mother	<0.1	<0.1	3	0,0264
5	child	<0.1	<0.1	6	0,3240
6	grandmother	<0.1	<0.1	1	0,0030
6	mother	<0.1	<0.1	1	0,0037
6	child	<0.1	<0.1	2	0,0111
7	grandmother	<0.1	<0.1	2	0,0178
7	mother	<0.1	<0.1	2	0,0122
7	child	<0.1	<0.1	5	0,0667
8	grandmother	<0.1	<0.1	5	0,0337
8	mother	<0.1	<0.1	5	0,0851
8	child	<0.1	<0.1	2	0,0057
9	grandmother	<0.1	<0.1	2	0,0136
9	mother	<0.1	<0.1	3	0,0122
9	child	0,1335	4,424	7	4,7066
10	grandmother	<0.1	<0.1	2	0,0091
10	mother	<0.1	<0.1	1	0,0035
10	child	<0.1	<0.1	3	0,0459
11	grandmother	<0.1	<0.1	6	0,0889
11	mother	<0.1	<0.1	5	0,0349
11	child	<0.1	<0.1	5	0,0199
12	grandmother	<0.1	<0.1	3	0,0410
12	mother	<0.1	<0.1	5	0,2113
12	child	<0.1	<0.1	3	0,0317
13	grandmother	<0.1	<0.1	5	0,1217
13	mother	<0.1	<0.1	3	0,0195
13	child	<0.1	<0.1	5	0,0795

	Chemical Units	HBCD ng/g blood	TBBP-A ng/g blood
Family	Generation		
1	grandmother	<0.1	<0.05
1	mother	<0.1	0,23
1	child	<0.1	0,13
2	grandmother	0,101	0,06
2	mother	<0.1	0,16
2	child	<0.1	0,12
3	grandmother	<0.1	<0.05
3	mother	<0.1	<0.05
3	child	<0.1	<0.05
4	grandmother	<0.1	<0.05
4	mother	<0.1	0,24
4	child	<0.1	0,10
5	grandmother	<0.1	<0.05
5	mother	<0.1	0,21
5	child	<0.1	0,13
6	grandmother	<0.1	<0.05
6	mother	<0.1	<0.05
6	child	<0.1	<0.05
7	grandmother	<0.1	<0.05
7	mother	<0.1	<0.05
7	child	<0.1	<0.05
8	grandmother	<0.1	0,08
8	mother	<0.1	<0.05
8	child	<0.1	0,15
9	grandmother	<0.1	<0.05
9	mother	<0.1	<0.05
9	child	<0.1	0,32
10	grandmother	<0.1	<0.05
10	mother	<0.1	0,05
10	child	<0.1	0,07
11	grandmother	<0.1	0,06
11	mother	<0.1	0,10
11	child	<0.1	0,08
12	grandmother	<0.1	<0.05
12	mother	<0.1	<0.05
12	child	<0.1	<0.05
13	grandmother	<0.1	<0.05
13	mother	<0.1	0,11
13	child	<0.1	<0.05

	Chemical	PFOA	PFOS	PFNA	PFDA	PFUnA	PFDoA	PFTrA	PFOSA	PFCs	PFCs
	Units	ng/g blood	ng/g blood	ng/g blood	ng/g blood	ng/g blood	ng/g blood	ng/g blood	ng/g blood	n=	Total
Family	Generation										
1	grandmother	<0.1	35,3	<0.1	<0.1	<0.1	0,21	<0.1	1,58	3	37,09
1	mother	<0.1	11,40	<0.1	<0.1	<0.1	<0.1	<0.1	0,27	2	11,67
1	child	0,11	9,20	<0.1	0,17	<0.1	0,13	<0.1	0,55	5	0,16
2	grandmother	0,39	2,93	0,13	<0.1	<0.1	0,13	<0.1	2,04	5	5,62
2	mother	0,12	19,30	<0.1	<0.1	<0.1	2,45	<0.1	0,71	4	22,58
2	child	0,13	11,41	<0.1	<0.1	<0.1	0,78	<0.1	0,33	4	12,65
3	grandmother	0,43	2,23	0,35	0,16	0,54	<0.1	<0.1	0,37	6	4,08
3	mother	<0.1	7,50	<0.1	<0.1	<0.1	<0.1	<0.1	0,45	2	7,95
3	child	<0.1	14,60	<0.1	<0.1	<0.1	<0.1	<0.1	0,44	2	15,04
4	grandmother	<0.1	6,18	<0.1	<0.1	<0.1	<0.1	<0.1	0,87	2	7,05
4	mother	<0.1	17,10	<0.1	<0.1	<0.1	0,27	<0.1	0,59	3	17,96
4	child	0,12	10,73	<0.1	<0.1	<0.1	0,13	<0.1	0,4	4	11,38
5	grandmother	<0.1	2,04	<0.1	<0.1	<0.1	<0.1	<0.1	0,46	2	2,50
5	mother	<0.1	0,95	<0.1	<0.1	<0.1	<0.1	<0.1	0,35	2	1,30
5	child	0,15	0,73	<0.1	<0.1	<0.1	<0.1	<0.1	0,62	3	1,50
6	grandmother	<0.1	1,82	<0.1	<0.1	<0.1	<0.1	<0.1	0,18	2	2,00
6	mother	<0.1	1,06	<0.1	<0.1	<0.1	<0.1	<0.1	0,3	2	1,36
6	child	0,12	6,59	<0.1	<0.1	<0.1	0,11	<0.1	0,15	4	6,97
7	grandmother	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
7	mother	<0.1	0,36	<0.1	<0.1	<0.1	0,70	<0.1	0,16	3	1,22
7	child	<0.1	0,41	<0.1	<0.1	<0.1	<0.1	<0.1	0,16	2	0,57
8	grandmother	<0.1	1,09	<0.1	<0.1	<0.1	0,30	<0.1	0,18	3	1,57
8	mother	<0.1	2,30	<0.1	<0.1	<0.1	0,91	<0.1	0,25	3	3,46
8	child	<0.1	2,47	<0.1	<0.1	<0.1	0,33	<0.1	0,16	3	2,96
9	grandmother	<0.1	1,60	<0.1	<0.1	<0.1	0,36	<0.1	0,19	3	2,15
9	mother	<0.1	8,19	<0.1	<0.1	<0.1	0,28	<0.1	0,77	3	9,24
9	child	<0.1	1,99	<0.1	<0.1	<0.1	0,29	<0.1	1,15	3	3,43
10	grandmother	<0.1	1,99	<0.1	<0.1	<0.1	0,52	<0.1	0,49	3	3,00
10	mother	<0.1	0,99	<0.1	<0.1	<0.1	0,22	<0.1	0,23	3	1,44
10	child	0,11	5,59	<0.1	<0.1	<0.1	0,22	<0.1	0,53	4	6,45
11	grandmother	<0.1	6,32	<0.1	<0.1	<0.1	0,31	<0.1	0,78	3	7,41
11	mother	<0.1	4,28	<0.1	<0.1	<0.1	0,21	<0.1	0,82	3	5,31
11	child	<0.1	8,37	<0.1	<0.1	<0.1	0,88	<0.1	1,2	3	10,45
12	grandmother	0,48	1,36	0,14	<0.1	<0.1	<0.1	<0.1	1,13	4	3,11
12	mother	No results - sample extract was damaged by laboratory									
12	child	0,79	1,42	0,22	<0.1	<0.1	0,89	<0.1	<0.1	4	3,32
13	grandmother	2,14	1,17	0,63	0,31	0,24	0,45	<0.1	0,62	7	5,56
13	mother	<0.1	0,95	<0.1	<0.1	<0.1	<0.1	<0.1	0,43	2	1,38
13	child	0,12	0,67	<0.1	<0.1	<0.1	<0.1	<0.1	0,6	3	1,39

WWF DETOX CAMPAIGN

Family	Generation	ADBI (celestolide) ng/g blood	AHTN (tonalide) ng/g blood	ATTI (traseolide) ng/g blood	DPMI (cashmeron) ng/g blood	HHCB (galaxolide) ng/g blood	MK (musk ketone) ng/g blood	MX (musk xylene) ng/g blood	Musks n=	Musks Total
Chemical Units										
1	grandmother	<0.05	<0.05	<0.05	<0.1	0,92	<0.05	<0.05	1	0,92
1	mother	<0.05	<0.05	<0.05	<0.1	0,52	<0.05	<0.05	1	0,52
1	child	<0.05	<0.05	<0.05	<0.1	0,45	<0.05	<0.05	1	0,45
2	grandmother	<0.05	<0.05	<0.05	<0.1	0,31	<0.05	<0.05	1	0,31
2	mother	<0.05	<0.05	<0.05	<0.1	0,31	<0.05	0,05	2	0,36
2	child	<0.05	0,39	<0.05	<0.1	2,52	<0.05	<0.05	2	2,91
3	grandmother	<0.05	<0.05	<0.05	<0.1	1,04	<0.05	0,06	2	1,1
3	mother	<0.05	<0.05	<0.05	<0.1	0,82	<0.05	0,06	2	0,88
3	child	<0.05	<0.05	<0.05	<0.1	1,9	<0.05	<0.05	1	1,9
4	grandmother	<0.05	<0.05	<0.05	<0.1	0,28	<0.05	<0.05	1	0,28
4	mother	<0.05	<0.05	<0.05	<0.1	0,44	<0.05	<0.05	1	0,44
4	child	<0.05	<0.05	<0.05	<0.1	0,38	<0.05	0,07	2	0,45
5	grandmother	<0.05	<0.05	<0.05	<0.1	0,38	<0.05	<0.05	1	0,38
5	mother	<0.05	<0.05	<0.05	<0.1	0,64	<0.05	<0.05	1	0,64
5	child	<0.05	0,05	<0.05	<0.1	0,53	<0.05	<0.05	2	0,58
6	grandmother	<0.05	<0.05	<0.05	<0.1	0,42	<0.05	<0.05	1	0,42
6	mother	<0.05	0,09	<0.05	<0.1	0,49	<0.05	<0.05	2	0,58
6	child	<0.05	0,06	<0.05	<0.1	0,36	<0.05	<0.05	2	0,42
7	grandmother	<0.05	<0.05	<0.05	<0.1	0,31	<0.05	<0.05	1	0,31
7	mother	<0.05	<0.05	<0.05	<0.1	0,25	<0.05	<0.05	1	0,25
7	child	<0.05	0,07	<0.05	<0.1	0,39	<0.05	<0.05	2	0,46
8	grandmother	<0.05	<0.05	<0.05	<0.1	0,46	<0.05	<0.05	1	0,46
8	mother	<0.05	<0.05	<0.05	<0.1	0,51	<0.05	0,21	2	0,72
8	child	<0.05	<0.05	<0.05	<0.1	1,37	<0.05	0,15	2	1,52
9	grandmother	<0.05	<0.05	<0.05	<0.1	0,17	<0.05	<0.05	1	0,17
9	mother	<0.05	<0.05	<0.05	<0.1	0,23	<0.05	<0.05	1	0,23
9	child	<0.05	<0.05	<0.05	<0.1	0,11	<0.05	<0.05	1	0,11
10	grandmother	<0.05	<0.05	<0.05	<0.1	0,31	<0.05	<0.05	1	0,31
10	mother	<0.05	<0.05	<0.05	<0.1	0,33	<0.05	<0.05	1	0,33
10	child	<0.05	<0.05	<0.05	<0.1	0,18	<0.05	<0.05	1	0,18
11	grandmother	<0.05	0,05	<0.05	<0.1	0,21	<0.05	<0.05	2	0,26
11	mother	<0.05	<0.05	<0.05	<0.1	0,11	<0.05	<0.05	1	0,11
11	child	<0.05	<0.05	<0.05	<0.1	0,43	<0.05	<0.05	1	0,43
12	grandmother	<0.05	0,06	<0.05	<0.1	0,16	<0.05	<0.05	2	0,22
12	mother	<0.05	<0.05	<0.05	<0.1	0,37	<0.05	<0.05	1	0,37
12	child	<0.05	<0.05	<0.05	<0.1	0,44	<0.05	<0.05	1	0,44
13	grandmother	<0.05	<0.05	<0.05	<0.1	0,33	<0.05	<0.05	1	0,33
13	mother	<0.05	0,07	<0.05	<0.1	0,33	<0.05	<0.05	2	0,4
13	child	<0.05	<0.05	<0.05	<0.1	0,13	<0.05	<0.05	1	0,13

	Chemical Units	BPA ng/g blood	Triclosan ng/g blood	Methyl triclosan ng/g blood
Family	Generation			
1	grandmother	0,14	<0.1	<0.1
1	mother	0,12	0,33	<0.1
1	child	0,85	0,17	<0.1
2	grandmother	<0.1	<0.1	<0.1
2	mother	0,11	0,23	<0.1
2	child	0,12	0,32	<0.1
3	grandmother	<0.1	<0.1	<0.1
3	mother	<0.1	0,21	<0.1
3	child	<0.1	<0.1	<0.1
4	grandmother	0,17	0,23	<0.1
4	mother	0,14	<0.1	<0.1
4	child	0,15	<0.1	<0.1
5	grandmother	<0.1	<0.1	<0.1
5	mother	<0.1	0,28	<0.1
5	child	<0.1	0,35	<0.1
6	grandmother	<0.1	<0.1	<0.1
6	mother	<0.1	<0.1	<0.1
6	child	<0.1	<0.1	<0.1
7	grandmother	<0.1	<0.1	<0.1
7	mother	<0.1	<0.1	<0.1
7	child	<0.1	<0.1	<0.1
8	grandmother	<0.1	0,31	<0.1
8	mother	<0.1	<0.1	<0.1
8	child	<0.1	0,55	<0.1
9	grandmother	0,52	<0.1	<0.1
9	mother	<0.1	<0.1	<0.1
9	child	<0.1	<0.1	<0.1
10	grandmother	<0.1	<0.1	<0.1
10	mother	<0.1	<0.1	<0.1
10	child	<0.1	<0.1	<0.1
11	grandmother	<0.1	0,57	<0.1
11	mother	<0.1	0,85	<0.1
11	child	<0.1	0,30	<0.1
12	grandmother	<0.1	0,29	<0.1
12	mother	<0.1	0,36	<0.1
12	child	<0.1	<0.1	<0.1
13	grandmother	<0.1	<0.1	<0.1
13	mother	<0.1	0,24	<0.1
13	child	<0.1	<0.1	<0.1

	Chemical Units	Totals n=	Total pg/g serum	Total ng/g blood
Family	Generation			
1	grandmother	33	19595	38,150
1	mother	32	5173	12,880
1	child	30	3977	11,766
2	grandmother	34	4458	6,106
2	mother	21	1035	23,453
2	child	22	848	16,129
3	grandmother	31	3892	5,187
3	mother	34	2821	9,047
3	child	23	533	40,929
4	grandmother	34	7207	7,809
4	mother	26	3458	18,788
4	child	31	1175	12,203
5	grandmother	27	4313	2,895
5	mother	32	3135	2,456
5	child	27	984	2,884
6	grandmother	39	15118	2,423
6	mother	19	2021	1,944
6	child	24	954	7,401
7	grandmother	27	8802	0,328
7	mother	18	5205	1,482
7	child	19	1987	1,097
8	grandmother	32	6028	2,454
8	mother	30	7689	4,265
8	child	24	3329	5,186
9	grandmother	27	14495	2,854
9	mother	22	3423	9,482
9	child	24	1863	8,567
10	grandmother	25	32457	3,319
10	mother	28	19107	1,824
10	child	19	4008	6,746
11	grandmother	32	11338	8,389
11	mother	34	5209	6,405
11	child	26	1623	11,280
12	grandmother	38	4115	3,661
12	mother	29	7028	0,941
12	child	25	1422	3,792
13	grandmother	32	5320	6,012
13	mother	29	3147	2,149
13	child	30	631	1,600

SAFER CHEMICALS

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