Concentrations of Selected Persistent Organic Pollutants (POPs) in the Serum of New Zealanders

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Summary

Background. This study aimed to quantify the concentrations of selected Persistent Organic Pollutants (POPs) in the serum of adult New Zealanders. POPs determined in this study include polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs), polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs), brominated flame retardants (BFRs) and perfluorinated compounds (PFCs).

Methods. New Zealand residents in the 19-64 year age range were randomly selected from the 2010 electoral roll and invited to provide a blood sample (up to 30 mL) at a local private pathology laboratory for the purpose of this study. Occupational exposure to POPs, health problems that would prohibit blood donation, and non-residency in New Zealand were exclusion criteria. It was aimed to include 20 participants in each of 64 strata determined by age group (19-24, 25-34, 35-49, 50-64), ethnicity (Māori, non-Māori), gender (male, female), and geographic region (Northland/Auckland, Waikato/Bay of Plenty, Lower North Island, South Island). These strata were chosen so that the association between demographic factors and serum concentration of POPs could be assessed, and to provide a direct comparison with the New Zealand serum concentrations of POPs determined 15 years earlier.

Over the period between May 2011 and April 2013 a total of 747 serum samples were collected. Within 24 hours blood samples were centrifuged and serum transferred to two 5 mL amber glass vials (intended for analysis of PCDD/Fs, PCBs, OCPs, and BFRs) and a 5 mL polypropylene vial (intended for PFCs analysis). Individual samples were combined into pools according to the 64 strata. Further pooling of certain strata over the four geographic regions was done for those strata with low participation (i.e. the youngest age groups) to obtain sufficient sample volume required for sensitive analysis of PCDD/Fs, PCBs, BFRs and OCPs, resulting in a total of 49 pooled serum samples for these analytes. For the pools of serum intended for PFC analysis, sufficient serum was available for 63 pools (there were no participants in one stratum) to allow analysis of PFC concentrations.

POPs were determined in each of the pooled serum samples using gas chromatography-high-resolution mass spectrometry (GC-HRMS) for the PCDD/Fs, PCBs, OCPs and BFRs, and liquid chromatography-tandem mass spectrometry (LC-MS/MS) for the PFCs. From each pool 0.5 mL of serum was used for enzymatic lipid determination. Serum concentrations of PCDD/Fs, PCBs, OCPs and BFRs were expressed as nanogram (ng) or picogram (pg) per gram lipid and concentrations of PFCs were expressed as nanogram per millilitre serum. To obtain an estimate of the average serum concentration of each POP in the New Zealand population in the 19-64 age range, the serum concentrations of each of the age-gender-ethnicity-region-specific strata were weighted by the number of 2010 Electoral Roll individuals in each of the strata as a fraction of the total number individuals on the 2010 Electoral Roll in the 19-64 age range.

Results. The weighted mean serum concentration of the PCDD/Fs Toxic Equivalence using the 2005 toxic equivalence factors (TEQ_{05}) was 5.81 pg/g lipid for the New Zealand population, and increased with age (3.27-4.47-4.97-8.51 pg/g lipid for the 19-24, 25-34, 35-49, 50-64 year age groups respectively). The weighted mean serum concentration of the PCB TEQ_{05} was calculated to be 1.54 pg/g lipid, and increased with age (0.85-0.87-1.47-2.28 pg/g lipid for the 19-24, 25-34, 35-49, 50-64 year age groups respectively). Of the quantified OCPs, the highest serum

concentrations were determined for the major metabolite of the insecticide DDT, *p,p'*-DDE (weighted mean = 250 ng/g lipid) followed by the insecticide lindane isomer *beta*-HCH (weighted mean = 12.9 ng/g lipid), the fungicide hexachlorobenzene (HCB) (weighted mean = 7.62 ng/g lipid) and the insecticide dieldrin (weighted mean = 5.22 ng/g lipid). For most OCPs concentrations increased with age. Of the quantified BFRs, the highest serum concentrations were determined for the polybrominated diphenyl ether congener BDE209, (weighted mean = 3.57 ng/g lipid), followed by BDE47 (weighted mean = 2.15 ng/g lipid), BDE153 (weighted mean = 1.34 ng/g lipid) and BDE99 (weighted mean = 1.02 ng/g lipid). In contrast with the PCDD/Fs, PCBs and OCPs, for many of the BDE congeners the highest serum concentrations were observed for the youngest age group. Of the four PFCs that could be detected in the serum samples, the highest serum concentrations were determined for perfluorooctanesulfonic acid (PFOS) (weighted mean = 3.59 ng/mL), followed by perfluorooctanoic acid (PFOA) (weighted mean = 2.51 ng/mL), perfluorohexane sulfonate (PFHxS) (weighted mean = 1.24 ng/mL) and perfluorononanoic acid (PFNA) (weighted mean = 0.69 ng/mL). Serum concentrations of PFCs increased with age. For most POPs there was no evidence that serum concentrations differed among the four regions, while for *p,p'*-DDE serum concentrations were higher in the south compared to the north of New Zealand. For none of the POPs there was convincing evidence that serum concentrations differed between Māori and non-Māori. There were no substantial differences in serum concentrations between men and women, except for dieldrin, mirex, PBDEs and the four PFCs, which were higher in males compared to females.

When comparing serum concentrations with those determined for the New Zealand population 15 years earlier, a reduction in serum concentrations over time was evident for the chlorinated POPs that were determined in both surveys (PCDD/Fs, PCBs and OCPs). The reduction in serum concentrations was most substantial for *p,p'*-DDE (77%; an average of 5% per year), followed by the PCB TEQ (64% reduction; 4% per year), dieldrin (60%; 4% per year) and the PCDD/Fs TEQ (49%; 3% per year). Historical data on New Zealand serum concentrations of PBDEs and PFCs were not available therefore a time-trend could not be determined for these compounds.

Conclusions. This study provides valuable reference data for the serum concentrations in the New Zealand adult population of a wide range of POPs. Age at which the serum samples are taken and timing of the survey (i.e. this survey compared to the survey conducted 15 years earlier) were the two single most important determinants of POPs serum concentrations. New Zealanders' body burdens of PCDD/Fs and PCBs are low by international comparison, while for OCPs they are similar or lower compared to those reported for other developed countries. National and international action to reduce environmental contamination with PCDD/Fs, PCBs and OCPs has resulted in a substantial reduction in the New Zealand body burdens of chlorinated POPs. Future surveys will determine whether this trend will continue. This study provided baseline data for serum concentrations of brominated and fluorinated POPs, which were detected in all samples in an order of magnitude of ng/g lipid and ng/mL respectively, comparable to, or less than, concentrations reported for other developed countries. Future surveys are needed to determine how serum concentrations of BFRs and PFCs are changing over time in the New Zealand population.

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1. Introduction

Persistent organic pollutants (POPs) are a group of chemical compounds that can be found throughout the environment, in wildlife and in humans. The characteristics of POPs are defined in the Stockholm Convention [1] as toxic, resistant to degradation, bio-accumulative, and transported through air, water and migratory species across international boundaries. Since the 1970's POPs have been studied extensively and have been shown to be ubiquitous environmental contaminants [2-4].

New Zealand ratified the Stockholm Convention in September 2004 and has taken a number of measures to reduce the effects of POPs on human health and the environment [5]. One of New Zealand's obligations under the Stockholm Convention is to undertake regular biological monitoring of POPs in the environment and in the general population. The Ministry of Health and the Ministry for the Environment jointly lead a program of monitoring of POPs in New Zealand, with studies of POPs in food [6], air [7], soil [8], and human biological samples. There has been one national study of POPs in human serum completed in 2001 [9] and three breast milk surveys of POPs carried out in 1988 [10], 1998 [11], and 2008 [12, 13]. The surveys undertaken to date have mainly focused on the following POPs:

- Polychlorinated dibenzodioxins (PCDDs)
- Polychlorinated dibenzofurans (PCDFs)
- Polychlorinated biphenyls (PCBs)
- Organochlorine pesticides (OCPs)
- Polybrominated diphenyl ethers (PBDEs) – 2008 breast milk survey only

Studies to date have shown that New Zealanders are primarily exposed to chlorinated POPs through their diet, particularly from foods of animal origin [14]. Compared to other countries where POPs studies have been carried out, intakes of chlorinated POPs and associated body burdens in serum and breast milk in New Zealand are relatively low [6, 9, 12]. With the exception of breast milk studies, which show that levels of chlorinated POPs in breast milk are declining in breast feeding women in the 20-30 year age range[12][11], there is currently no information on temporal trends for POPs in the broader general New Zealand population.

This report provides the results of the 2nd national POPs biological monitoring program in the serum of adult New Zealanders (referred to as the 2013 POPs serum study). In addition to the previously-monitored POPs chemicals listed above, the current POPs serum study includes a number of "new" POPs including those recently added to, or are being considered for addition to, the Stockholm Convention. These additional POPs include:

- Brominated flame retardants (BFRs) including polybrominated diphenyl ethers (PBDEs), PBEB, HBB, BB153, and DBDPE
- Perfluorinated compounds (PFCs)
- Additional organochlorine pesticides (OCPs) including pentachlorobenzene, toxaphene, endosulfan, and methoxychlor[1].

[1] Methoxychlor is not included in the Stockholm Convention but is listed as persistent, bioaccumulative, and toxic under the USEPA Toxic Release Inventory programme

The 2013 POPs serum study had the following aims:

- To obtain data on current serum concentrations of POPs in the adult New Zealand population;
- To compare these concentrations with previous concentrations and evaluate temporal trends of POPs in serum in the New Zealand population;
- To measure for the first time additional POPs (as recommended by the Stockholm Convention on Persistent Organic pollutants) in serum, such as polybrominated diphenylethers (PBDEs) and perfluorinated compounds (PFCs), in addition to the chlorinated POPs;
- To study sex, age, geographic region and ethnicity in relation to the concentrations of POPs in the New Zealand population;
- To support the Ministry of Health deliver its environmental & border health protection work programme in relation to hazardous substances;
- To assist with implementing New Zealand's obligations under the Stockholm Convention on POPs;
- To provide recommendations for prioritising POPs for remedial action in New Zealand;
- To work with MoH and MfE to develop a framework for ongoing surveying of POPs levels in the New Zealand population.

2. Background information on the selected POPs

2.1. Dioxins and furans (PCDD/Fs)

Polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are unintentionally-produced by-products from combustion and industrial processes [15]. PCDDs and PCDFs are commonly referred to collectively as "dioxins" and include a range of lipophilic and bioaccumulative congeners that are named according to the degree of chlorine substitution of the compound's benzene rings (Figure 2.1).

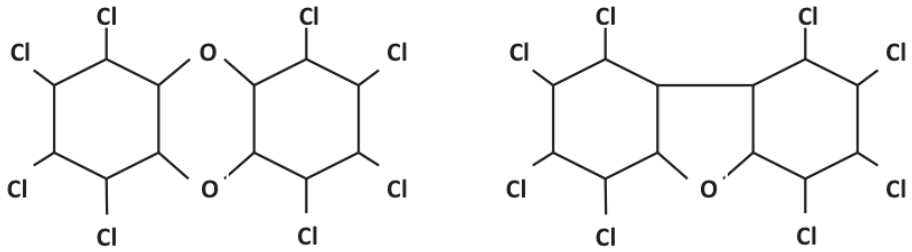


Figure 2.1. Chemical structure of octachlorodibenzodioxin and octachlorodibenzofuran (OCDD, left and OCDF, right).

The World Health Organization (WHO) reports that the toxic and biological effects associated with the dioxins and dioxin-like compounds (i.e. certain PCBs – see section 2.2) are attributed to interaction with the aryl hydrocarbon receptor (AhR) in vertebrates [16]. Reported toxic effects of dioxin exposure in humans include cardiovascular disease, diabetes, cancer, endocrine disruption, and altered thyroid homeostasis [15]. WHO identifies 7 PCDDs and 10 PCDFs which have been assigned Toxic Equivalency Factors (TEFs) based on toxic potency relative to 2,3,7,8-TCDD (Table 2.1). TEFs were published in 1998 and updated in 2005 [16]. TEFs are multiplied by measured concentrations of dioxin and furan congeners to calculate the Toxic Equivalents, a proxy measure of the relative toxicity of mixtures of dioxin and dioxin-like compounds.

Table 2.1. Dioxins and furans including WHO TEF values [16]

Congener	WHO 1998 TEF	WHO 2005 TEF
2,3,7,8-TCDD	1	1
1,2,3,7,8-PCDD	1	1
1,2,3,4,7,8-HxCDD	0.1	0.1
1,2,3,6,7,8-HxCDD	0.1	0.1
1,2,3,7,8,9-HxCDD	0.1	0.1
1,2,3,4,6,7,8-HpCDD	0.01	0.01
OCDD	0.0001	0.0003
2,3,7,8-TCDF	0.1	0.1
1,2,3,7,8-PeCDF	0.05	0.03
2,3,4,7,8-PeCDF	0.5	0.3
1,2,3,4,7,8-HxCDF	0.1	0.1
1,2,3,6,7,8-HxCDF	0.1	0.1
1,2,3,7,8,9-HxCDF	0.1	0.1
2,3,4,6,7,8-HxCDF	0.1	0.1
1,2,3,4,6,7,8-HpCDF	0.01	0.01
1,2,3,4,7,8,9-HpCDF	0.01	0.01
OCDF	0.0001	0.0003

Sources of dioxins include chemical manufacture, where dioxins and furans may unintentionally be produced and incorporated into the end-product. For example, dioxin can be found as a contaminant in 2,4,5-T, a herbicide extensively used in New Zealand until the 1980's, and pentachlorophenol (PCP), a common timber preservative used in New Zealand until it was de-registered in the late 1980's[17]. Other sources of dioxins include combustion, from both industrial (e.g. municipal waste incineration), and natural sources (e.g. forest fires, volcanoes) [15]. It has been estimated that global industrial anthropogenic emissions of dioxins began in the 1930's and environmental concentrations peaked in the 1970's [18]. Once formed, dioxins may be released into air or water, including through industrial accidents (e.g. the 1976 dioxin accident in Seveso, Italy [19]). Dioxins are lipophilic and may bioaccumulate in both the terrestrial and marine food chain. Due to their environmental persistence and mobility dioxins can end up in a wide range of environmental media including food, household dust, soil and sediment, potentially leading to human exposure.

Numerous studies have investigated concentrations of dioxins in human biological samples (e.g. serum, breast milk) and in the environment [20-22]. Since dioxins were first measured in biological monitoring and environmental surveys in the 1970's, concentrations in humans and the environment have reduced several-fold [18]. Research commissioned by the New Zealand Ministry of Health and Ministry for the Environment indicates that concentrations of dioxins in people, the environment, and food in New Zealand are low by international standards, and the temporal results of the breast milk studies suggest that these concentrations are reducing over time [5, 14].

2.2. Polychlorinated biphenyls (PCBs)

Polychlorinated biphenyls (PCBs) are a broad class of organic compounds that have been historically used in a variety of industrial, manufacturing, and building applications since the early twentieth century [15]. There are 209 PCB congeners, of which 12 have been described as "dioxin-like" and TEFs have been assigned (Table 2.2). PCBs share a common chemical structure with 2 aromatic rings joined by a single carbon-carbon bond. The naming convention for PCBs is determined based on the degree of chlorine substitution on the aromatic rings, with PCB209, the fully chlorine substituted congener, shown as an example in Figure 2.2.

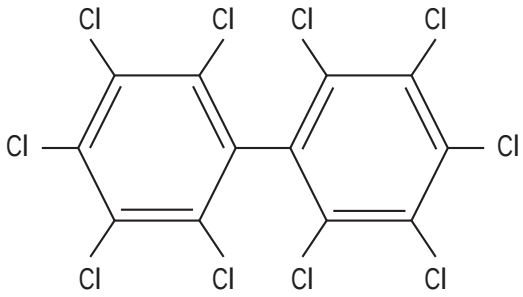


Figure 2.2. PCB209 with fully chlorine-substituted biphenyl structure.

Table 2.2. Dioxin-like PCBs including WHO TEF values [16]

Congener	WHO 1998 TEF	WHO 2005 TEF
Non-*ortho*-substituted PCBs		
3,3',4,4'-tetraCB (PCB 77)	0.0001	0.0001
3,4,4',5-tetraCB (PCB 81)	0.0001	0.0003
3,3',4,4',5-pentaCB (PCB 126)	0.1	0.1
3,3',4,4',5,5'-hexaCB (PCB 169)	0.01	0.03
Mono-*ortho*-substituted PCBs		
2,3,3',4,4'-pentaCB (PCB 105)	0.0001	0.00003
2,3,4,4',5-pentaCB (PCB 114)	0.0005	0.00003
2,3',4,4',5-pentaCB (PCB 118)	0.0001	0.00003
2',3,4,4',5-pentaCB (PCB 123)	0.0001	0.00003
2,3,3',4,4',5-hexaCB (PCB 156)	0.0005	0.00003
2,3,3',4,4',5'-hexaCB (PCB 157)	0.0005	0.00003
2,3',4,4',5,5'-hexaCB (PCB 167)	0.00001	0.00003
2,3,3',4,4',5,5'-heptaCB (PCB 189)	0.0001	0.00003

Historically, PCBs were used in a number of applications such as heat transfer fluids, hydraulic fluids, solvent extenders, flame retardants, and dielectric fluids [5]. Prior to regulatory control for PCBs in many developed countries in the late 1970's, the use and inappropriate management of PCBs resulted in widespread contamination of the environment, particularly in the Northern hemisphere [5]. PCBs were formally prohibited for importation into New Zealand in 1986, and in 1995 regulations came into force to prohibit the use and storage of PCBs with exemptions for small amounts of PCBs remaining in service until 2016 [5, 8].

Numerous studies have investigated concentrations of PCBs in human biological samples (e.g. serum, breast milk) [21, 22] and in the environment [23-25]. Similar to dioxins, concentrations of PCBs in human serum [26, 27] and breast milk [28, 29] have decreased markedly since the 1970's when controls on their use, storage and disposal were imposed around the world. Research commissioned by the New Zealand Ministry of Health and Ministry for the Environment indicates that concentrations of PCBs in people (serum and breast milk), the environment, and food in New Zealand are low by international standards, and the temporal results of the breast milk studies suggest that these concentrations are reducing over time [5, 12-14].

2.3. Organochlorine pesticides (OCPs)

New Zealand has a long history of pesticide use because of the importance of primary industry to the economy. Organochlorine pesticides (OCPs) are a broad class of pesticides that were first introduced to New Zealand in the 1940's, with use persisting until the 1970's [9]. Use of OCPs was widespread during this period, ranging from agriculture, horticulture, timber treatment, control of human pathogens and parasites, and household uses [9]. Table 2.3 provides a list of the key OCPs that were commonly used in New Zealand until their formal de-registration in the late 1980's and early 1990's, and are listed as a POP under the Stockholm Convention.

Table 2.3. Organochlorine pesticides included in the current POPs study [5, 9, 30-44].

Chemical name	Uses
Organochlorine pesticides listed under the Stockholm Convention	
HCH	Technical hexacyclochlorohexane (HCH) is a mixture of five isomers α-HCH, β-HCH, γ-HCH, δ-HCH, and ε-HCH. Virtually all the insecticidal properties are resided in γ-HCH, commonly called Lindane. Lindane is used to control lice, keds and blowflies on cattle and sheep, and grass grub in pasture and for household control of winged insects. Lindane is still approved as a treatment for scabies and lice in humans.
PeCB	Pentachlorobenzene was used as a component of a chlorobenzene mixture incorporated into PCB products to reduce viscosity, as a fungicide, flame retardant, and to combat oyster drills. PeCB has been found as an impurity in dyestuff carriers, as well as in herbicides, pesticides, and fungicides, including hexachlorobenzene (1.8%). Used as a chemical intermediate for the production of pentachloronitrobenzene (quintozene). PeCB is also produced unintentionally during combustion, thermal and industrial processes.
HCB	Hexachlorobenzene (HCB) was used between 1970 and 1972 in New Zealand as an experimental seed dressing fungicide for cereal grains. HCB was also an impurity in the manufacture of chlorinated solvents and other chlorinated compounds including certain pesticides (e.g. pentachlorophenol).
Aldrin and dieldrin	Used to control ectoparasites in sheep and to control horticultural and household pests. Dieldrin was also used as a timber preservative and in carpet treatment. The use of aldrin and dieldrin in New Zealand ceased around 1989. Aldrin breaks down into dieldrin in humans and the environment.
Endrin	Used as an insecticide, rodenticide, and avicide to control a range of pests on crops. Endrin is a stereoisomer of dieldrin. Very little endrin was used in New Zealand. Endrin aldehyde and endrin ketone occur as impurities or degradation products of endrin.
Heptachlor	Used as a soil and seed treatment for the protection of corn and grains, and to control ants, cutworms, maggots, termites, thrips, weevils, wireworms, termites, and household insects. Heptachlor is a component of chlordane (10% by weight). Heptachlor epoxide is an unintentional breakdown product of heptachlor and chlordane. Very little heptachlor was used in New Zealand.
Chlordane	Used to control a broad range of agricultural pests as well as controlling termites and borer for timber preservation, including as an additive in glues used for the manufacture of plywood, finger-jointed and laminated timber. Chlordane is a mixture of a number of chemicals including *trans*-chlordane (gamma-chlordane), *cis*-chlordane (alpha-chlordane), heptachlor, and *trans*- and *cis*-nonachlor. Oxychlordane is a metabolic degradation product of chlordane. The use of chlordane in New Zealand timber treatment ceased around 1989.
DDT	Used to control grass grub and porina caterpillars in pasture, lawns, market gardens and parks. DDT breaks down to dichlorodiphenyltrichloroethylene (DDE) and dichlorodiphenyldichloroethane (DDD) in humans and the environment. DDT is listed as a POP under the Stockholm Convention, with specific exemptions for use and production in certain countries.
Mirex	Used as a pesticide to control fire ants in the southeastern USA, and as a flame retardant in plastics, rubber, paint, paper, and electrical goods. Mirex was never registered for use in New Zealand.
Endosulfan	Used on a range of vegetable, fruit and ornamental plants, and also used on turf at golf courses, bowling clubs, parks, sports grounds, and airports. Technical grade endosulfan contains 94% α-endosulfan and β-endosulfan with a ratio of 7:3 for α and β isomers. Endosulfan sulfate is a reaction impurity found in technical-grade endosulfan. Endosulfan was not used in aerial application or domestic use in New Zealand and was prohibited for import or use in 2008. Endosulfan is listed as a POP under the Stockholm Convention, with specific exemptions for use and production in certain countries.

Chemical name	Uses
Toxaphene	Used for control of insect pests on cotton and other crops in the southern USA, and for controlling other crop pests and pest fish. Toxaphene is a mixture of hundreds of different chlorinated camphene congeners and related chemicals. Congeners are named according to the Parlar system (after Dr. H. Parlar) according to their order of analytical detection. Toxaphene became a popular insecticide after worldwide bans on DDT. Very little toxaphene was used in New Zealand, where it was never registered for use.
Chlordecone	Chlordecone, also known by its trade name Kepone®, was introduced to New Zealand in 1958 as an experimental insecticide to control DDT-resistant apple leaf roller. Chlordecone could not be assessed in the current POPs study because of analytical difficulties.
Organochlorine pesticides determined in this study but not listed under the Stockholm Convention	
Methoxychlor	Used as an insecticide for a range of pests (e.g houseflies, mosquitoes, cockroaches) in crops, stored grain, livestock and domestic pets. Methoxychlor was developed as a replacement for DDT and the USEPA decided not to re-register it in 2004. Methoxychlor is not listed as a POP under the Stockholm Convention but is listed as persistent, bioaccumulative, and toxic chemical under the USEPA's Toxics Release Inventory (TRI) program. There is little information on the use of methoxychlor in New Zealand, though it was apparently used in sheep dipping and its use was banned in 1961 along with DDT, dieldrin, aldrin, and lindane.

OCPs have been associated with a number of health effects including testicular cancer [45, 46], non-Hodgkin lymphoma [47], endocrine disruption [48] and reproductive health [49].

Human serum concentrations of OCPs, excluding heptachlor and toxaphene, were assessed in New Zealand [9] in the last POP serum study, with the following findings:

- Concentrations of β-HCH were at the low end of international values,
- Concentrations of DDE were comparable to international values, and
- There was insufficient international data to compare concentrations of dieldrin.

2.4. Brominated flame retardants (BFRs)

Brominated flame retardants (BFRs) are a broad class of synthetic organic compounds that are added to a wide range of consumer products to improve fire resistance and safety [50]. The most commonly used BFRs are polybrominated diphenyl ethers (PBDEs), hexabromocyclododecane (HBCD), tetrabromobisphenol A (TBBPA), and polybrominated biphenyls (PBBs). BFRs are generally additives in plastic consumer products; meaning they are not chemically bonded to the products, resulting in release of BFRs to the environment as the products are used or disposed. Certain BFRs, TBBPA in particular, are chemically-bonded to plastic polymers and are therefore not as prone to environmental release [50].

Little is known of the exposure of New Zealanders to BFRs in consumer products. Investigations into the presence of BFRs in plastic consumer goods (e.g. electronic and electrical goods, automobile seat foams, sofa fabric) and waste electrical and electronic equipment (WEEE) have been carried out using a hand-held portable x-ray diffraction (XRF) device [51, 52]. As part of these investigations the investigators calculated New Zealand estimates of the quantity of BFRs present in consumer goods and landfills.

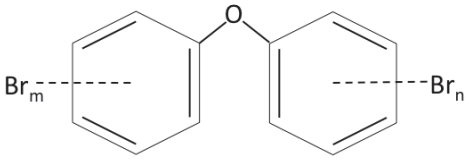
Because of their use in numerous household and office appliances, people are exposed to BFRs during their daily activities directly from a source (e.g. televisions, computers), as well as from indirect sources (e.g. diet). A number of studies over the past 20 years have investigated

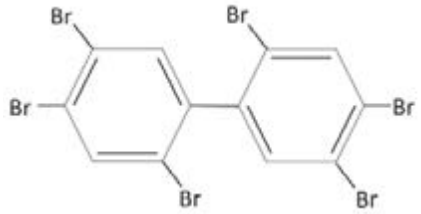
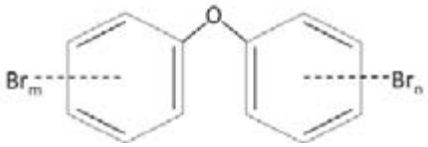
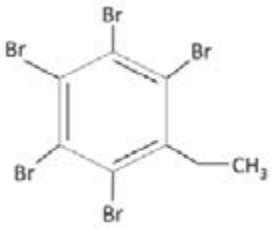
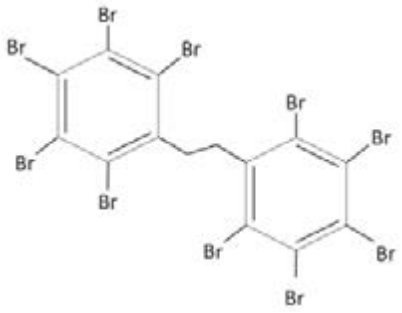
sources for human exposure to BFRs in domestic [53, 54], office [55-57], and outdoor environments [50, 58, 59]. Similarly a number of studies have investigated concentrations of BFRs in human blood [60] [26, 61] and breast milk [12, 62-65]. PBDEs were previously measured in serum of 23 donors in Wellington, New Zealand, collected in 2001 [66]. More recently, PBDEs were determined in the 2008 New Zealand breast milk survey, indicating that New Zealand breast milk concentrations are comparable to or higher than those measured in Europe, while being substantially lower than those reported for the United States and Australia [12, 13]. There is evidence that household dust is an exposure pathway for BFRs and that ingestion of BFR-contaminated dust results in increased human body burdens of BFRs [67-69], a finding supported by a recent New Zealand study investigating concentrations of BFRs in matched samples of indoor dust and breast milk [70]. Diet has also been shown to be a source of BFR exposure [69, 71, 72].

BFRs are suspected to exhibit toxic effects in humans, with limited evidence of neurological effects in adults [73], impacts on thyroid homeostastis in pregnant women [74], and impaired pregnancy outcomes [75]. Recent research attention on the toxic effects of BFRs has mostly focused on children, with reported negative associations between neurological development and exposure to higher levels of BFRs [76-81].

Selected brominated flame retardants are illustrated in Table 2.4. PBDEs are named according to the same system as for PCBs [82], with up to 209 congeners. Common commercial PBDE formulations (commercial pentabromodiphenyl ether, C-PentaBDE, and commercial octabromodiphenyl ether, C-OctaBDE) were listed in the Stockholm Convention in 2009 and are shown in Table 2.4. A full list of PBDE congeners is included in Appendix C.

Table 2.4. Selected brominated flame retardants (BFRs)[83-85].

Chemical Name	Chemical Structure
BFRs listed under the Stockholm Convention	
<u>*Commercial pentabromodiphenyl ether (C-PentaBDE):*</u> The major components of C-PentaBDE are tetrabromodiphenyl ether (BDE40 to BDE81, m=2, n=2) and pentabromodiphenyl ether (BDE82 to BDE 127, m=2, n=3). BDE47 and BDE99 are the two main components of C-PentaBDE.	
<u>*Commercial octabromodiphenyl ether (C-OctaBDE):*</u> The major components of C-OctaBDE are nonabromodiphenyl ether (BDE206 to BDE 208, m=4, n=5), octabromodiphenyl ether (BDE194 to BDE 205, m=4, n=4), heptabromodiphenyl ether (BDE170 to BDE193 m=4, n=3) and hexabromodiphenyl ether (BDE128 to BDE169, m=3, n=3). Different C-OctaBDE formulations include varying percentages of these components, typically with the highest proportion from heptaBDEs and octaBDEs.	

Hexabromobiphenyl (HBB) has 42 isomeric forms and belongs to the wider group of polybromobiphenyls (PBBs). The common commercial formulation (Firemaster®) contains several PBBs with HBB as the principal component.	
BFRs determined in this study but not listed under the Stockholm Convention	
Monobrominated diphenyl ethers (BDE1 to BDE3, m=1, n=0) Dibrominated diphenyl ethers (BDE4 to 15, m=1, n=1) Tribrominated diphenyl ethers (BDE16 to BDE 39, m=2, n=1) Decabromodiphenyl ether (BDE209, m=5, n=5)	
Hexabromobenzene	
Pentabromoethylbenzene (PBEB)	
Decabromodiphenylethane (DBDPE)	

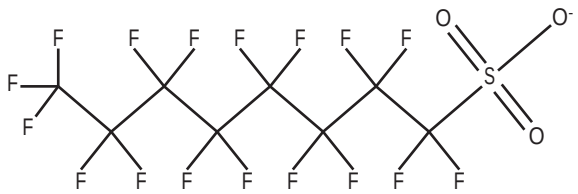
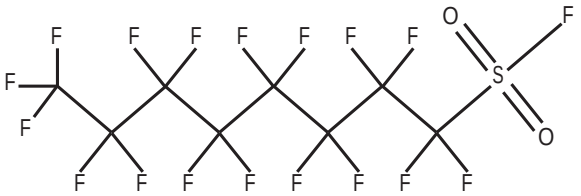
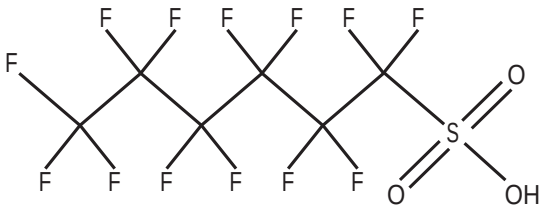
2.5. Perfluorinated compounds (PFCs)

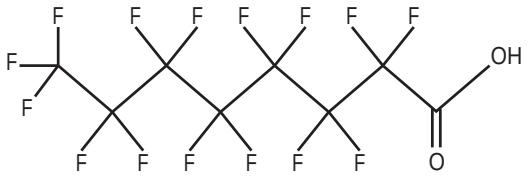
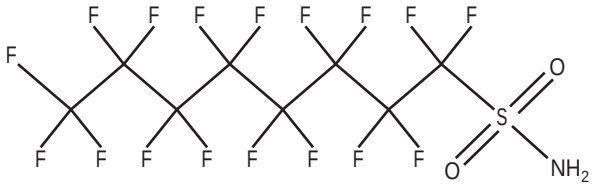
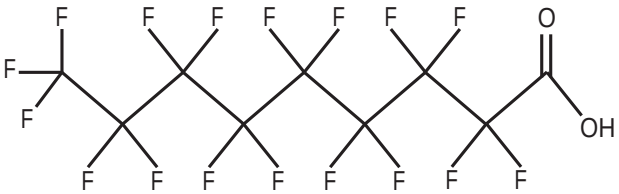
Perfluorinated compounds (PFCs) are a class of chemicals with unique chemical properties; they repel both lipids and water and are very resistant to degradation. As a chemical additive to a wide range of consumer goods including carpets, textiles, leather, paper, food packaging materials, cosmetics, and fire-fighting foams, PFCs have been in use since their first commercial production in the 1950's [86, 87]. In 2000, the primary North American producer of PFCs announced a voluntarily phase-out of the manufacture of selected PFCs, however there are non-US companies that are believed to be currently manufacturing PFCs [86]. PFCs are not

naturally-occurring and break down extremely slowly in the environment, and within organisms, because of the strong carbon-fluorine bonds in their chemical structure.

Perfluoroalkyl sulfonate (PFAS) is a generic term used to describe the group of 260 fully fluorinated linear, branched, or cyclic carbon chain sulfonate compounds including derivatives and polymers of perfluoroalkyl sulfonate, perfluoroalkyl sulfonamide, and perfluoroalkyl sulfonyl chemicals [88]. Perfluorooctane sulfonate (PFOS) and its related compounds comprise some 165 different PFAS compounds with fully-fluorinated eight-carbon chains. Perfluorocarboxylic acid (PFCA) is a generic term used to describe the group of carboxylic acids with a fully-fluorinated carbon chain. Perfluorooctanoic acid (PFOA) is a PFCA and is usually a reactive intermediate in the production of fluoropolymers and fluoroelastomers. PFOA-related compounds comprise some 30 different compounds, including derivatives and polymers of perfluorooctane, perfluorooctyl and perfluorooctanamide chemicals. In 2009 perfluorooctane sulfonate (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF) were added to the Stockholm Convention on POPs [1]. PFOSF is the primary intermediate for the electro-chemical fluorination (ECF) process used to generate PFOS and related compounds, and PFOS is a degradation product of PFOSF. Common PFCs and their chemical structures are shown in Table 2.5. A complete list of PFCs included in this study can be found in Appendix B.

Table 2.5. Common perfluorinated compounds (PFCs)

Chemical name	Chemical structure
PFCs listed under the Stockholm Convention	
Perfluorooctane sulfonate (PFOS)	
Perfluorooctane sulfonyl fluoride (PFOSF)	
PFCs determined in this study but not listed under the Stockholm Convention	
Perfluorohexanesulfonic acid (PFHxS)	

Perfluorooctanoic acid (PFOA)	
Perfluorooctanesulfonamide (PFOSA)	
Perfluorononanoic acid (PFNA)	

PFCs may be released to the environment during both manufacture and use of PFC-containing articles, and there is evidence that PFCs accumulate in various environmental compartments including sewage sludge and landfill leachate [1]. Organisms, including humans, are exposed to PFCs through air, water, food and household dust [89]. PFCs have been investigated in indoor and outdoor air, household dust, food, and drinking water and all these are considered exposure pathways for adult exposure to PFCs in western countries [87]. In addition, human biomonitoring data shows the presence of PFCs in human blood, breast milk, and other tissues [87]. Because of their lipophobic and hydrophobic properties, PFCs exhibit different patterns of accumulation in humans compared to other POPs such as dioxins, PCBs, and BFRs. In serum, PFCs are associated with proteins (e.g. albumin) rather than lipid [90], with some evidence of higher accumulation in males, but inconsistent evidence of age-related accumulation [87].

PFCs have been shown to be toxic to mammals at low concentrations [86], but epidemiological evidence of human health effects of PFCs is limited [91]. Recent studies have shown associations between body burdens of PFCs and cancer [92], male hormone levels and semen quality [93, 94], and thyroid hormone levels in children [95]. However, these studies acknowledge limitations related to sample sizes, confounding and the potential for chance findings due to multiple statistical testing.

In 2009, PFOS, its salts and PFOSF were added to Annex B of the Stockholm Convention [96]. Other common PFCs, such as PFOA, are not included in the Stockholm Convention but a Tolerable Daily Intake (TDI) for PFOA of 1.5 µg/kg b.w./day was established by the European Food Safety Authority in 2008 [97].

There have been no previous investigations into human exposure to PFCs and body burdens in New Zealand.

3. Study protocol

3.1. Study design

The study was a cross sectional survey investigating serum concentrations of POPs in the adult New Zealand population, using a stratified sampling method. The sampling frame was the 2010 Electoral Roll from the New Zealand Electoral Commission (www.elections.org.nz). Ethical approval for the study protocol was granted by the Upper South A Regional Ethics Committee on 11 August 2010 (reference URA/10/07/054). Where possible, the study population in terms of age, region and ethnicity was made comparable to the 2001 serum survey in order to provide a basis for comparability of the two studies.

3.2. Steering Committee

A Steering Committee comprising representatives from government departments with interest in the results of the study was assembled at the outset of the project. Representatives from the Ministry of Health, Ministry for the Environment, ERMA New Zealand (now part of the New Zealand Environmental Protection Agency, NZEPA), Department of Labour (now part of the Ministry of Business, Innovation, and Enterprise, MBIE), and Veteran's Affairs provided valuable guidance and direction during the development of the study protocol, and during the duration of the study at meetings. The role of the Steering Committee was to assist in the strategic development of the project, peer review of reports and maintaining stakeholder relationships.

3.3. Sample frame and recruitment

The 2010 Electoral Roll was used as the survey sample frame. Potential study participants were selected based on their age, sex, geographic region, and ethnicity. The survey sample was based on 64 sample strata enabling direct comparability with the previous study:

- Age (4 categories): 19–24, 25–34, 35–49, 50–64
- Geographic region (4 categories): Northland/Auckland, Waikato/Bay of Plenty, Lower North Island, South Island (Figure 3.1)
- Ethnicity (2 categories): Māori and non-Māori
- Gender (2 categories): male and female.

Although the previous and current POPs study are very similar, there are some notable differences between the two studies which need to be taken into account when comparing the results. In particular, for the current survey, potential participants were selected from the 2010 Electoral Roll, and invited to provide a blood sample for the sole purpose of the current survey. For the 2001 study, blood samples were collected as part of the National Nutrition Survey completed in 1997, of which a selection was made for inclusion into the 2001 survey, which provided more choice to include or exclude individual samples based on sample volume or other parameters, compared to the current survey. In addition, the 2001 survey included a 65+ age group, while the current survey does not, and the 2001 study youngest age group covered the ages 15 to 24, while the current survey covers the ages 19-24. As a result, direct comparisons cannot be made for certain age groups (15-18 and 65+ years) between the 2001 and current POPs studies. The sample collection period for the 2001 survey was December 1996 through to November 1997, while for the 2013 survey it was May 2011-April 2013. Thus, an average of 15 years passed between the first and second New Zealand POPs serum survey.

Figure 3.1. Study geographic regions (from [9])

Mailed invitation letters, along with an information sheet and reply form, were sent to 14,310 people randomly selected from the Electoral Roll. Approximately equal numbers of letters were sent to people in each of the 64 strata specified above, with a target of 1,280 participants (20 for each of the 64 strata). The reasons for using a stratum sample size of 20 were to reduce the possible impact of outliers (e.g. subjects with extremely high or low serum concentrations of POPs), and to obtain a sufficient volume of blood to reach a satisfactory laboratory limit of detection (LOD).

Individuals were sent a letter during one of six mailing periods for the study. If no response to the letter was received, follow up telephone calls were made using the White Pages telephone directory and an address-matched list of telephone numbers provided by a professional mailing services provider (phone numbers were found for 2160 individuals). We initially attempted to do 3 follow-up telephone calls to non-respondents, however as the study progressed we focused our follow-up telephone calls on those strata with low response rates (e.g. young males). It was not feasible to make telephone calls to all of the people who did not reply to the mailouts, so a targeted approach was used to contact individuals in strata that had relatively poor response rates (e.g. younger adults aged 19-24). After each mail-out the number of willing participants in each stratum was used to determine the quantities of invitations sent out per strata in the following mail-out. This approach aimed to weight the subsequent mail-outs towards those strata with relatively poor response rates to increase their representation in the study.

A short screening questionnaire (Appendix A), to determine eligibility, was completed during a telephone interview with willing participants before final selection was made. The questionnaire collected information on the following reasons for exclusion of a potential study participant:

- Current or previous employment in occupations with high exposure to POPs,
- Medical conditions which would prohibit giving blood, or
- Non residency in New Zealand.

If the participant was eligible we sent a package to the participant with the necessary materials for blood collection (i.e. 3 red-top 10 mL glass vacutainers, 2 amber glass 5 mL vials, 1 polypropylene 5 mL vial). Included in the package were an Information Sheet and Consent Form that the participants were asked to sign and return (Appendix A). Participants were offered a petrol voucher to assist with transportation to a nearby blood collection facility, and any costs charged to the participant by the facility to collect the serum sample were fully reimbursed. No other incentives or rewards were provided to study participants.

3.4. Sample collection

Participants were asked to visit a local private pathology laboratory to have their blood samples taken. The period of serum collection for all participants in the study was from May 2011 to April 2013. Three 10 mL red-top glass vacutainers (up to 30 ml in total) of whole blood were taken per study participant, with instructions for the pathology laboratory to avoid inverting or agitating the glass vacutainers. Pathology labs were asked to allow the blood in the vacutainers to clot for 30 – 45 minutes at room temperature. Depending on the facilities at the pathology lab, the samples were then centrifuged on site or sent to a central processing facility. It was requested that the blood samples were centrifuged as soon as possible, and that the samples remain in the vacutainer for no longer than 24 hours before centrifuging.

Following centrifuging, serum was removed from the vacutainers using cleaned glass pipettes and rubber bulbs in order to minimise potential contamination from plastic pipette tips. Serum was transferred to the two 5 mL amber glass vials and a 5 mL polypropylene vial. The serum in the glass vials was intended for analysis of PCDD/Fs, PCBs, OCPs, and BFRs. The serum in the polypropylene vial was intended for PFC analysis. Polypropylene vials were used for PFC determination to (a) allow the control and assessment of potential contamination from the septa of the amber glass vials which may contain perfluorinated compounds (PFCs), and (b) control for potential adhesion of PFCs to glassware during storage [98]. Any remaining material in the vacutainers was discarded. All vials were labeled with a unique subject ID code.

Serum samples in the vials were stored frozen (-20^{0}C) by the local pathology lab until a courier pick-up was arranged by the Centre for Public Health Research (CPHR). Samples were sent to CPHR by courier using frozen containers (chilly-bins with ice-packs or frozen Bio-Freeze™ containers).

3.5. Sample handling and storage

Serum samples in the glass and polypropylene vials were stored at -20^{0}C in cardboard freezer cryo-boxes. Sample collection and storage details were registered on a computer database maintained by CPHR.

3.6. Quality assessment

Samples for quality control and quality assurance (QA/QC) were prepared as outlined in Table 3.1.

Table 3.1. Samples for quality assurance and quality control.

QA/QC sample	Purpose	Approach
Bovine serum blanks and bovine serum method blanks	To assess any contamination resulting from sample handling and storage	Approximately 150 mL of bovine serum was separated into 5 mL aliquots into 20 glass and 10 polypropylene vials, frozen and stored in the same freezer as the human serum samples (method blanks). Method blanks were prepared for laboratory analysis, including pooling, in the same way as pooled human serum samples. The analytical results for the method blanks were compared to analytical results for unprepared serum from the same batch of bovine serum.
Replicate pools	To confirm the representativeness of pooling.	For 3 strata replicate pools were prepared (same stratum, different individuals), with approximately equal numbers of individuals contributing to replicate pooled samples. Replicate samples were analysed blind at the laboratory.
Duplicate pools	To evaluate precision of analyses by the study laboratory.	Pooled serum samples from 4 strata were split and analysed separately (1 duplicate was analysed for PCDD/F, BFRs and PCBs; 1 duplicate for OCPs; 2 duplicates for PFCs). To minimise potential contamination the duplicate samples were prepared by the analytical laboratory prior to analysis.
Laboratory blanks	To assess potential contamination from laboratory procedures and calibrate analytical results.	The analytical laboratory included a laboratory blank sample (deionised water) with each batch of 10 to 15 study serum samples.

Inter-laboratory duplicate pools	To confirm the accuracy of the analytical results	Pooled serum samples from 4 strata were split and the samples were analysed (1 duplicate was analysed for PCDD/F, BFRs and PCBs; 1 duplicate for OCPs; 2 duplicates for PFCs) at separate laboratory facilities – AsureQuality (Wellington, New Zealand) and Axys Analytical Services (Sidney, British Columbia, Canada)

3.7. Serum pooling

When all individual serum samples were collected, the analytical laboratory pooled the individual serum samples in each stratum. A pooling strategy was developed and agreed by the study investigators and the Steering Committee to address the following factors:

1. Sufficient serum must be in each pool in order to achieve appropriate laboratory detection limits. Approximately 50 mL of serum was considered optimum for PCDD, PCDF, PCB, and BFR analysis, 25 mL for OCP analysis, and <5 mL for PFC analysis.
2. There was a wide range in the volume of serum provided by individual participants so there was a need to minimise potential bias from individuals who provided high or low serum volumes.
3. One of the study's aims was to have serum remaining after the study to enable future analysis for other POPs.

The previous POPs study created pools using equal aliquots of serum from each individual within a stratum. For the current study we did not have sufficient participants to create pools using equal aliquots, while still creating pools of sufficient volume to achieve the other factors listed above (i.e. detection limits and remaining serum). An alternative pooling strategy was developed in order to maximise the amount of pooled sample available for analysis.

Each study participant provided two glass vials of serum, with between 1 and 10 mL for the combined volume of serum from the glass vials. The serum in the glass vials was intended for analysis of PCDD/Fs, PCBs, OCPs, and BFRs only, therefore a relatively large volume of serum was required in order to meet laboratory detection limits. Equal volumetric aliquots of serum from participants in the majority of strata would not provide sufficient pooled serum to achieve appropriate detection limits, therefore pooling with equal aliquots was not feasible. The 75th percentile volume of serum for each stratum was calculated and used as the maximum volume that would be aliquoted from the combined glass vials from each participant. If a participant's glass vials provided a combined serum volume less than the 75th percentile volume, the complete contents were aliquoted to the pool. If a participant's glass vials provided a combined serum volume more than the 75th percentile volume, the individual's serum up to the 75th percentile volume was aliquoted to the pool, and the remaining volume stored. In addition, for age strata with very low numbers of participants (e.g. Māori males aged 19-24), the four geographic regions were combined together into one pool (Table 4.1).

Each study participant also provided a polypropylene vial of serum with between 1 and 6 mL of serum. The serum in the polypropylene vial was intended for PFC analysis only, therefore a

relatively small volume of serum was required in order to meet laboratory detection limits. Equal volumetric aliquots of between 0.5 and 1.0 mL provided sufficient pooled serum. There was no need to combine strata with very low numbers of participants, so a pool was made for each stratum using serum in the polypropylene vials.

3.8. Laboratory analysis

Pooled samples were analyzed for lipid content and the compounds listed below:

"Old" POPs (included in previous serum survey)

> PCDDs, PCDFs, PCBs, OCPs (aldrin, chlordane, dieldrin, DDT, endrin, heptachlor, hexachlorobenzene, hexachlorocyclohexane, mirex.)

"New" POPs (not included in previous serum survey)

> BFRs, PFCs, additional OCPs (pentachlorobenzene, toxaphene and endosulfan. Methoxychlor was included although it is not listed as a POP in the Stockholm Convention.

A detailed list of analytes is included in Appendix B. All "old" and "new" POPs listed in the Stockholm Convention are included and other compounds (such as methoxychlor, additional BFRs and additional PFCs) were added to the list.

Methods were based on the following references:

- PCDD/Fs – US EPA Method 1613, Revision B, Tetra- through Octa-Chlorinated Dioxins and Furans by Isotope Dilution HRGC/HRMS. U.S. Environmental Protection Agency October 1994
- PCBs – US EPA Method 1668B Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS U.S. Environmental Protection Agency November 2008
- BFRs – US EPA Method 1614 Brominated Diphenyl Ethers in Water Soil, Sediment and Tissue by HRGC/HRMS, U.S. Environmental Protection Agency, August 2007
- OCPs – US EPA Method 1699: Pesticides in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS U.S. Environmental Protection Agency, December 2007.
- Toxaphene – In-house developed GC-HRMS method
- PFCs – In-house developed LC-MS/MS method

In brief, samples were spiked with labelled internal standards prior to extraction. After extraction, sample extracts were cleaned up and concentrated. Extracts were analysed using either Gas Chromatography – High Resolution Mass Spectrometry (GC-HRMS) or Liquid Chromatography – Tandem Mass Spectrometry (LC-MS/MS), as specified in the following sections. The sample concentrations were calculated from their relative response against the slope of a 5-point calibration curve.

Lipid Determination

A 0.5 mL aliquot of serum from each pool was sent to a private pathology laboratory for enzymatic lipid determination. The cholesterol and triglyceride results were used to determine the total lipid content using the following formula [99]:

Total lipid (g/L) = 2.27 * Cholesterol (g/L) + Triglycerides (g/L) + 0.632

PCDD/Fs, PCBs, BFRs

A 40 mL aliquot of serum was analysed for PCDD/Fs, PCBs and BFRs. A matrix spike and reagent blank was included with each batch of samples. Each sample was spiked with ^{13}C labelled internal standards prior to extraction using C18 SPE. Clean-up and fractionation was achieved using acid silica, basic alumina, florisil and carbon column chromatography. The cleaned extracts were spiked with recovery standards before being reduced to a final volume of 10 µL (PCDD/Fs) and 50 µL (PCBs/BFRs). PCDD/Fs, PCBs and BFRs were analysed by GC-HRMS using Agilent 6890/7890 GC coupled with Waters Ultima/Premier HRMS. PCDD/Fs were analysed at 10,000 mass resolution. BFRs were analysed by GC-HRMS at 5,000 mass resolution. Quantification was performed using Waters QuanLynx software. The internal standards were used for quantification of the target analytes, thus results are recovery corrected. The recovery standard was used for quantification of the internal standards to determine the percent recovery. Results were reported as pg/g on a lipid adjusted basis. DBDPE was not reported for a number of samples because of low recovery of internal standards.

OCPs

A 10 mL aliquot of serum was analysed for OCPs and toxaphene. A matrix spike and reagent blank was included with each batch of samples. Samples were spiked with ^{13}C labelled internal standards prior to soxhlet extraction. Clean-up was achieved using florisil and gel permeation chromatography. The cleaned extracts were spiked with recovery standards before being reduced to a final volume of 25 µL. OCPs and toxaphene were analysed by GC-HRMS using Agilent 6890/7890 GC coupled with Waters Ultima/Premier HRMS. OCPs and toxaphene were analysed at 10,000 mass resolution. Quantification was performed using Waters QuanLynx software. The internal standards were used for quantification of the target analytes, thus results are recovery corrected. The recovery standard was used for quantification of the internal standards to determine the percent recovery. Results were reported as ng/g on a lipid adjusted basis. Several OCPs (chlordecone, endrin aldehyde, endrin ketone, endosulfan sulphate) were not reported by the laboratory because of low internal standard recovery in laboratory matrix spikes.

PFCs

A 0.5 mL aliquot of serum was analysed for PFCs. Samples were spiked with labelled internal standards prior to liquid-liquid extraction. Clean-up was achieved using hexane partitioning. The cleaned extracts were spiked with recovery standards before being reduced to a final volume of 1 mL. PFCs were analysed by LC-MS/MS using Agilent 1200 gradient HPLC coupled with AB Sciex API 5000 triple quadrupole mass spectrometer. Quantification was performed using AB Sciex MultiQuant software. The internal standards were used for quantification of the target analytes, thus results are recovery corrected. The recovery standard was used for quantification of the internal standards to determine the percent recovery. Results were reported as ng/mL on a whole serum basis. The results for PFOS include the salts of PFOS and perfluorooctanesulfonyl fluoride (PFOSF).

3.9. Data handling

All study participants were assigned a unique ID number at the beginning of the study. All data was processed and stored using MS Access (Microsoft Corporation) database software. Access to the database was limited to the study investigators. Any information related to the study participants (e.g. completed Reply Forms, Screening Questionnaires) was archived securely at CPHR, or destroyed confidentially if there was duplicate or redundant information. Samples sent to the analytical laboratory were identified only by the subject ID number with no other personal information provided to the laboratory.

3.10. Data analysis

For those analytical results below the laboratory limit of detection (LOD), a value of 0.5 x LOD was assigned – all concentration results tables and figures in Chapter 4 report middle-bound values including 0.5 x LOD. Summary statistics for each analyte (detection frequency, minimum, maximum, weighted mean, standard deviation) were calculated using Microsoft Excel 2010 and SAS (Cary, North Carolina, USA). Weighted mean concentrations of POPs, which provide an estimate of the mean concentration in the New Zealand adult population, were calculated using population weights determined from the 2010 Electoral Roll for each strata (Table 3.2). Weights were calculated by dividing the number of Electoral Roll individuals in each of the 64 study strata by the total number of Electoral Roll individuals in the 19-64 age range. For combined strata (e.g. Males 19-34, Māori Females 19-24) weights were the sums of individual weights from each of the combined strata.

Table 0.2. Weights for each stratum

			Stratum weight			
Age Group	**Gender**	**Ethnicity**	**Northland/ Auckland**	**Waikato/Bay of Plenty**	**Lower North Island**	**South Island**
19-24	Female	Māori	0.0042	0.0035	0.0033	0.0021
		Non-Māori	0.0179	0.0073	0.0097	0.0125
	Male	Māori	0.0032	0.0028	0.0028	0.0019
		Non-Māori	0.0169	0.0070	0.0092	0.0124
25-34	Female	Māori	0.0062	0.0053	0.0050	0.0031
		Non-Māori	0.0333	0.0119	0.0165	0.0204
	Male	Māori	0.0052	0.0043	0.0043	0.0028
		Non-Māori	0.0302	0.0112	0.0153	0.0193
35-49	Female	Māori	0.0094	0.0081	0.0078	0.0048
		Non-Māori	0.0609	0.0266	0.0331	0.0439
	Male	Māori	0.0079	0.0066	0.0065	0.0042
		Non-Māori	0.0550	0.0239	0.0300	0.0404
50-64	Female	Māori	0.0059	0.0054	0.0049	0.0028
		Non-Māori	0.0478	0.0254	0.0299	0.0415
	Male	Māori	0.0049	0.0046	0.0044	0.0028
		Non-Māori	0.0462	0.0245	0.0284	0.0406

Results were tabulated in a similar way as was done for the 2001 survey [9] to facilitate easy comparison between the two studies. For each group of POPs (PCDD/Fs, PCBs, OCPs, BFRs,

PFCs), the overall weighted mean is presented, followed by the weighted mean by age group, weighted mean by region, and weighted mean by sex and ethnicity.

For the PCDDs, PCDFs, PCBs, and OCPs, the current serum concentrations were directly compared to those of the previous POPs survey to assess temporal trends. Because the included age-range was not fully comparable between the 2001 and current survey this comparison was done by age group.

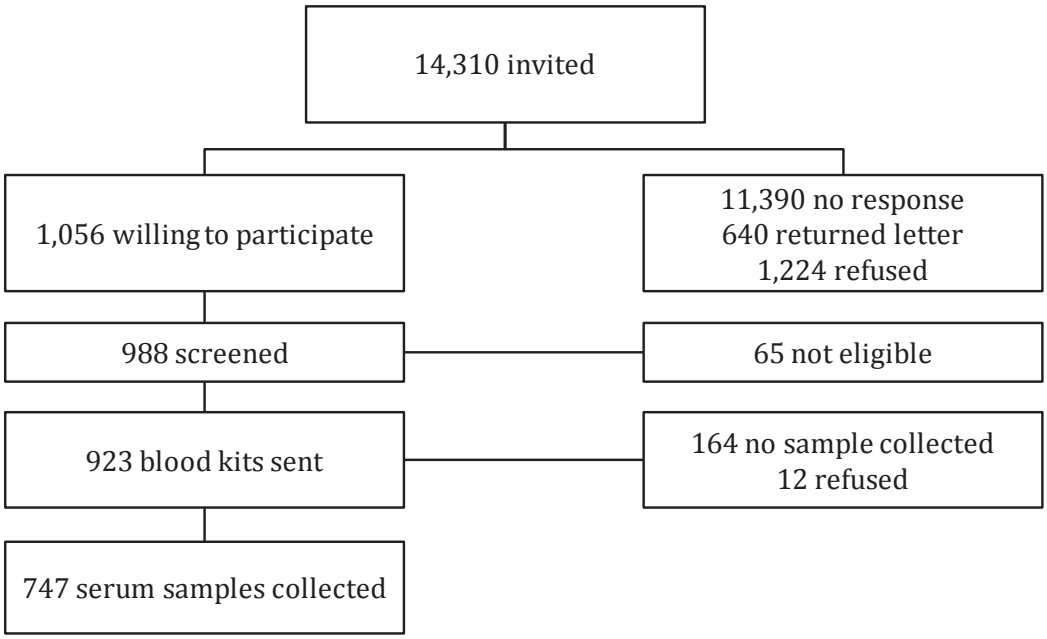
Time trends were not studied for the BFRs, PFCs, and certain OCPs because they were not included in the previous survey. For BFRs (selected PBDEs) a comparison was made with a study of BFRs in 23 donors in Wellington, New Zealand, collected in 2001 [66]. For all compound groups the New Zealand results were compared to other recent population studies including the ongoing work in Australia, North America, Europe and South America (details of the studies are provided in Section 1).

4. Concentrations of selected POPs in the serum of New Zealanders

4.1. Description of the study population

An overall schematic of the participant recruitment for the study is provided in Figure 4.1, with summary data for different study groups illustrated in Figure 4.2 to Figure 4.5. Summary statistics for the demographic information gathered from the Electoral Roll and obtained during screening questionnaires is provided in Table 4.1.

Figure 4.1. Study recruitment flowchart



Note that Figure 4.1 includes all participants who provided a serum sample for the study, including those whose serum sample was used for replicate pooled samples.

The study protocol sought to obtain equal representation from all demographic groups included in the study (i.e. equal numbers for each of the 64 strata). The summary data for the actual study sample shows no major differences in number of participants between the 4 study regions, however younger age groups (19-35 years) are under-represented in the study, particularly younger males (Māori and Non-Māori) and Māori females in the 19-24 age group.

Table 4.1. Summary demographic statistics for the study participants

			Number of participants			
Age Group	**Gender**	**Ethnicity**	**Northland/ Auckland**	**Waikato/Bay of Plenty**	**Lower North Island**	**South Island**
19-24	Female	Māori	5	5	6	4
		Non-Māori	8	15	14	10
	Male	Māori	1	2	2	0
		Non-Māori	5	7	9	4
25-34	Female	Māori	12	11	14	8
		Non-Māori	12	14	17	16
	Male	Māori	3	6	2	2
		Non-Māori	3	11	4	8
35-49	Female	Māori	12	12	9	20
		Non-Māori	14	22	18	18
	Male	Māori	8	8	10	6
		Non-Māori	11	18	15	10
50-64	Female	Māori	18	14	13	16
		Non-Māori	23	11	20	20
	Male	Māori	16	13	11	11
		Non-Māori	17	19	20	16

Shaded cells indicate strata that were combined for all regions because of low participant numbers. Note that this table does not include participants whose samples were used in replicate pooled samples (see section 3.6).

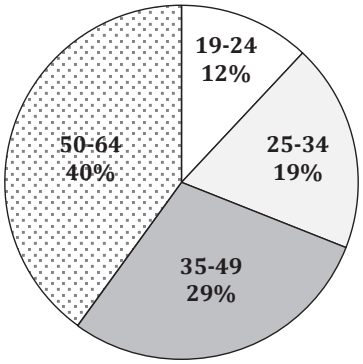


Figure 4.2. Serum collected by age group

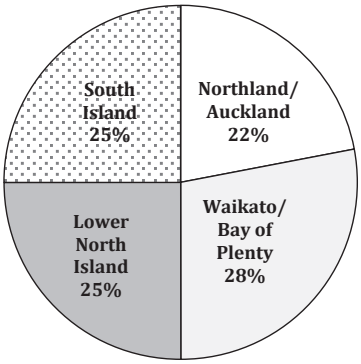


Figure 4.3. Serum collected by region

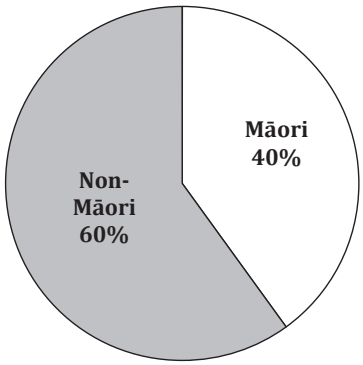


Figure 4.4. Serum collected by ethnicity

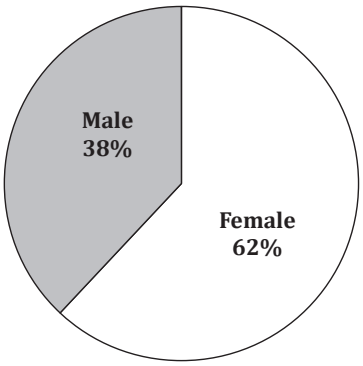


Figure 4.5. Serum collected by gender

4.2. Dioxins and furans (PCDD/Fs)

Summary statistics for concentrations of dioxins and furans in serum are provided in Table 4.2. Detailed data for all strata are included in Appendix C.

The majority of dioxin and furan congeners were detected in more than 50% of the pooled serum samples, except for 2,3,7,8-TCDD, 1,2,3,7,8,9-HxCDF, 1,2,3,4,7,8,9-HpCDF, and OCDF which were detected in 37%, 0%, 0% and 0% of strata, respectively. The congeners 1,2,3,4,6,7,8-HpCDD, OCDD, and 2,3,4,7,8-PeCDF were detected in all pooled samples (i.e. strata).

The congeners were ranked according to their weighted mean serum concentrations in the following order (congeners with <50% detection are excluded):

1. OCDD
2. 1,2,3,4,6,7,8-HpCDD
3. 1,2,3,6,7,8-HxCDD
4. 1,2,3,4,6,7,8-HpCDF
5. 2,3,4,7,8-PeCDF
6. 1,2,3,7,8-PeCDD
7. 1,2,3,7,8-PeCDF
8. 1,2,3,4,7,8-HxCDF
9. 1,2,3,4,7,8-HxCDD
10. 1,2,3,6,7,8-HxCDF
11. 2,3,7,8-TCDD
12. 1,2,3,7,8,9-HxCDD
13. 2,3,7,8-TCDF
14. 2,3,4,6,7,8-HxCDF

The weighted mean concentration for dioxins and furans across the New Zealand population aged 19-64 was determined as 5.81 pg TEQ_{05}/g lipid (6.40 pg TEQ_{98}/g lipid).

Table 4.2. Concentrations of dioxins and furans in serum (pg/g lipid)

N = 49 pools					
Congener (TEF_{05})	**Detection frequency**	**Minimum**	**Maximum**	**Weighted mean**	**SD**
2,3,7,8-TCDD (1)	37%	0.26	3.15	0.88	0.09
1,2,3,7,8-PeCDD (1)	98%	0.89	5.63	2.37	0.15
1,2,3,4,7,8-HxCDD (0.1)	63%	0.05	3.71	1.16	0.11
1,2,3,6,7,8-HxCDD (0.1)	96%	1.26	20.30	6.38	0.57
1,2,3,7,8,9-HxCDD (0.1)	86%	0.40	2.91	1.55	0.09
1,2,3,4,6,7,8-HpCDD (0.01)	100%	4.29	24.90	13.35	0.63
OCDD (0.0003)	100%	67.90	263.00	127.02	6.14
2,3,7,8-TCDF (0.1)	53%	0.24	2.12	0.72	0.06
1,2,3,7,8-PeCDF (0.03)	61%	0.19	4.12	0.82	0.12
2,3,4,7,8-PeCDF (0.3)	100%	1.18	5.68	2.99	0.14
1,2,3,4,7,8-HxCDF (0.1)	96%	0.50	3.73	1.66	0.10
1,2,3,6,7,8-HxCDF (0.1)	96%	0.42	3.68	1.76	0.10
1,2,3,7,8,9-HxCDF (0.1)	0%	(0.21)	(1.18)	(0.43)	-
2,3,4,6,7,8-HxCDF (0.1)	51%	0.21	1.43	0.58	0.04
1,2,3,4,6,7,8-HpCDF (0.01)	98%	1.18	10.10	3.42	0.23
1,2,3,4,7,8,9-HpCDF (0.01)	0%	(0.23)	(2.48)	(0.76)	-
OCDF (0.0003)	0%	(0.29)	(3.03)	(0.86)	-
PCDD/F TEQ_{05}	-	2.75	13.05	5.81	0.36
PCDD/F TEQ_{98}	-	3.04	14.24	6.40	0.39

For congeners with a detection frequency of 0% the summary statistics are placed between brackets, because they merely reflect the limit of detection divided by 2, and SD values are not reported.

Figure 4.6 shows the contribution of each congener to the total TEQ. It shows that 1,2,3,7,8-PeCDD is the largest contributor, accounting for 41% of the PCDD/F TEQ_{05}. 2,3,4,7,8-PeCDF and 2,3,7,8-TCDD each account for 15% of the PCDD/F TEQ_{05}, followed by 1,2,3,6,7,8-HxCDD (11%), and the other congeners contributing 3% or less.

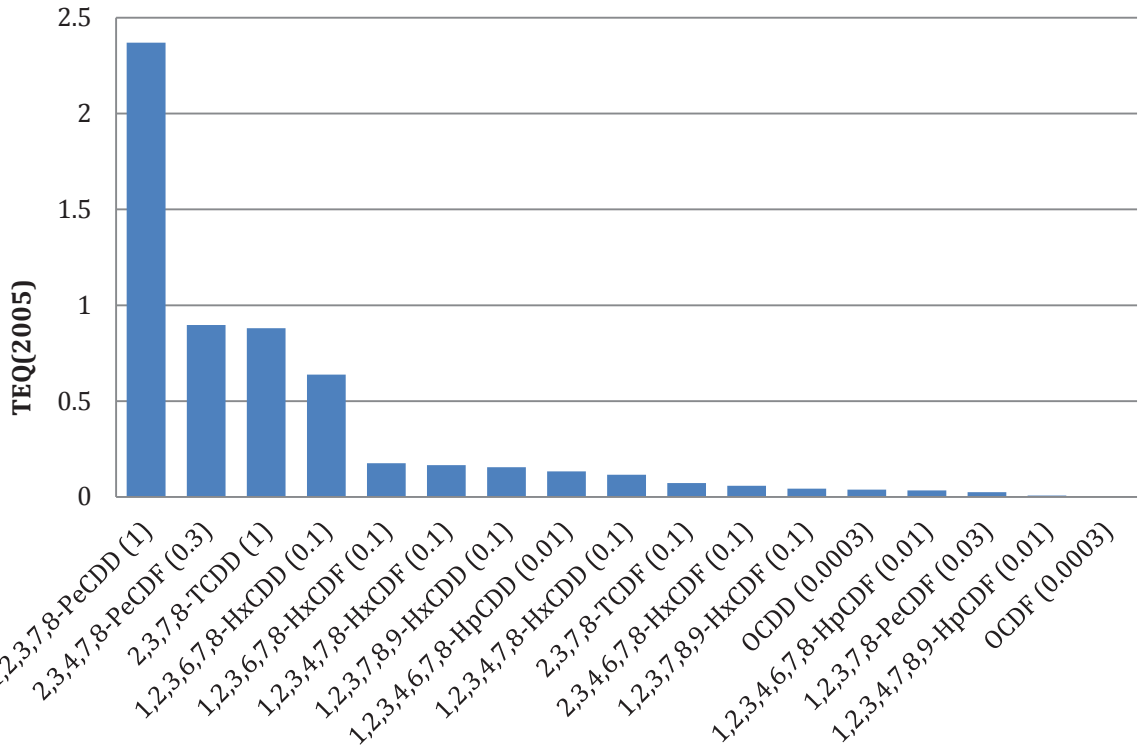


Figure 4.6. Contribution of PCDD/F congeners to the PCDD/F TEQ_{05}. The TEF of each congener is between brackets.

The following tables in this section only provide data for those congeners with detection frequency greater than 50%. Although the detection frequency for 2,3,7,8-TCDD was less than 50% (it was 37%), this congener is included in the following tables because of its key importance among the dioxin-like compounds.

The mean concentrations of dioxins and furans for each age group in the study are shown in Table 4.3. These data show a trend of higher dioxin and furan concentrations in the higher age groups, with PCDD/F TEQ_{05} in the 50-64 year age group being 2.6 times higher compared to the 19-24 years age group. This age-gradient for the PCDD/F TEQ was present for both males and females, Māori and non-Māori (see Figure 4.7) and for all four regions (Appendix C6).

The age gradient was not equally strong for each congener. The age-gradient was generally stronger for the dioxins compared to the furans, and no age-gradient was observed for the furan congeners 2,3,7,8-TCDF, 2,3,4,6,7,8-HxCDF and 1,2,3,4,6,7,8-HpCDF.

Table 4.3. Concentrations of dioxins and furans in serum, by age (pg/g lipid)

Age	19-24 yrs.	25-34 yrs.	35-49 yrs.	50-64 yrs.
N pools	**7**	**10**	**16**	**16**
2,3,7,8-TCDD	0.47	0.51	0.68	1.49
1,2,3,7,8-PeCDD	1.41	1.90	2.05	3.37
1,2,3,4,7,8-HxCDD	0.58	0.55	1.00	1.93
1,2,3,6,7,8-HxCDD	2.05	3.57	5.06	11.19
1,2,3,7,8,9-HxCDD	1.11	1.19	1.39	2.13
1,2,3,4,6,7,8-HpCDD	8.01	10.95	12.84	17.34
OCDD	84.55	99.43	125.25	161.33
2,3,7,8-TCDF	0.59	0.90	0.68	0.69
1,2,3,7,8-PeCDF	0.37	1.25	0.57	1.02
2,3,4,7,8-PeCDF	1.74	2.56	2.72	4.02
1,2,3,4,7,8-HxCDF	0.87	1.64	1.51	2.13
1,2,3,6,7,8-HxCDF	1.01	1.77	1.56	2.26
2,3,4,6,7,8-HxCDF	0.42	0.70	0.47	0.70
1,2,3,4,6,7,8-HpCDF	3.37	4.19	2.92	3.56
PCDD/F TEQ_{05}	3.27	4.47	4.97	8.51
PCDD/F TEQ_{98}	3.61	4.99	5.50	9.31

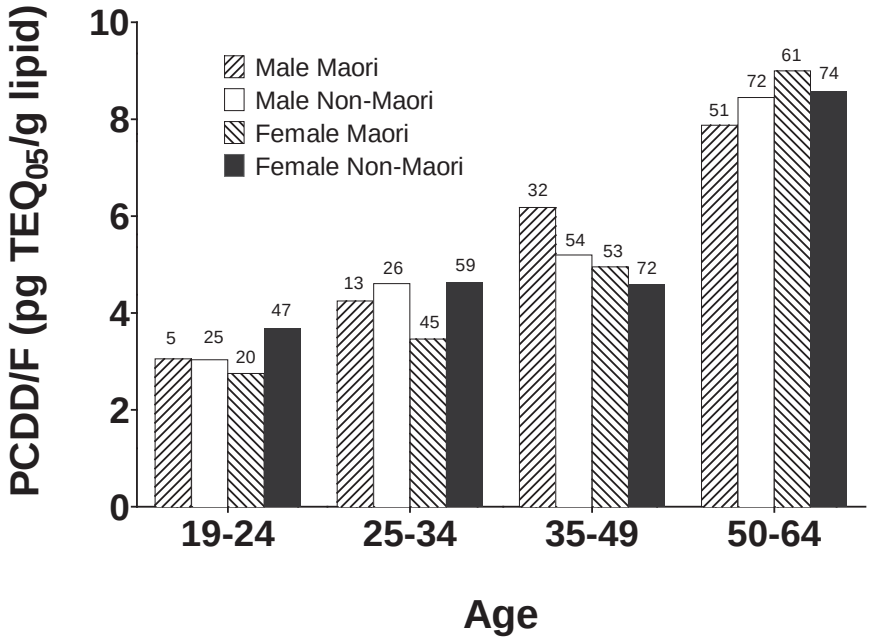


Figure 4.7. Concentrations of dioxins and furans in serum (TEQ_{05}). Numbers above bars are individuals included in the result.

The mean concentrations of dioxins and furans for each region in the study are shown in Table 4.4. These data indicate marginally higher overall dioxin and furan concentrations in the Waikato/Bay of Plenty and South Island regions compared to the Northland/Auckland and Lower North Island regions, however regional differences were only present for non-Māori females (Appendix C6) indicating that regional differences were not consistently observed.

Table 4.4. Concentrations of dioxins and furans in serum, by region (pg/g lipid)

Region	**Northland/ Auckland**	**Waikato/ Bay of Plenty**	**Lower North Island**	**South Island**
N pools	**8**	**8**	**8**	**8**
2,3,7,8-TCDD	0.82	1.32	0.87	1.33
1,2,3,7,8-PeCDD	2.16	3.25	2.20	3.28
1,2,3,4,7,8-HxCDD	1.06	2.26	1.12	1.58
1,2,3,6,7,8-HxCDD	6.58	11.36	7.18	7.84
1,2,3,7,8,9-HxCDD	1.39	2.24	1.53	1.99
1,2,3,4,6,7,8-HpCDD	14.67	17.71	13.03	14.86
OCDD	136.33	165.91	134.91	138.60
2,3,7,8-TCDF	0.63	0.70	0.33	1.05
1,2,3,7,8-PeCDF	0.55	0.67	0.36	1.50
2,3,4,7,8-PeCDF	3.03	3.47	3.14	3.76
1,2,3,4,7,8-HxCDF	1.45	1.94	1.48	2.41
1,2,3,6,7,8-HxCDF	1.60	1.92	1.72	2.37
2,3,4,6,7,8-HxCDF	0.45	0.60	0.46	0.82
1,2,3,4,6,7,8-HpCDF	2.42	3.16	3.18	4.33
PCDD/F TEQ_{05}	5.48	8.05	5.67	7.88
PCDD/F TEQ_{98}	6.07	8.73	6.27	8.64

NOTE: only data from the 2 oldest age groups (35-64 years) are included in Table 4.5 because several of the strata in the younger age groups (19-34 years) were combined due to low numbers of study participants.

The weighted mean concentrations of dioxins and furans by gender and ethnicity are shown in Table 4.5. These data indicate similar overall dioxin and furan TEQ_{05} for Māori compared to non-Māori and male compared to female. There appears to be a difference in concentrations of OCDD, with 1.2-1.3 times higher concentrations in both Māori and non-Māori females compared to males, but this small difference had no impact on the PCDD/F TEQ. 1,2,3,7,8-PeCDF concentrations were 1.6 times higher in males compared to females in both Māori and non-Māori.

Table 4.5. Concentrations of dioxins and furans in serum, by ethnicity and gender (pg/g lipid)

	Male Māori	**Male Non-Māori**	**Female Māori**	**Female Non-Māori**
N pools	**10**	**10**	**13**	**16**
2,3,7,8-TCDD	0.59	0.83	0.74	1.00
1,2,3,7,8-PeCDD	2.40	2.50	2.23	2.26
1,2,3,4,7,8-HxCDD	1.51	1.12	0.87	1.20
1,2,3,6,7,8-HxCDD	6.56	6.26	6.29	6.48
1,2,3,7,8,9-HxCDD	1.55	1.48	1.76	1.58
1,2,3,4,6,7,8-HpCDD	12.05	12.00	12.76	14.92
OCDD	107.30	109.16	131.90	145.94
2,3,7,8-TCDF	0.84	0.73	0.45	0.74
1,2,3,7,8-PeCDF	0.75	1.06	0.48	0.68
2,3,4,7,8-PeCDF	3.07	3.20	2.32	2.90
1,2,3,4,7,8-HxCDF	1.60	1.81	1.39	1.58
1,2,3,6,7,8-HxCDF	1.74	1.91	1.35	1.70
2,3,4,6,7,8-HxCDF	0.66	0.62	0.51	0.55
1,2,3,4,6,7,8-HpCDF	3.22	3.50	3.11	3.44
PCDD/F TEQ_{05}	5.64	5.95	5.18	5.82
PCDD/F TEQ_{98}	6.24	6.59	5.63	6.38

4.3. Polychlorinated biphenyls (PCBs)

Summary data for concentrations of PCBs in serum are provided in Table 4.6. Detailed data for all strata are included in Appendix C.

The majority of PCB congeners were detected in more than 50% of the pooled samples, except for PCB169, PCB15, PCB37, PCB19, PCB155, PCB54, PCB77, PCB81, PCB104, and PCB188. The congeners that were detected in greater than 50% of strata were ranked according to their weighted mean concentrations in the following order:

1. PCB180
2. PCB153
3. PCB138/163/164
4. PCB170
5. PCB187
6. PCB194
7. PCB118
8. PCB156
9. PCB196/203
10. PCB74
11. PCB28
12. PCB183
13. PCB99
14. PCB167
15. PCB206
16. PCB105
17. PCB157
18. PCB209
19. PCB202
20. PCB189
21. PCB52
22. PCB208
23. PCB101
24. PCB114
25. PCB110
26. PCB44
27. PCB205
28. PCB70
29. PCB49
30. PCB4/10
31. PCB3
32. PCB123
33. PCB1
34. PCB126

The weighted mean concentration of PCBs across the New Zealand population aged 19-64 was determined as 1.54 pg TEQ_{05}/g lipid (2.46 pg TEQ_{98}/g lipid).

Table 4.6. Concentrations of PCBs in serum (pg/g lipid)

N = 49 pools					
Congener (TEF_{05})	**Detection frequency**	**Minimum**	**Maximum**	**Weighted mean**	**SD**
PCB1	100%	9.67	59.90	16.63	0.87
PCB3	100%	12.20	62.30	22.15	0.99
PCB4/10	57%	8.30	60.60	31.25	1.96
PCB15	29%	7.00	70.90	19.22	1.53
PCB19	18%	3.66	20.20	9.36	0.55
PCB28	100%	454.00	3050.00	968.29	67.53
PCB37	29%	4.77	30.80	15.25	1.06
PCB44	90%	7.70	178.00	56.38	4.38
PCB49	76%	6.95	87.80	32.50	2.61
PCB52	100%	81.90	363.00	149.14	9.85
PCB54	0%	(3.07)	(29.85)	(9.22)	-
PCB70	84%	7.55	76.30	35.36	1.78
PCB74	100%	494.00	2690.00	1324.61	83.21
PCB77 (0.0001)	0%	(3.21)	(10.25)	(4.95)	-
PCB81 (0.0003)	0%	(3.50)	(10.25)	(4.92)	-
PCB99	100%	313.00	2090.00	799.02	53.61
PCB101	100%	72.70	276.00	125.21	6.08
PCB104	0%	(1.25)	(8.70)	(3.62)	-
PCB105 (0.00003)	100%	142.00	723.00	357.17	21.61
PCB110	100%	35.20	151.00	63.83	4.54
PCB114 (0.00003)	98%	8.20	244.00	117.44	9.08
PCB118 (0.00003)	100%	640.00	3450.00	1774.33	113.30
PCB123 (0.00003)	73%	4.23	48.00	21.94	1.56
PCB126 (0.1)	51%	3.56	24.70	9.96	0.74
PCB138/163/164	100%	2820.00	21400.00	8716.78	667.42
PCB153	100%	3540.00	32500.00	12404.65	990.91
PCB155	6%	0.88	11.40	3.51	0.37
PCB156 (0.00003)	100%	466.00	3980.00	1728.41	134.39
PCB157 (0.00003)	100%	92.00	732.00	326.47	25.54
PCB167 (0.00003)	100%	139.00	984.00	433.08	34.15
PCB169 (0.03)	41%	5.80	28.10	13.09	0.79
PCB170	100%	1010.00	10600.00	4449.70	367.32
PCB180	100%	2690.00	32700.00	13385.62	1110.08
PCB183	100%	237.00	2590.00	845.65	70.56
PCB187	100%	531.00	6400.00	2511.50	207.68
PCB188	0%	(2.94)	(19.45)	(7.93)	-
PCB189 (0.00003)	100%	26.30	544.00	237.48	21.00
PCB194	100%	376.00	7140.00	2489.08	233.31
PCB196/203	100%	236.00	4980.00	1714.52	152.07
PCB200	0%	(1.02)	(31.45)	(5.47)	-
PCB202	100%	41.10	869.00	295.53	26.82
PCB205	78%	5.85	103.00	46.68	3.88
PCB206	100%	60.50	1190.00	396.84	36.38
PCB208	92%	5.75	447.00	142.60	14.35
PCB209	100%	102.00	768.00	307.72	19.67
PCB TEQ_{05}	-	0.65	3.60	1.54	0.10
PCB TEQ_{98}	-	0.97	5.32	2.46	0.17

For congeners with a detection frequency of 0% the summary statistics are placed between brackets, because they merely reflect the limit of detection divided by 2, and SD values are not reported. All congeners with TEFs are included in the calculation of the TEQ.

Figure 4.8 shows the contribution of each dioxin-like PCB to the total PCB TEQ_{05}. PCB126 is by far the largest contributor to the PCB TEQ, accounting for 65% of the PCB TEQ_{05}. PCB169 accounts for 26% while the other congeners account for 3% or less of the PCB TEQ_{05}.

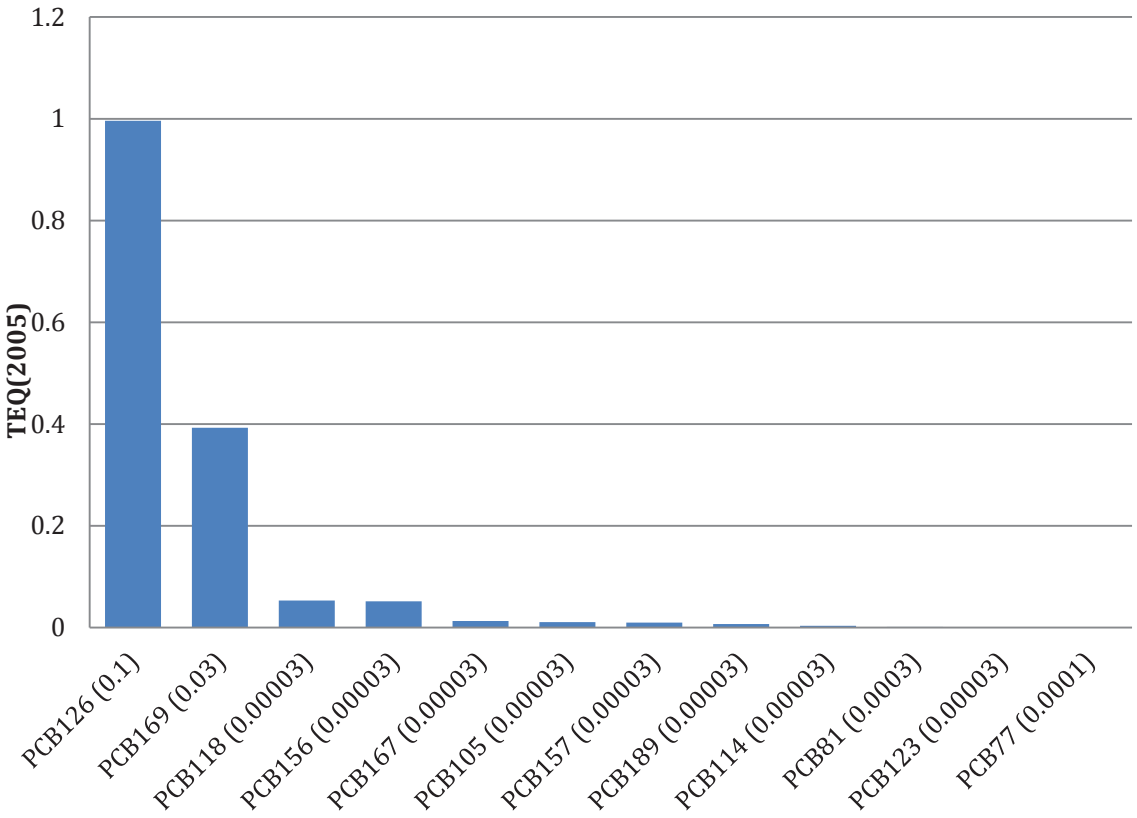


Figure 4.8. Contribution of dioxin-like PCBs to total PCB TEQ_{05}. The TEF of each congener is between brackets.

Following tables in this section only provide data for those congeners with detection frequency greater than 50%.

The mean concentrations of PCBs for each age group in the study are shown in Table 4.7. These data show a trend of higher PCB concentrations in the higher age groups, with PCB TEQ_{05} in the 50-64 year age group being 2.7 times higher compared to the 19-24 years age group. A similar age-gradient was present for both males and females, Māori and non-Māori (Figure 4.9). The magnitude of the age-gradient appeared to be greater for the PCB congeners with more chlorine atoms: for the higher chlorinated PCB208, PCB194, PCB205, PCB206, and PCB196/203 a 7- to 9-fold difference between PCB concentrations in the lowest and highest age groups was observed (for example see PCB194 in Figure 4.10), while for the lower chlorinated PCBs (e.g. PCB1 to PCB52) no obvious age-gradient was present.

Table 4.7. Concentrations of PCBs in serum, by age (pg/g lipid)

Age	**19-24 yrs.**	**25-34 yrs.**	**35-49 yrs.**	**50-64 yrs.**
N pools	**7**	**10**	**16**	**16**
PCB1	21.84	15.28	17.76	14.26
PCB3	22.95	20.60	23.88	20.80
PCB4/10	39.63	38.27	28.06	27.61
PCB28	780.26	1035.51	793.73	1197.60
PCB44	44.19	64.82	50.57	62.40
PCB49	28.89	34.85	28.99	36.45
PCB52	125.68	180.31	130.97	159.74
PCB70	18.50	33.89	40.40	36.60
PCB74	625.18	972.76	1122.25	2027.12
PCB99	378.40	554.61	685.59	1231.85
PCB101	114.65	135.65	109.06	141.37
PCB105	170.15	264.10	306.18	540.80
PCB110	57.76	87.85	51.29	65.92
PCB114	42.00	62.13	100.97	197.58
PCB118	823.89	1168.83	1548.81	2749.18
PCB123	7.82	14.80	20.08	33.59
PCB126	5.42	5.01	9.56	15.09
PCB138/163/164	3506.54	4531.70	7679.49	14356.81
PCB153	4492.20	6100.68	11201.21	20509.35
PCB156	657.77	831.39	1548.11	2871.95
PCB157	126.15	155.88	289.38	545.97
PCB167	182.12	208.55	372.03	731.48
PCB170	1486.86	1960.69	4098.72	7447.50
PCB180	4084.75	5561.85	12914.85	22074.33
PCB183	296.49	418.81	767.40	1395.58
PCB187	763.29	1125.93	2307.88	4225.90
PCB189	61.93	88.71	228.34	402.43
PCB194	510.02	871.74	2344.30	4360.60
PCB196/203	407.70	645.01	1644.98	2921.18
PCB202	80.24	118.63	274.95	505.29
PCB205	9.52	19.70	47.60	75.57
PCB206	94.22	149.95	375.88	681.40
PCB208	25.84	42.79	146.49	241.32
PCB209	125.50	169.33	329.02	433.69
PCB TEQ_{05}	0.85	0.87	1.47	2.28
PCB TEQ_{98}	1.15	1.28	2.27	3.87

The weighted mean concentrations of PCBs for each region in the study are shown in Table 4.8. These data indicate no apparent region-related trend for individual PCB congeners, with marginally higher overall PCB TEQ_{05} in the Waikato/Bay of Plenty region compared to the other study regions. However, these regional differences were only present for non-Māori females and Māori-males (not for Māori females or non-Māori-males), indicating that regional differences were not consistently observed.

Table 4.8. Concentrations of PCBs in serum, by region (pg/g lipid)

Region	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island
N pools	**8**	**8**	**8**	**8**
PCB1	17.12	17.81	17.73	12.40
PCB3	24.28	22.94	21.72	20.29
PCB4/10	26.91	28.82	31.48	25.51
PCB28	805.76	976.16	1548.12	761.26
PCB44	46.46	43.08	85.04	54.46
PCB49	30.29	37.28	44.87	22.02
PCB52	114.29	137.76	212.94	133.39
PCB70	37.38	38.73	38.34	40.45
PCB74	1488.99	1595.13	1779.45	1385.99
PCB99	810.60	1051.10	1142.85	867.77
PCB101	105.24	152.61	146.05	111.45
PCB105	410.91	474.00	459.07	344.66
PCB110	47.65	71.38	67.29	55.24
PCB114	143.62	165.78	149.37	132.08
PCB118	2008.01	2406.14	2227.35	1930.45
PCB123	27.92	29.72	25.23	22.86
PCB126	12.79	15.80	10.16	10.30
PCB138/163/164	9628.90	12487.93	11675.51	10393.38
PCB153	14247.93	17583.76	16624.01	14891.12
PCB156	2026.01	2437.15	2207.92	2116.48
PCB157	391.61	464.50	407.69	392.65
PCB167	488.56	644.30	514.09	552.12
PCB170	5338.42	6128.98	5582.72	5795.42
PCB180	16624.65	18341.70	17379.04	16898.68
PCB183	938.06	1107.91	1235.45	1042.97
PCB187	3054.07	3544.98	3434.47	2959.16
PCB189	290.19	348.13	294.74	318.74
PCB194	3274.79	3319.81	3458.58	3117.59
PCB196/203	2262.43	2124.38	2486.53	2083.16
PCB202	401.39	359.39	437.57	327.15
PCB205	62.23	69.66	59.70	52.85
PCB206	553.79	441.10	609.98	449.30
PCB208	215.37	146.85	227.33	158.52
PCB209	364.31	310.03	432.08	398.19
PCB TEQ_{05}	1.89	2.22	1.63	1.70
PCB TEQ_{98}	2.99	3.59	2.85	2.78

NOTE: only data from the 2 oldest age groups (35-64 years) are included in this table because several of the strata in the younger age groups (19-34 years) were combined due to low numbers of study participants.

The mean concentrations of PCBs for each gender/ethnicity combination in the study are shown in Table 4.9. These data indicate similar PCB concentrations for Māori compared to non-Māori and male compared to female. For some higher chlorinated PCBs concentrations were marginally higher (1.4-fold) in males compared to females (e.g. PCB189, PCB194, PCB202).

Table 4.9. Concentrations of PCBs in serum, by ethnicity and gender (pg/g lipid)

	Male Māori	Male Non-Māori	Female Māori	Female Non-Māori
N pools	**10**	**10**	**13**	**16**
PCB1	24.14	15.32	15.40	16.91
PCB3	29.76	20.39	20.96	22.81
PCB4/10	33.05	36.73	24.96	27.01
PCB28	725.28	1085.18	818.45	925.16
PCB44	59.44	72.83	44.95	42.63
PCB49	37.72	36.71	30.47	28.12
PCB52	144.22	183.20	135.91	120.50
PCB70	32.20	34.23	36.02	36.79
PCB74	964.50	1307.47	1336.81	1395.18
PCB99	712.40	886.37	739.92	741.95
PCB101	121.09	137.08	131.96	113.50
PCB105	311.81	358.67	353.08	363.68
PCB110	58.23	73.18	64.99	55.74
PCB114	94.72	123.48	100.68	118.50
PCB118	1522.72	1688.13	1755.04	1898.25
PCB123	16.67	23.41	17.91	22.15
PCB126	10.79	9.28	9.94	10.47
PCB138/163/164	9295.15	9212.29	8417.31	8217.67
PCB153	12788.99	13754.56	10887.89	11363.38
PCB156	1837.41	1957.90	1419.00	1554.11
PCB157	321.42	370.46	256.86	299.06
PCB167	415.38	407.52	439.59	458.59
PCB170	4852.87	5182.91	3505.50	3875.87
PCB180	14023.53	15787.27	10037.26	11661.33
PCB183	878.05	930.16	773.83	774.84
PCB187	2731.93	2833.11	2178.80	2237.75
PCB189	268.22	282.44	172.69	202.63
PCB194	2448.15	3043.85	1625.12	2137.35
PCB196/203	1644.88	1997.97	1242.42	1548.20
PCB202	272.77	359.26	195.05	258.20
PCB205	48.54	51.30	36.26	44.01
PCB206	345.80	433.80	262.27	395.37
PCB208	110.06	159.08	87.12	142.63
PCB209	236.86	344.52	208.66	302.91
PCB TEQ_{05}	1.67	1.55	1.44	1.53
PCB TEQ_{98}	2.57	2.55	2.22	2.40

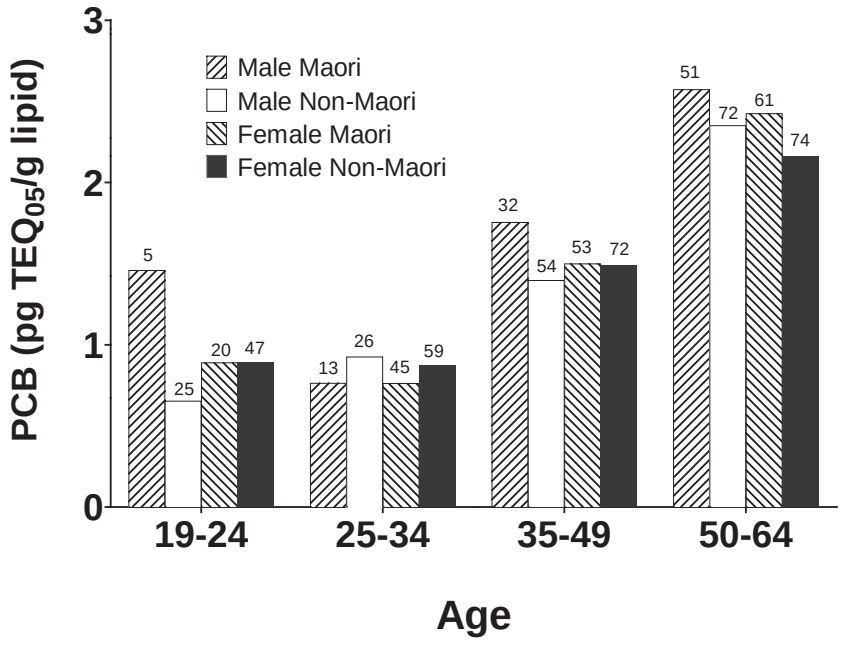


Figure 4.9. Concentrations of PCBs in serum (TEQ_{05}). Numbers above bars are individuals in the result.

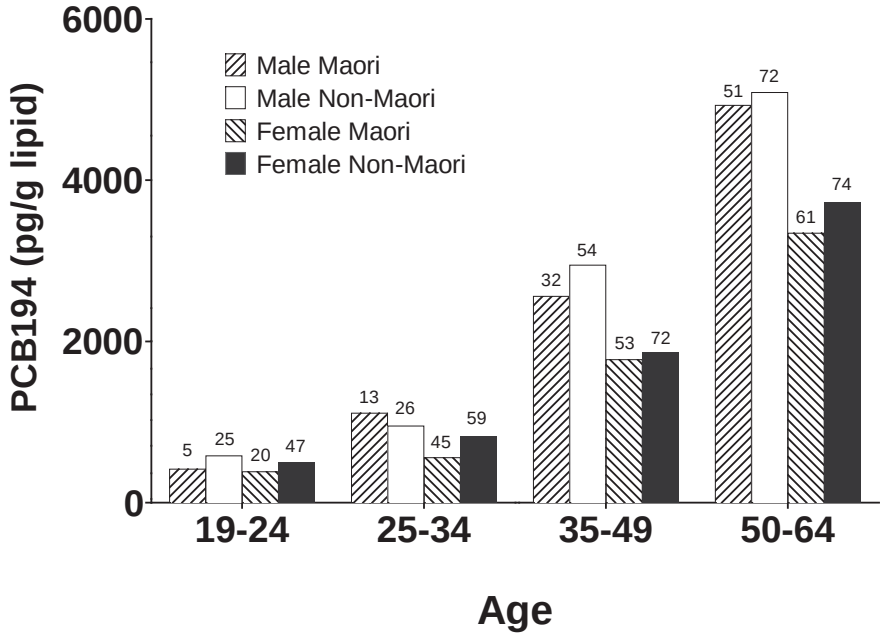


Figure 4.10. Concentrations of PCB194 in serum. Numbers above bars are individuals in the result.

4.4. Organochlorine pesticides (OCPs)

Summary data for concentrations of OCPs in serum are provided in Table 4.10. Detailed data for all strata are included in Appendix C.

Only 7 OCPs were present in greater than 50% of samples from all strata: *beta*-HCH, PeCB, HCB, dieldrin, *p,p'*-DDT, and *p,p'*-DDE. Following tables in this section only provide data for those OCPs with detection frequency greater than 50%. The laboratory encountered analytical problems for endrin aldehyde, endrin ketone, endosulfan sulfate, and kepone (chlordecone) therefore these analytes are not reported.

Table 4.10. Concentrations of OCPs in serum (ng/g lipid)

N = 49 pools					
	Detection frequency	**Minimum**	**Maximum**	**Weighted mean**	**SD**
alpha-HCH	0%	(0.18)	(1.19)	(0.33)	-
beta-HCH	100%	1.09	64.50	12.91	2.56
gamma-HCH (lindane)	2%	0.14	1.88	0.38	0.03
delta-HCH	0%	(0.16)	(0.85)	(0.33)	-
PeCB	96%	0.39	2.84	0.86	0.07
HCB	100%	4.07	15.70	7.62	0.33
Aldrin	0%	(0.13)	(0.78)	(0.25)	-
Dieldrin	100%	1.70	16.20	5.22	0.39
Endrin	0%	(0.14)	(0.62)	(0.27)	-
Heptachlor	4%	0.12	0.78	0.21	0.02
Heptachlor epoxide	27%	0.13	0.70	0.30	0.02
alpha-chlordane	2%	0.10	0.73	0.20	0.01
gamma-chlordane	4%	0.08	0.83	0.21	0.01
oxy-chlordane	27%	0.20	1.88	0.71	0.06
trans-nonachlor	18%	0.32	4.34	1.15	0.14
cis-nonachlor	0%	(0.17)	(0.99)	(0.46)	-
o,p'-DDT	2%	0.13	1.28	0.23	0.02
p,p'-DDT	100%	1.24	6.05	2.69	0.16
o,p'-DDD	2%	0.13	0.98	0.22	0.02
p,p'-DDD	2%	0.12	0.86	0.20	0.01
o,p'-DDE	0%	(0.12)	(0.58)	(0.22)	-
p,p'-DDE	100%	75.30	676.00	249.80	18.26
Mirex	94%	0.14	2.77	0.65	0.07
Endosulfan A	0%	(0.47)	(3.70)	(1.15)	-
Endosulfan B	0%	(0.52)	(2.89)	(1.27)	-
Methoxychlor	0%	(0.10)	(0.62)	(0.21)	-
Toxaphene (Parlar 26)	0%	(0.69)	(2.28)	(1.11)	-
Toxaphene (Parlar 50)	0%	(0.50)	(1.68)	(0.82)	-
Toxaphene (Parlar 62)	0%	(0.45)	(1.75)	(0.86)	-

For congeners with a detection frequency of 0% the summary statistics are placed between brackets, because they merely reflect the limit of detection divided by 2, and SD values are not reported.

The mean concentrations of OCPs for each age group in the study are shown in Table 4.11. These data show a trend of higher OCP concentrations in the higher age groups particularly for *beta*-HCH, *p,p'*-DDE and mirex. For *beta*-HCH, there was a 5.2-fold difference between the oldest

and youngest age group, and this pattern was consistent for Māori males and Māori females (Figure 4.11). However, some high concentration outliers were observed in some strata for non-Māori males and non-Māori females, indicating that for *beta*-HCH outliers among individual samples may obscure demographic patterns. For *p,p'*-DDE there was a 3.1-fold difference in concentration between the oldest and youngest age group. A similar age-gradient was present for both males and females, Māori and non-Māori (Figure 4.16). For mirex a 4.3-fold difference between the oldest and youngest age group was observed. This age-gradient was consistent for males and females, Māori and non-Māori (Figure 4.17). For HCB (Figure 4.13), dieldrin (Figure 4.14), and p,p'-DDT (Figure 4.15) only weak age-gradients were observed, while for PeCB no consistent age-gradient was present (Figure 4.12).

Table 4.11. Concentrations of OCPs in serum, by age (ng/g lipid)

	19-24 yrs.	**25-34 yrs.**	**35-49 yrs.**	**50-64 yrs.**
N pools	**7**	**10**	**16**	**16**
beta-HCH	3.06	5.47	17.31	15.93
PeCB	1.33	0.53	0.81	0.94
HCB	5.91	6.57	6.94	9.65
Dieldrin	4.06	5.12	5.00	5.97
p,p'-DDT	1.98	2.68	2.10	3.64
p,p'-DDE	125.34	173.69	207.61	390.13
Mirex	0.23	0.41	0.61	0.99

The mean concentrations of OCPs for each region in the study are shown in Table 4.12. These data show higher concentrations of *beta*-HCH in Northland/Auckland and lower *beta*-HCH concentrations in the South Island. However, this pattern was not consistently observed for males/females and Māori/non-Māori, suggesting that outliers among individual samples may have caused the observed regional pattern (Appendix C6). Concentrations of dieldrin are marginally lower in the Northland/Auckland region, but this is not consistently observed for male/female and Māori/non-Māori (Appendix C6). Concentrations of *p,p'*-DDE appear to have a north to south gradient with serum concentrations in the South Island being 1.6 higher than the most northern region. This pattern was present in several of the age- and ethnicity-groups for both males and females (Appendix C6).

Table 4.12. Concentrations of OCPs in serum, by region (ng/g lipid)

	Northland/ Auckland	**Waikato/ Bay of Plenty**	**Lower North Island**	**South Island**
N pools	**8**	**8**	**8**	**8**
beta-HCH	25.59	16.66	15.77	5.67
PeCB	0.97	0.88	0.65	0.92
HCB	7.42	9.53	7.31	9.02
dieldrin	3.74	5.78	7.20	6.07
p,p'-DDT	2.47	2.51	3.50	2.92
p,p'-DDE	217.68	334.68	306.19	350.17
mirex	0.71	1.12	0.93	0.54

NOTE: only data from the 2 oldest age groups (35-64 years) are included in this table because several of the strata in the younger age groups (19-34 years) were combined due to low numbers of study participants.

The mean concentrations of OCPs for gender/ethnicity combinations are shown in Table 4.13. These data show lower concentrations of *beta*-HCH in Māori. As illustrated in Appendix C6, no high outliers for beta-HCH concentrations were observed among Māori, while several outliers were observed among both male and female non-Māori. Concentrations of dieldrin and mirex are marginally lower in females compared to males, and this pattern was consistent for most age-groups.

Table 4.13. Concentrations of OCPs in serum, by ethnicity and gender (ng/g lipid)

	Male Māori	**Male Non-Māori**	**Female Māori**	**Female Non-Māori**
N pools	**10**	**10**	**13**	**16**
beta-HCH	3.51	19.02	3.57	10.40
PeCB	1.28	0.89	0.79	0.78
HCB	8.17	7.44	7.83	7.65
dieldrin	6.29	6.19	5.26	4.14
p,p'-DDT	3.03	2.70	2.92	2.58
p,p'-DDE	297.95	261.65	270.08	227.33
mirex	1.05	0.76	0.64	0.49

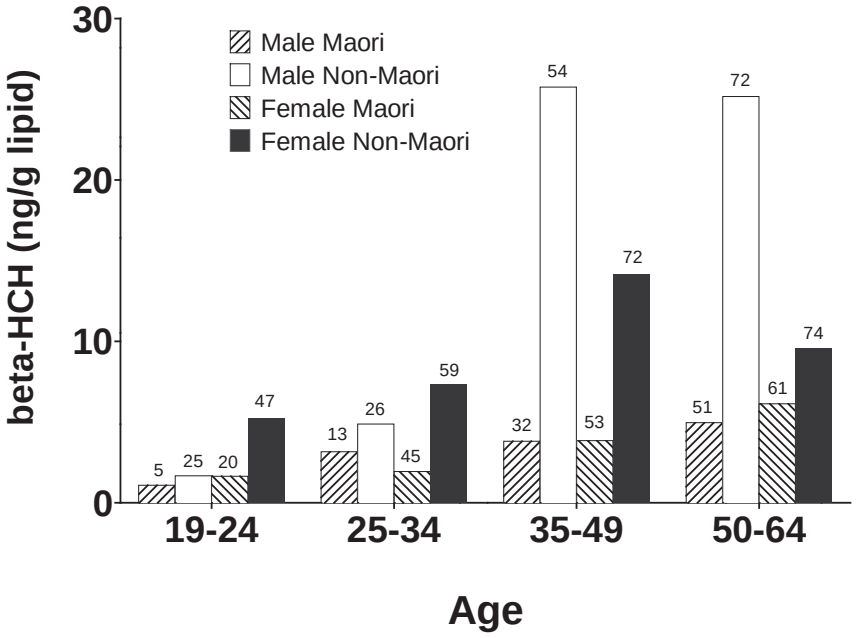


Figure 4.11. Concentrations of *beta*-HCH in serum. Numbers above bars are individuals in the result.

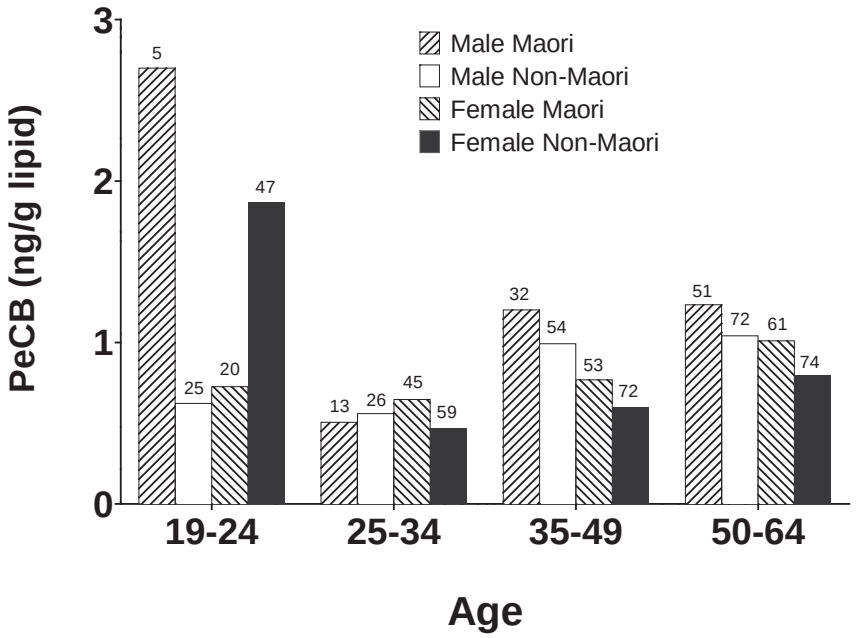


Figure 4.12. Concentrations of PeCB in serum. Numbers above bars are individuals in the result.

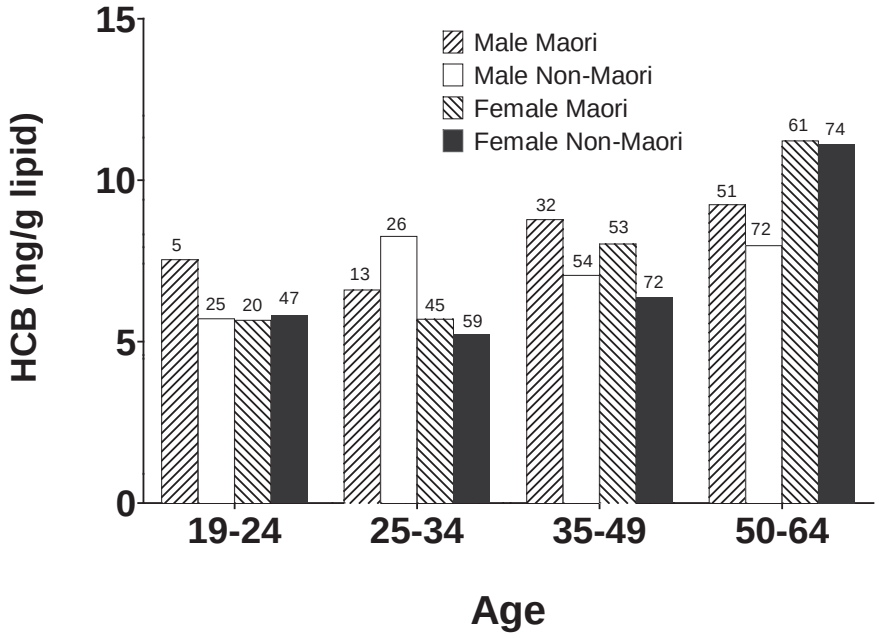


Figure 4.13. Concentrations of HCB in serum. Numbers above bars are individuals in the result.

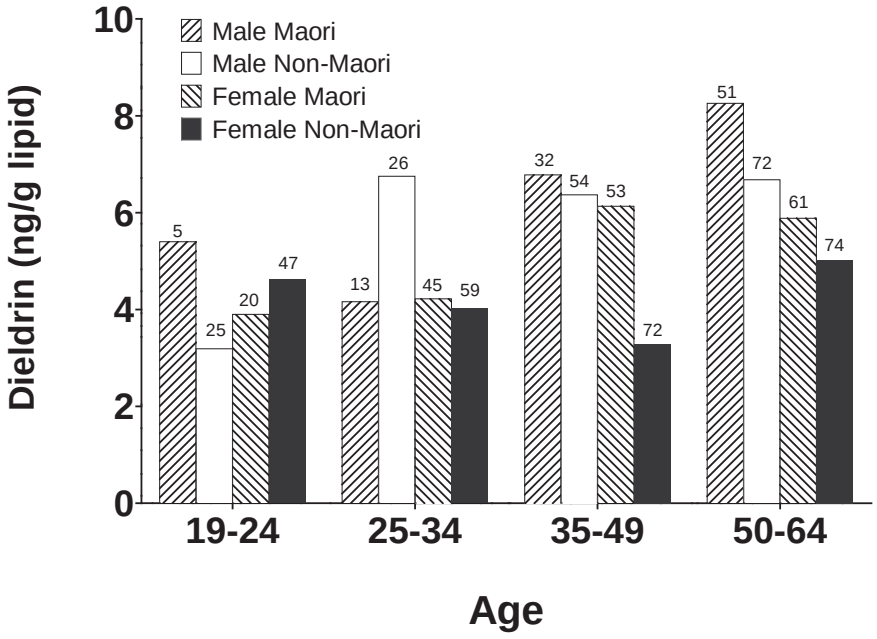


Figure 4.14. Concentrations of dieldrin in serum. Numbers above bars are individuals in the result.

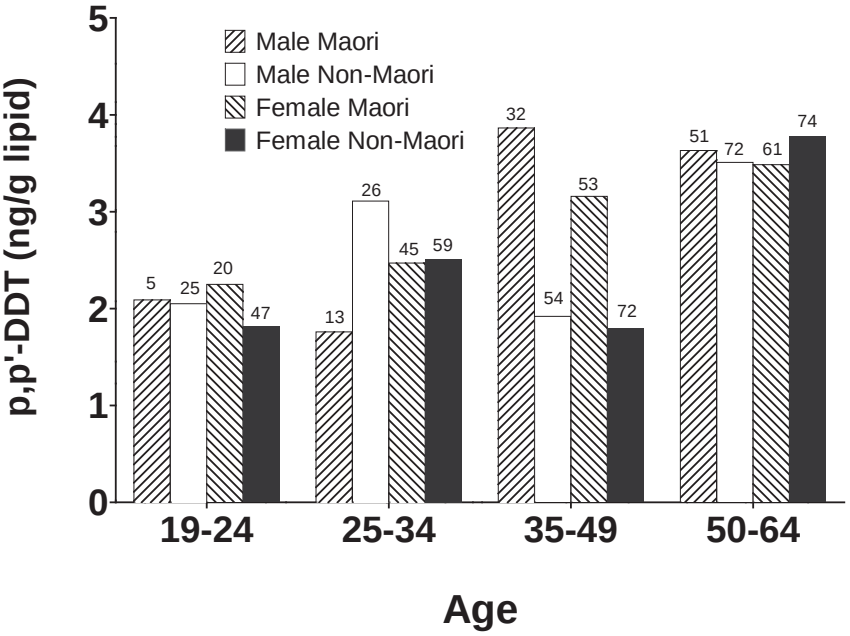


Figure 4.15. Concentrations of p,p'-DDT in serum. Numbers above bars are individuals in the pooled result.

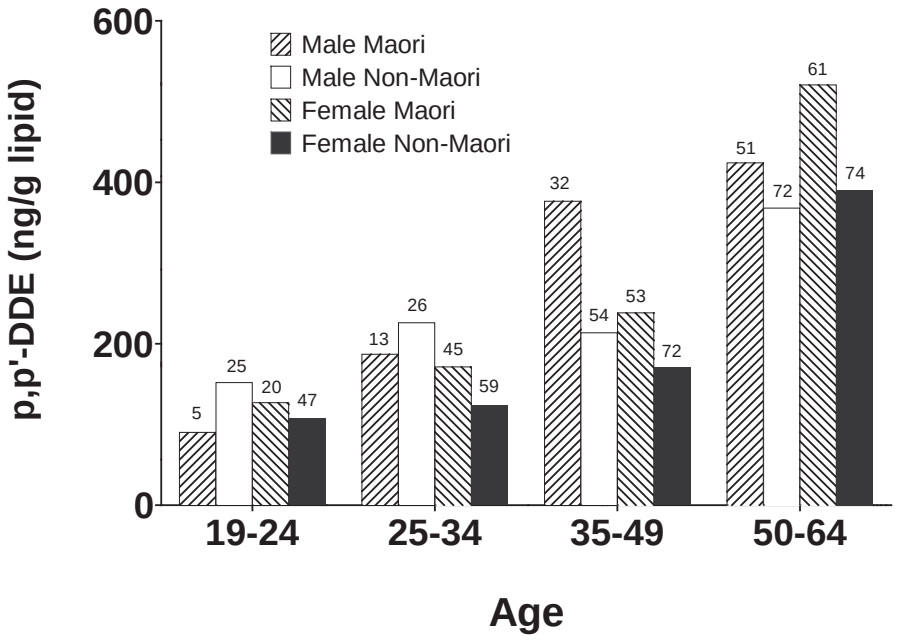


Figure 4.16. Concentrations of p,p'-DDE in serum. Numbers above bars are individuals in the result.

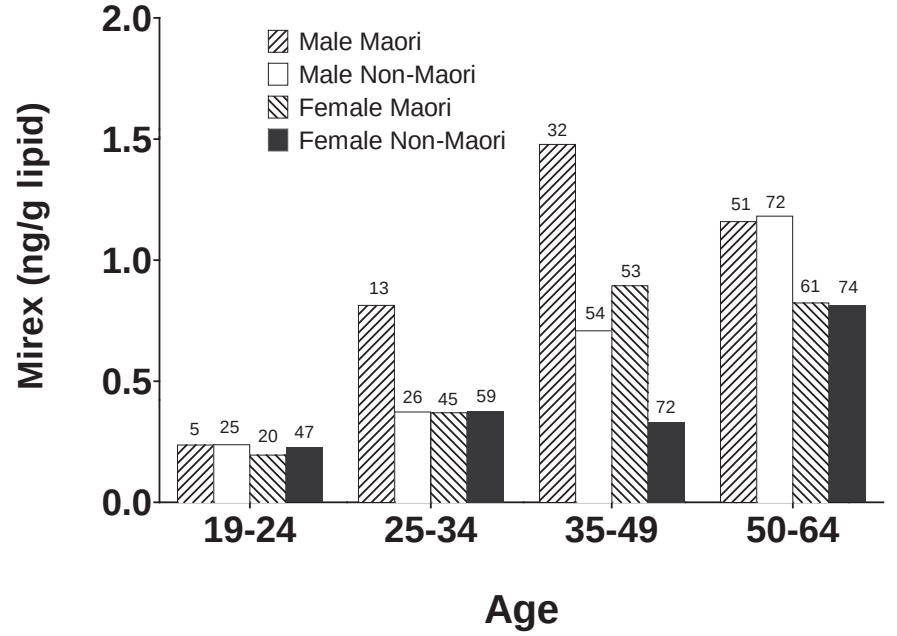


Figure 4.17. Concentrations of mirex in serum. Numbers above bars are individuals in the result.

4.5. Brominated flame retardants (BFRs)

Summary data for concentrations of BFRs in serum are provided Table 4.14. Detailed data for all strata are included in Appendix C.

Table 4.14. Concentrations of BFRs in serum (pg/g lipid)

	Detection Frequency	N pools	Minimum	Maximum	Weighted Mean	SD
BDE7	0%	49	(1.14)	(20.60)	(6.06)	(0.62)
BDE15	100%	49	20.70	101.00	47.38	2.41
BDE17	18%	49	0.52	74.30	8.41	1.74
BDE28/33	100%	49	63.20	282.00	120.45	5.25
BDE30	31%	49	3.54	76.80	16.64	2.45
BDE47	100%	49	1000.00	6710.00	2151.11	133.17
BDE49	98%	49	3.38	209.00	50.30	4.81
BDE66	86%	49	4.61	102.00	25.65	2.35
BDE71	0%	49	(1.27)	(15.30)	(5.56)	(0.45)
BDE77	2%	49	0.88	12.50	4.13	0.33
BDE85	94%	49	7.15	1140.00	61.60	20.68
BDE99	100%	49	311.00	20000.00	1020.05	362.94
BDE100	100%	49	199.00	3150.00	492.08	57.00
BDE119/120	0%	49	(2.01)	(33.30)	(6.35)	(0.63)
BDE126	2%	49	1.56	9.25	5.13	0.29
BDE138/166	10%	49	5.10	228.00	19.21	4.46
BDE139	45%	49	4.85	212.00	22.95	4.60
BDE140	10%	49	4.40	49.00	10.32	0.91
BDE153	100%	49	738.00	6490.00	1335.61	84.82
BDE154	98%	49	6.00	1780.00	121.52	32.08
BDE156/169	0%	49	(2.29)	(28.10)	(11.35)	(0.75)
BDE171	16%	49	7.95	82.40	23.16	2.39
BDE180	14%	49	4.84	111.00	25.20	3.01
BDE183/175	100%	49	78.40	1780.00	314.57	55.65
BDE184	59%	49	4.48	42.80	16.99	1.53
BDE191	0%	49	(5.05)	(30.60)	(16.96)	(0.82)
BDE196	80%	49	25.30	368.00	121.15	11.62
BDE197	100%	49	400.00	1560.00	771.68	44.27
BDE201	100%	49	84.50	297.00	160.57	7.34
BDE203	84%	49	32.00	484.00	174.86	14.79
BDE204	0%	49	(10.10)	(118.00)	(35.82)	(2.46)
BDE205	0%	49	(22.40)	(156.00)	(73.06)	(4.84)
BDE206	95%	42	106.00	646.00	319.95	17.14
BDE207	100%	42	497.00	1780.00	933.57	40.34
BDE208	100%	42	169.00	946.00	375.80	24.57
BDE209	100%	42	2100.00	6920.00	3573.61	186.99
PBEB	6%	49	0.89	10.10	4.12	0.25
HBB	41%	49	9.10	52.70	20.98	1.32
BB153	100%	49	114.00	2170.00	489.37	39.58
DBDPE	0%	9	(1095.00)	(3045.00)	(2074.25)	(92.80)

For congeners with a detection frequency of 0% the summary statistics are placed between brackets, because they merely reflect the limit of detection divided by 2, and SD values are not reported. There are differences in N pools for different analytes because a reliable result could not be produced by the laboratory for some pooled samples.

Of the 40 tested BFRs, twenty-one (21) were present in greater than 50% of pooled samples. BDE7, BDE71, BDE119/120, BDE156/169, BDE191, BDE204, BDE205, and DBDPE were not detected in any of the samples. Following tables in this section only provide data for those BFRs with detection frequency greater than 50%.

The mean concentrations of BFRs for each age group in the study are shown in Table 4.15. For many of the BDE congeners, the highest concentrations were observed for the youngest age group. The steepest negative age-gradient was observed for BDE49, for which the concentrations in the 19-24 age-group were 3.0 times higher compared to the mean concentration of the 50-64 age group (Figure 4.18). For most other BDE congeners the concentrations of the youngest age group were between 1 and 2 times the concentration on the oldest age group, and this age pattern was consistent for both males and females and Māori and non-Māori. In contrast, for BB153 a positive age-gradient was observed, with those in the 50-64 age group having 2.5 times higher concentrations compared to the 19-24 year age group (Figure 4.19).

Table 4.15. Concentrations of BFRs in serum, by age (pg/g lipid)

Weighted mean	**19-24 yrs.**	**25-34 yrs.**	**35-49 yrs.**	**50-64 yrs.**
N pools	**7**	**10**	**16**	**16**
BDE15	38.70	41.8	46.18	55.34
BDE28/33	143.52	114.48	122.22	113.62
BDE47	3117.42	2498.06	1968.82	1798.03
BDE49	73.34	62.58	58.92	24.50
BDE66	35.20	34.83	25.53	16.73
BDE85	76.00	126.87	41.64	39.76
BDE99	1320.11	2342.88	576.77	619.02
BDE100	667.37	650.23	439.5	392.75
BDE153	1228.17	1232.45	1520.40	1224.19
BDE154	146.89	221.18	83.81	95.28
BDE183/175	161.50	200.94	518.76	203.81
BDE184	18.62	16.43	20.78	12.35
BDE196	164.23	109.59	145.42	84.45
BDE197	715.95	755.48	847.91	713.9
BDE201	192.90	166.76	163.86	141.23
BDE203	224.16	154.66	213.3	124.76
BDE206	441.89	346.12	349.30[T]	196.47[T]
BDE207	1171.46	968.72	948.37[T]	760.36[T]
BDE208	534.51	343.63	421.77[T]	262.56[T]
BDE209	4254.72	3560.35	4021.21[T]	2661.46[T]
BB153	271	239.71	528.75	675.21

T – N pools equals 14 and 11 for the 35-49 and 50-64 years age groups, respectively. Some results for these age groups were not reported because of anomalies in blank concentrations.

The mean concentrations of BFRs for each region in the study are shown in Table 4.16. These data show no apparent region-related trends for BFRs.

Table 4.16. Concentrations of BFRs in serum, by region (pg/g lipid)

Weighted mean	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island
N pools	**8**	**8**	**8**	**8**
BDE15	55.47	54.81	60.45	32.74
BDE28/33	116.83	115.81	138.83	105.23
BDE47	1723.58	1590.9	2428.68	1882.22
BDE49	54.63	49.08	41.05	24.83
BDE66	22.05	21.19	26.94	16.41
BDE85	44.55	30.46	42.44	41.58
BDE99	600.81	519.43	683.8	573.72
BDE100	412.77	379.98	511.89	375.16
BDE153	1611.98	1292.15	1230.53	1266.41
BDE154	99.98	68.38	99.43	80.97
BDE183/175	439.69	174.36	267.06	505.77
BDE184	20.66	12.64	17.33	14.44
BDE196	137.89	88.15	95.81	126.88
BDE197	862.45	649.82	733.59	820.42
BDE201	170.92	147.4	152.78	134.83
BDE203	220.31	154.66	129.33	155.39
BDE206	298.97[T]	298.07	246.46	221.07[T]
BDE207	884.43[T]	904.3	802.07	872.33[T]
BDE208	368.01[T]	398.45	283.18	382.17[T]
BDE209	3557.36[T]	3722.64	2860.91	4544.73[T]
BB153	499.35	683.55	743.82	546.98

T – N pools equals 6 and 3 for the Northland/Auckland and South Island region groups, respectively. Some results for these regions were not reported because of anomalies in blank concentrations. Only data from the 2 oldest age groups (35-64 years) are included in this table because several of the strata in the younger age groups (19-34 years) were combined due to low numbers of study participants.

The mean concentrations of BFRs for gender/ethnicity combinations are shown in Table 4.17. There is a general pattern of marginally higher concentrations in males compared to females. On average (over all congeners), concentrations for Māori males are 1.4 times the concentrations of Māori females. For non-Māori this gender difference is 1.3-fold.

Table 4.17. Concentrations of BFRs in serum, by ethnicity and gender (pg/g lipid)

Weighted mean	Male Māori	Male Non-Māori	Female Māori	Female Non-Māori
N pools	**10**	**10**	**13**	**16**
BDE15	50.02	46.97	42.3	48.31
BDE28/33	146.58	124.01	139.99	109.37
BDE47	2652.45	2189.71	2425.46	1984.82
BDE49	83.95	39.62	46.89	55.63
BDE66	43.43	22.21	25.52	26.09
BDE85	79.45	38.01	62.33	80.73
BDE99	1463.36	675.5	805	1312.56
BDE100	734.70	436.63	487.06	506.63
BDE153	1877.88	1526.62	928.64	1147.12
BDE154	157.76	92.13	111.92	145.09
BDE183/175	227.84	512.96	225.80	159.16
BDE184	20.99	22.37	12.75	12.10
BDE196	138.18	159.99	112.15	83.81
BDE197	889.92	1004.64	612.60	564.68
BDE201	185.82	189.97	136.51	133.57
BDE203	232.94	226.04	119.36	128.14
BDE206	361.43[T]	325.78[T]	316.70[T]	307.99[T]
BDE207	1004.83[T]	1031.71[T]	843.69[T]	848.91[T]
BDE208	411.30[T]	421.28[T]	354.07[T]	331.86[T]
BDE209	4218.74[T]	3856.16[T]	4108.10[T]	3083.04[T]
BB153	660.62	550.13	444.33	413.89

T – N pools equals 8, 8, 12, and 14 for the Male Māori, Male Non-Māori, Female Māori, and Female Non-Māori groups, respectively. Some results for these gender/ethnicity groups were not reported because of anomalies in blank concentrations.

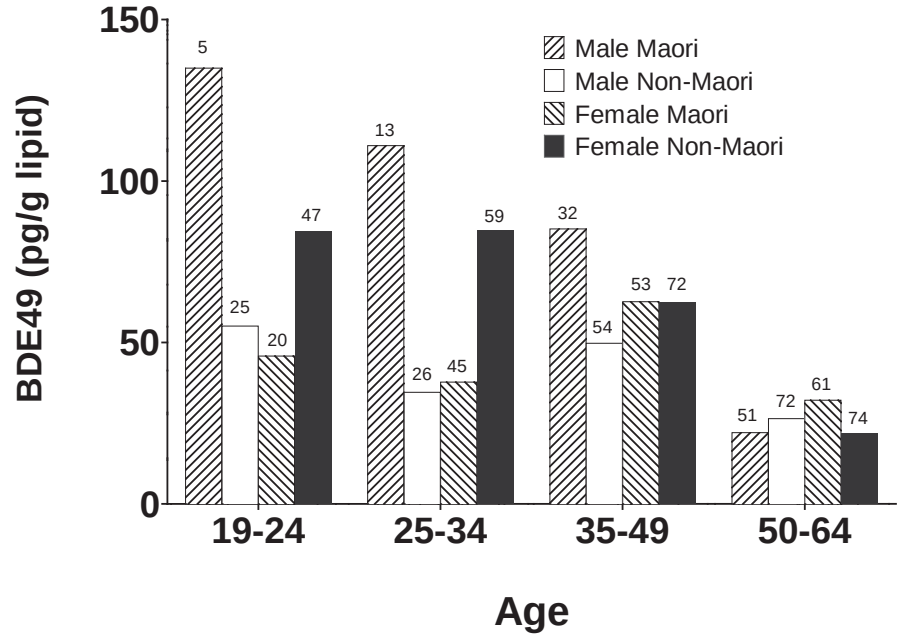


Figure 4.18. Concentrations of BDE49 in serum. Numbers above bars are individuals in the result.

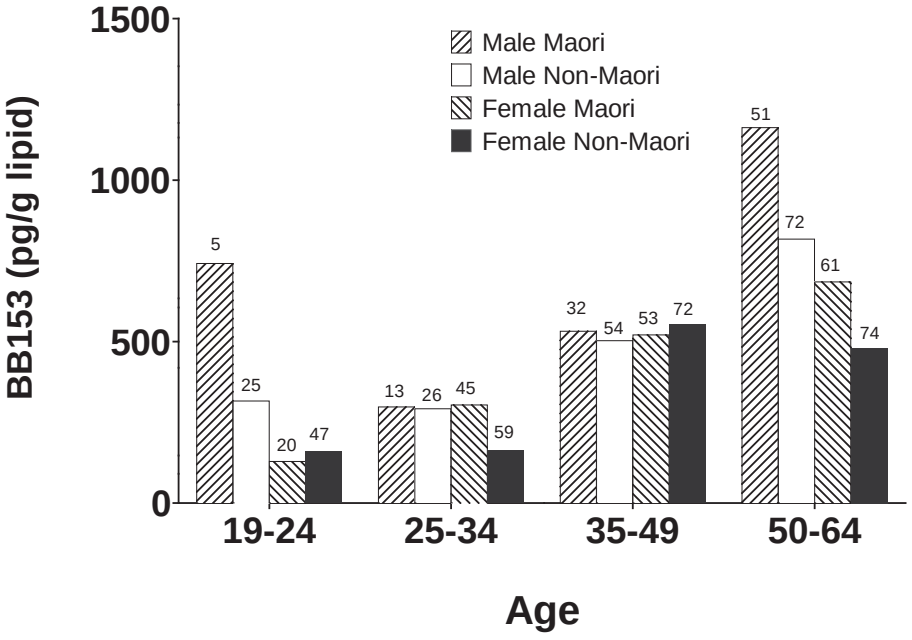


Figure 4.19. Concentrations of BB153 in serum. Numbers above bars are individuals in the result.

4.6. Perfluorinated compounds (PFCs)

Summary data for concentrations of PFCs that were detected in serum are provided in Table 4.18. Detailed data for all strata are included in Appendix C.

Table 4.18. Concentrations of PFCs in serum, (ng/mL)

N = 63 pools					
	Detection frequency	**Minimum**	**Maximum**	**Weighted mean**	**SD**
PFHxS	84%	0.25	3.47	1.24	0.10
PFOS	100%	1.73	7.19	3.59	0.15
PFOA	100%	1.53	4.20	2.51	0.09
PFNA	87%	0.25	1.34	0.69	0.02

Only four PFCs were detected in the serum samples – PFHxS, PFOS, PFOA, and PFNA. The following PFCs were not detected in any of the samples: PFDS, PFHxA, PFHpA, PFUnA, PFDoA, PFTrDA, PFTeDA, PFOSA, and NEtFOSAA (with a limit of detection of 0.5 ng/mL). PFDA and NMeFOSAA were each detected in one sample only (separate samples) at concentrations of 0.51 ng/mL and 0.59 ng/mL respectively. PFOS and PFOA were present at the highest mean concentrations of the four detected PFCs.

The mean concentrations of PFCs for each age group in the study are shown in Table 4.19. These data suggest marginally higher PFC concentrations in the higher age groups, particularly in the 50-64 age group, compared to the younger age groups (for example see Figure 4.21). On average the 50-64 year age group have 1.4 times higher concentrations of PFCs compared to the 19-24 year age group.

Table 4.19. Concentrations of PFCs in serum, by age (ng/mL)

Age	**19-24 yrs.**	**25-34 yrs.**	**35-49 yrs.**	**50-64 yrs.**
N pools	**15**	**16**	**16**	**16**
PFHxS	1.08	0.90	1.25	1.50
PFOS	3.04	3.12	3.40	4.31
PFOA	2.24	2.28	2.39	2.88
PFNA	0.56	0.63	0.63	0.83

The mean concentrations of PFCs for each of the study regions are shown in Table 4.20. These data suggest marginally higher concentrations of PFOS, PFOA, and PFNA in the Northland/Auckland and Waikato/Bay of Plenty regions, but this pattern is not consistent for Māori/non-Māori and males/females (Appendix C6).

Table 4.20. Concentrations of PFCs in serum, by region (ng/mL)

Region	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island
N pools	**16**	**16**	**16**	**15**
PFHxS	1.27	1.18	0.99	1.46
PFOS	3.68	4.04	3.41	3.32
PFOA	2.61	2.65	2.39	2.37
PFNA	0.72	0.75	0.65	0.62

The mean concentrations of PFCs for each ethnicity/gender combination are shown in Table 4.21. These data suggest that PFC concentrations are marginally higher in males compared to females. This pattern was observed for both Māori and non-Māori and for most age groups, suggesting that this gender difference is a consistent finding. For PFHxS the difference in concentrations between males and females is 1.4-fold for Māori and 2.1-fold for non-Māori (Figure 4.20). For PFOS, the difference in concentrations between males and females is 1.4-fold for both Māori and non-Māori (Figure 4.21). For PFOA the difference in concentrations between males and females is 1.3-fold for Māori and 1.4-fold for non-Māori (Figure 4.22). For PFNA the difference in concentrations between males and females is 1.1-fold for both Māori and non-Māori (Figure 4.23). No consistent difference in PFC concentrations was observed between Māori and non-Māori.

Table 4.21. Concentrations of PFCs in serum, by ethnicity and gender (ng/mL)

	Male Māori	Male Non-Māori	Female Māori	Female Non-Māori
N pools	**15**	**16**	**16**	**16**
PFHxS	0.97	1.82	0.67	0.85
PFOS	4.22	4.23	3.03	3.00
PFOA	2.80	2.98	2.10	2.10
PFNA	0.71	0.74	0.64	0.65

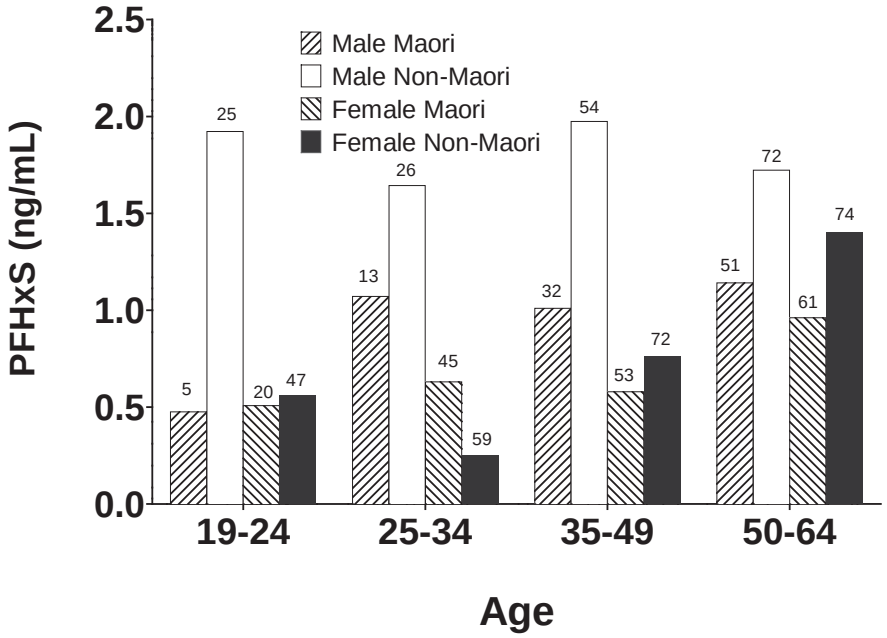


Figure 4.20. Concentrations of PFHxS in serum. Numbers above bars are individuals in the result.

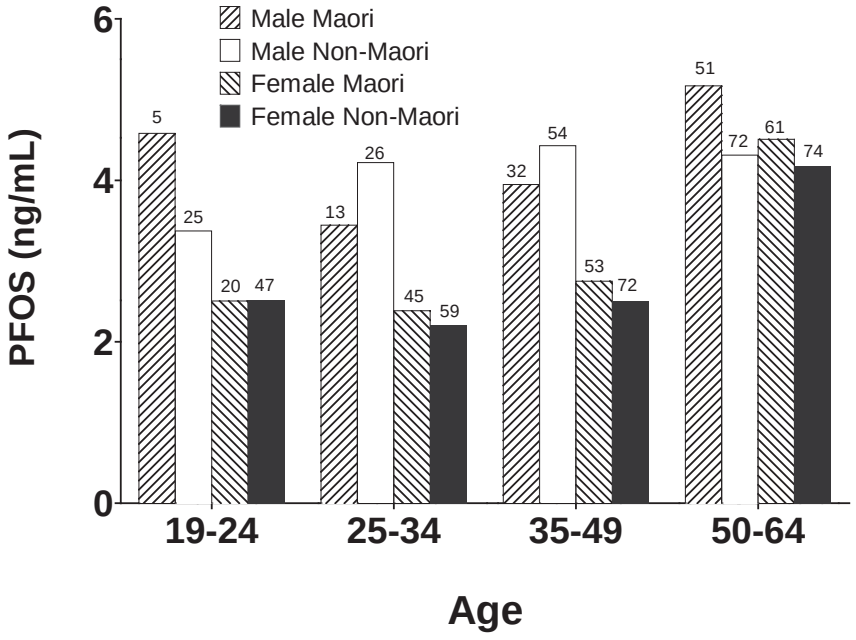


Figure 4.21. Concentrations of PFOS in serum. Numbers above bars are individuals in the result.

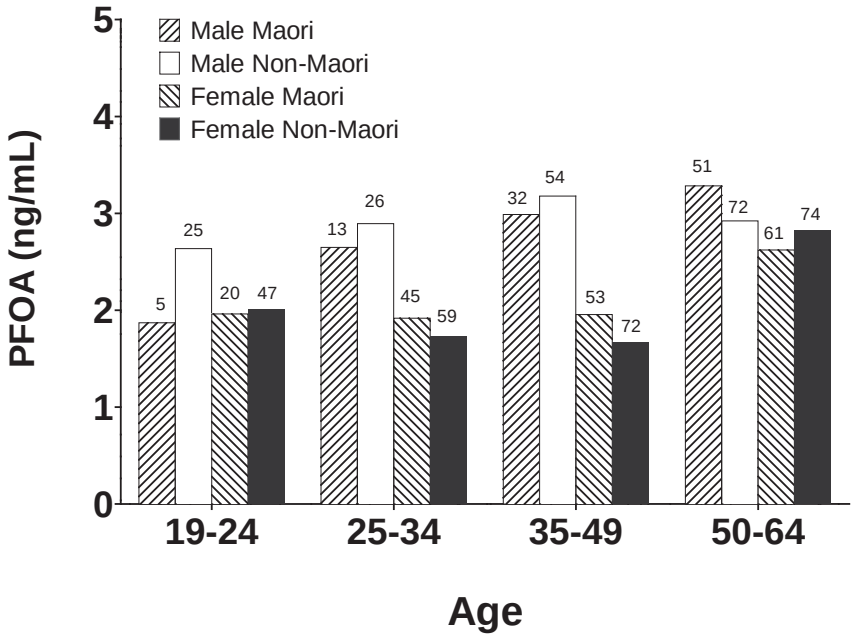


Figure 4.22. Concentrations of PFOA in serum. Numbers above bars are individuals in the result.

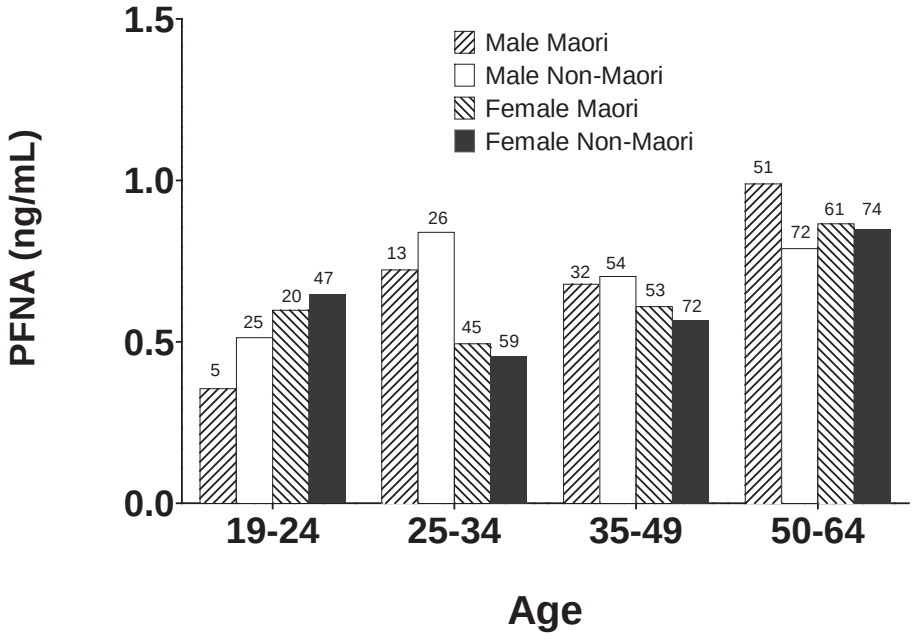


Figure 4.23. Concentrations of PFNA in serum. Numbers above bars are individuals in the result.

4.7. Laboratory QA/QC results

4.7.1. Duplicate and replicate samples

Coefficients of variation (CV) were calculated for replicate (same stratum, different individuals) and duplicate samples (same pooled sample split in two samples) included as part the laboratory analysis (see Table 3.1 for details) and are presented for each analyte in Table 4.22 to 4.26. Congeners for which both a replicate and duplicate CV could not be calculated (e.g. if one of the duplicate or replicate pairs were not detected) are excluded from the tables.

CVs were calculated using the following formula:

$$\textit{Coefficient of Variation (CV)} = \textit{Standard deviation } (\sigma) / \textit{ mean } (\mu)$$

The calculated CVs provide an indication of the probability that two measurements from the same sample (duplicates and replicates) are different because of assay variability or a true difference [100]. Mean CVs for each analyte group (PCDD/F, PCB, BFR, OCP, PFCs) are presented as an indicator of the overall agreement of replicate and duplicate samples for analyte groups.

The analytical error was modest as suggested by the mean CV values of 3-11% for duplicate samples (Tables 4.22 to 4.26). Analyses of samples from the same stratum, but from different individuals showed some intra stratum variance (i.e. mean CV values ranged from 7-30%; Tables 4.22 to 4.26) with the greatest observed variance for the BDEs. This is consistent with the highly variable concentrations of BDEs in the general population compared to other compound groups.

Table 4.22. Coefficient of variation (CV) for PCDD/F

	Reported value	Duplicate value	Duplicate CV	Reported value	Replicate value	Replicate CV
Units	**pg/g**	**pg/g**		**pg/g**	**pg/g**	
2,3,7,8-TCDD	1.3	1.12	10.5%	3.15	2.48	16.8%
1,2,3,7,8-PeCDD	2.72	2.80	2.05%	4.76	3.63	19.0%
1,2,3,4,7,8-HxCDD	1.26	1.19	4.04%	3.71	2.00	42.4%
1,2,3,6,7,8-HxCDD	9.85	8.10	13.8%	20.3	8.37	58.8%
1,2,3,7,8,9-HxCDD	1.65	2.12	17.6%	2.46	1.64	28.3%
1,2,3,4,6,7,8-HpCDD	18.3	15.9	9.90%	24.9	17.7	23.9%
OCDD	168	163	2.10%	263	149	39.1%
2,3,4,7,8-PeCDF	3.33	3.46	2.70%	4.44	4.81	5.66%
1,2,3,4,7,8-HxCDF	1.5	0.977	29.9%	2.24	2.28	1.25%
1,2,3,6,7,8-HxCDF	1.49	1.52	1.40%	3.35	2.26	27.5%
2,3,4,6,7,8-HxCDF	ND	ND	-	0.896	1.01	8.46%
1,2,3,4,6,7,8-HpCDF	2.47	2.46	0.287%	2.81	3.14	7.84%
Mean CV PCDD/F			8.6%			23.3%

ND – not detected

Table 4.23. Coefficient of variation (CV) for PCBs

	Reported value	Duplicate value	Duplicate CV	Reported value	Replicate value	Replicate CV
Units	**pg/g**	**pg/g**		**pg/g**	**pg/g**	
PCB1	15.8	17.1	5.59%	17.4	18.1	2.79%
PCB3	17.7	20	8.63%	19.7	24.4	15.1%
PCB4/10	31	30.8	0.458%	ND	ND	-
PCB28	835	864	2.41%	1190	935	17.0%
PCB44	34.6	36.8	4.36%	63.2	55.2	9.56%
PCB49	ND	22.8	-	77.1	39.2	46.1%
PCB52	94.5	106	8.11%	213	152	23.6%
PCB70	27.8	31.5	8.82%	54.5	51.7	3.73%
PCB74	2200	2120	2.62%	2350	1600	26.9%
PCB99	1030	993	2.59%	1330	764	38.2%
PCB101	96.6	108	7.88%	276	132	49.9%
PCB105	586	524	7.90%	664	328	47.9%
PCB110	47.2	43.2	6.26%	138	53.4	62.5%
PCB114	229	204	8.17%	227	155	26.7%
PCB118	3020	2840	4.34%	3430	2020	36.6%
PCB123	36.9	26.1	24.2%	48	34.2	23.7%
PCB126	15.6	20.9	20.5%	19.2	15.9	13.3%
PCB138/163/164	12700	13100	2.19%	15800	9580	34.7%
PCB153	18200	19000	3.04%	21500	14600	27.0%
PCB156	2560	2550	0.28%	2940	2120	22.9%
PCB157	492	473	2.78%	560	430	18.6%
PCB167	742	811	6.28%	910	634	25.3%
PCB169	16.0	ND	-	21.0	22.1	3.61%
PCB170	6180	6160	0.229%	7790	6130	16.9%
PCB180	19100	18100	3.80%	22300	19800	8.40%
PCB183	1190	1160	1.81%	1330	1020	18.7%
PCB187	4030	3870	2.86%	4500	3640	14.9%
PCB189	320	338	3.87%	409	372	6.70%
PCB194	4080	3740	6.15%	3720	4400	11.8%
PCB196/203	2820	2680	3.60%	2440	2780	9.21%
PCB202	487	457	4.49%	387	452	11.0%
PCB205	83.9	73.7	9.15%	98.1	74.5	19.3%
PCB206	751	729	2.10%	523	658	16.2%
PCB208	260	254	1.65%	147	253	37.5%
PCB209	414	411	0.514%	306	584	44.2%
Mean CV PCBs			5.39%			23.2%

ND – not detected

Table 4.24. Coefficient of variation (CV) for OCPs

	Reported value	Duplicate value	Duplicate CV	Reported value	Replicate value	Replicate CV
Units	**ng/g**	**ng/g**		**ng/g**	**ng/g**	
beta-HCH	3.73	3.73	0	4.77	6.21	18.5%
PeCB	0.983	2.1	51.2%	0.495	0.701	24.4%
HCB	6.96	7.56	5.84%	9.51	10.5	7.00%
Dieldrin	5.45	4.41	14.9%	4.66	5.32	9.35%
p,p'-DDT	2.41	2.4	0.294%	3.46	1.7	48.2%
p,p'-DDE	245	249	1.15%	473	353	20.5%
Mirex	0.415	0.384	5.49%	0.524	0.575	6.56%
Mean CV OCPs			11.3%			19.2%

Table 4.25. Coefficient of variation (CV) for BFRs

	Reported value	Duplicate value	Duplicate CV	Reported value	Replicate value	Replicate CV
Units	**pg/g**	**pg/g**		**pg/g**	**pg/g**	
BDE15	59.4	55.5	4.80%	45.7	39.4	10.5%
BDE28/33	76.5	79.3	2.54%	63.2	105	35.1%
BDE47	1370	1310	3.17%	1000	2200	53.0%
BDE49	22.7	37.8	35.3%	23.7	39	34.5%
BDE85	27.4	32.2	11.4%	27.8	51.5	42.3%
BDE99	513	466	6.79%	334	648	45.2%
BDE100	348	332	3.33%	199	434	52.5%
BDE153	940	866	5.79%	1880	811	56.2%
BDE154	86.4	88.5	1.70%	ND	78.4	-
BDE183/175	114	96.9	11.5%	129	131	1.09%
BDE196	75.1	73.1	1.91%	ND	ND	-
BDE197	476	405	11.4%	479	439	6.16%
BDE201	112	92.4	13.6%	84.5	102	13.3%
BDE203	97.6	130	20.1%	ND	106	-
BDE206	209	193	5.63%	106	ND	-
BDE207	638	647	0.990%	634	ND	-
BDE208	226	248	6.56%	234	ND	-
BDE209	2270	2240	0.941%	2100	ND	-
BB153	503	538	4.75%	638	509	15.9%
HBB	20.3	21.9	5.36%	ND	ND	-
Mean CV BFRs			7.88%			30.5%

ND – not detected

Table 4.26. Coefficient of variation (CV) for PFCs

	Report. value 1	Dup. value 1	Dup. CV 1	Report. value 2	Dup. value 2	Dup. CV 2	Report value	Rep. value	Rep. CV
Units	**ng/mL**	**ng/mL**		**ng/mL**	**ng/mL**		**ng/mL**	**ng/mL**	
PFHxS	1.07	1.17	5.95%	0.673	0.677	0.45%	0.617	0.690	7.93%
PFOS	2.56	2.64	2.30%	3.41	3.39	0.47%	3.44	3.22	4.64%
PFOA	1.95	1.90	1.91%	2.96	2.59	9.25%	2.17	2.68	14.8%
PFNA	0.571	0.566	0.577%	0.964	0.921	3.17%	0.742	0.706	3.56%
Mean			2.68%			3.33%			7.73%

4.7.2. Laboratory blanks and bovine serum blanks

A laboratory blank was included with each batch of 10 to 15 study serum samples during laboratory analysis and results are reported in Appendix C. Serum sample results were not blank-adjusted. As an arbitrary guideline, measured serum concentrations less than 3 times the average laboratory blank concentration were flagged and the percentage of serum concentrations below 3 times the average blank concentration was determined for each analyte. The analytes for which the percentage of serum levels below 3 times blank levels exceeded 25% are included in Table 4.27. This includes only those analytes for which at least one blank sample was above the limit of the detection, and for which at least 50% of the serum samples had concentrations above the limit of detection.

Table 4.27. Comparison of serum concentrations to laboratory blank concentrations

Analyte	Average lab blank (pg/g)	% < 3 x lab blank
2,3,7,8-TCDF	0.41	86%
PCB1	24.09	100%
PCB3	29.47	100%
PCB4/10	40.81	100%
PCB44	28.55	88%
PCB49	20.71	94%
PCB52	65.20	86%
PCB70	32.79	100%
PCB101	41.93	57%
PCB110	25.14	82%
PeCB	1290.00	100%
BDE209	954.38	30%

The results for the analytes in Table 4.27 with a high percentage (e.g. >30%) of serum levels below 3 times blank levels will need to be regarded as relatively uncertain, as this is an indication that contamination is likely to have contributed to imprecision. Particularly high blank concentrations were observed for PeCB and BDE209.

Potential contamination is particularly an issue for BDE209, given the high indoor dust concentrations for this compound [70]. One laboratory blank showed anomalously high concentrations of BDE209, therefore laboratory results were not reported for BDE209, BDE208, BDE207, and BDE206 for 8 samples. It should also be noted that there are analytical challenges

associated with BDE209 related to thermal stability of this congener, photolytic degradation, and potential contamination from BDE209 associated with dust in the laboratory environment [101-103]. Therefore, there may be relatively high uncertainty associated with the reported BDE209 concentrations for pooled serum samples in this study, compared to the results presented for other analytes.

The possibility of contamination during sample handling can be studied through comparing concentration in bovine serum handled and stored in the same way as the human serum samples (method blanks), with unprepared bovine serum (bovine blanks).

Coefficients of variation (CV) and normalised difference values for comparison of method blank and bovine blank samples are presented in Tables 4.28 to 4.30. PFCs were not detected in either method blanks or bovine blanks and are not reported. Normalised difference was calculated according to the equation:

Normalised difference (ND) = (value a – value b)/(value a + value b)*2*100%.

If contamination occurred during sample handling and storage one would expect higher method blank concentrations compared to bovine blank concentrations. Table 4.28 to 4.30 do not indicate consistent higher method blank concentrations compared to bovine blank concentrations.

Table 4.28. Comparison of method and bovine blanks for PCDD/F and PCBs

	Method blank	Bovine blank	CV	Normalised difference
Analyte	**pg/g lipid**	**pg/g lipid**		
OCDD	6.22	7.08	-9.14%	-12.9%
PCB1	32.3	30.6	+3.82%	+5.41%
PCB3	32.9	29.1	+8.67%	+12.3%
PCB4/10	60.7	61	-0.35%	-0.49%
PCB28	41.1	89.6	-52.5%	-74.2%
PCB52	51.8	62.2	-12.9%	-18.2%
PCB70	34.2	38.3	-8%	-11.3%
PCB101	41.2	26.5	+30.7%	+43.4%
PCB110	26.6	20.5	+18.3%	+25.9%
PCB118	26.8	29	-5.58%	-7.89%
PCB138/163/164	32.9	53.6	-33.8%	-47.9%
PCB153	48.6	72.1	-27.5%	-38.9%
PCB180	22.6	25.2	-7.69%	-10.9%

Table 4.29. Comparison of method and bovine blanks for OCPs

	Method blank	Bovine blank		
Analyte	**ng/g lipid**	**ng/g lipid**	**CV**	**Normalised difference**
PeCB	0.761	0.872	-9.61%	-13.6%
HCB	0.681	0.681	0%	0%
p,p-DDE	1.19	1.2	-0.59%	-0.84%

Table 4.30. Comparison of method and bovine blanks for BFRs

	Method blank	Bovine blank		
Analyte	pg/g	pg/g	CV	Normalised difference
BDE28/3 3	40.9	15	+66%	+93%
BDE47	319	272	+11.2%	+15.9%
BDE49	121	21.7	+98.4%	+139%
BDE99	308	176	+38.6%	+54.5%
BDE100	52	35.9	+26%	+37%
BDE153	55.3	163	-69.8%	-98.7%
BDE154	36.9	56.7	-29.9%	-42.3%
BDE183/175	19.9	239	-120%	-169%
BDE206	107	98.4	+5.92%	+8.37%
BDE207	155	126	+14.6%	+20.6%
BDE208	129	81.8	+31.7%	+44.8%
BDE209	938	1280	-21.8%	-30.8%
BB153	11	4.99	+53%	+75%

4.7.3. Inter-laboratory duplicates

Aliquots of the same pooled serum sample were analysed for the four compound groups by two different laboratories. Lab 2 in Tables 4.31 to 4.35 represents the New Zealand laboratory and Lab 1 represents the external laboratory. For PCDD/Fs the normalised difference ranged between 0% and +39%, with lab 1 generally reporting higher concentrations compared to lab 2. For PCBs, OCPs and PFCs the normalised difference ranged between -63% and +54% with no indication of one laboratory reporting consistently higher concentrations compared to the other. For PBDEs the normalised difference ranged between +19% to +90%, with lab 1 consistently reporting higher concentrations compared to lab 2.

This comparison indicates that the analytical results of the two different laboratories compare well, with normalised differences within the -50% and +50% range for the majority of analytes. It also indicates that the BDE serum concentrations reported by the New Zealand laboratory are consistently lower than those of the reference laboratory. Overall this inter-laboratory comparison indicates that less than a two-fold difference in reported serum concentrations could be attributable to laboratory differences alone, which needs to be taken into account when interpreting international differences in serum concentrations reported in chapter 5.

Table 4.31. Comparison of PCDD/F inter-laboratory duplicate samples

	Lab 1	Lab 2	
PCDD/F	Conc (pg/g lipid)	Conc (pg/g lipid)	Normalised difference
1,2,3,7,8-PeCDD	4.24	2.86	+38.8%
1,2,3,6,7,8-HxCDD	12.37	12.4	-0.219%
1,2,3,7,8,9-HxCDD	2.88	2.05	+33.7%
1,2,3,4,6,7,8-HpCDD	19.3	18.3	+5.43%
OCDD	129	106	+19.8%
2,3,4,7,8-PeCDF	4.24	3.47	+19.9%
1,2,3,4,6,7,8-HpCDF	3.73	3.49	+6.62%

Table 4.32. Comparison of PCB inter-laboratory duplicate samples

	Lab 1	Lab 2	
PCB	**Conc (pg/g lipid)**	**Conc (pg/g lipid)**	**Normalised difference**
1	9.49	18.2	-62.9%
3	12.9	24.5	-62.2%
52	86.8	121	-32.9%
105	651	562	+14.7%
114	241	244	-1.37%
118	2932	2580	+12.8%
123	39.8	31.9	+22.1%
167	803	743	+7.81%
170	9288	7990	+15.0%
187	4203	4530	-7.48%
189	580	530	+8.95%
194	5475	5310	+3.05%
202	895	536	+50.2%
205	85.9	90.8	-5.51%
206	802	589	+30.6%
208	297	193	+42.3%
209	444	365	+19.5%

Table 4.33. Comparison of OCP inter-laboratory duplicate samples

	Lab 1	Lab 2	
OCP	**Conc (ng/g lipid)**	**Conc (ng/g lipid)**	**Normalised difference**
p,p'-DDT	5.49	2.53	+18.5%
Dieldrin	7.63	4.5	+12.9%
beta-HCH	2.63	7.23	-23.3%
trans-nonachlor	1.77	1.36	+6.54%

Table 4.34. Comparison of PBDE inter-laboratory duplicate samples

	Lab 1	Lab 2	
PBDE	**Conc (pg/g lipid)**	**Conc (pg/g lipid)**	**Normalised difference**
15	43.2	34.9	+21.3%
28/33	110	85.1	+25.5%
47	1256	1040	+18.8%
49	30.8	21.2	+37.1%
99	588	330	+56.2%
100	381	279	+31.0%
153	1273	917	+32.5%
154	79.0	56.9	+32.5%
203	273	219	+21.9%
206	598	226	+90.3%
207	1539	771	+66.5%
208	753	305	+84.6%
209	4000	3000	+28.6%

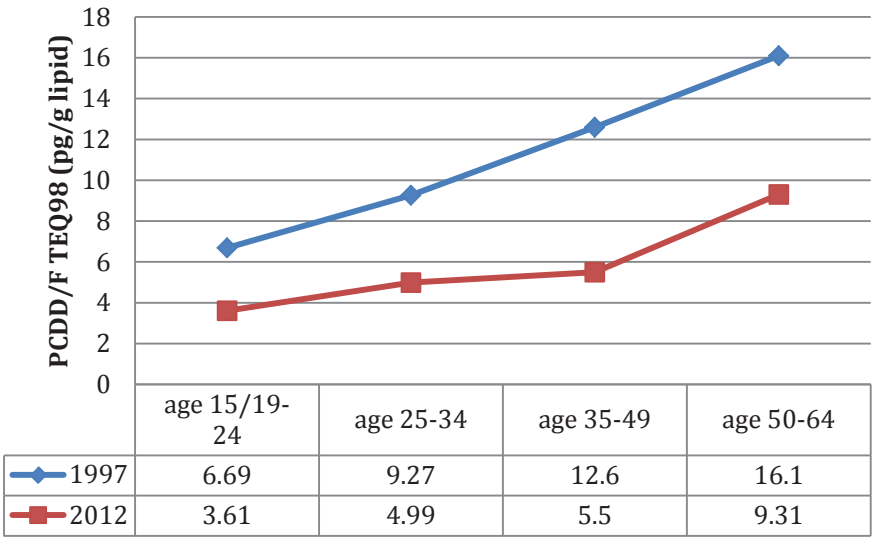
Table 4.35. Comparison of PFC inter-laboratory duplicate samples

	Lab 1	Lab 2	
PFC	**Conc. (ng/mL)**	**Conc. (ng/mL)**	**Normalised difference**
Sample 1			
PFHxS	1.03	1.36	-27.5%
PFOS	5.56	3.48	+46.1%
PFOA	2.09	2.53	-19.0%
PFNA	0.436	0.704	-47.1%
Sample 2			
PFHxS	1.21	1.96	-47.1%
PFOS	7.58	4.34	+54.3%
PFOA	2.77	3.08	-10.5%
PFNA	0.545	0.775	-34.9%

5. Comparison with previous studies

5.1. Comparison with the 2001 study results for PCDD/Fs, PCBs and OCPs

Comparisons of concentrations of dioxins, PCBs, and OCPs between the 2001 and current New Zealand serum studies are shown in Figure 5.1 to Figure 5.8. Because for many compounds concentration is associated with age and the age inclusions of the current study did not fully match the 2001 study, comparisons are made for the age-specific results. The data for the age-specific concentrations from the 2001 study were extracted from Tables 5.3, 5.7, and 5.11 of the 2001 study report [9]. The samples from the 2001 study were predominantly taken in 1997 and the samples of the current study were predominantly taken in 2012. The graphs therefore refer to 1997 and 2012 serum concentrations. The comparisons for the PCDD/Fs TEQ and PCB TEQ were based on the 1998 TEFs for both studies, because the 2001 study did not report 2005 TEQs.



	age 15/19-24	age 25-34	age 35-49	age 50-64
1997	6.69	9.27	12.6	16.1
2012	3.61	4.99	5.5	9.31

Figure 5.1. Comparison of PCDD/F serum concentrations between 2001 and current POPs studies (PCDD/F TEQ_{98})

Figure 5.1 shows that for all age groups, the PCDD/F TEQ has reduced by 49% on average (age weighted) during the 15 year period between studies. This equals an average reduction of 3% per year. By congener, the reduction over time was more substantial for the PCDDs compared to the PCDFs (see Table 5.1).

Table 5.1. Comparison of PCDD/F serum concentrations between 2001 and current POPs studies (age weighted average reduction).

Congener	Reduction between 1997 and 2012	Average reduction per year
2,3,7,8-TCDD	60%	4%
1,2,3,7,8-PeCDD	48%	3%
1,2,3,4,7,8-HxCDD	59%	4%
1,2,3,6,7,8-HxCDD	70%	5%
1,2,3,7,8,9-HxCDD	62%	4%
1,2,3,4,6,7,8-HpCDD	65%	4%
OCDD	65%	4%
2,3,4,7,8-PeCDF	23%	2%
1,2,3,4,7,8-HxCDF	21%	1%
1,2,3,6,7,8-HxCDF	29%	2%
2,3,4,6,7,8-HxCDF	45%	3%

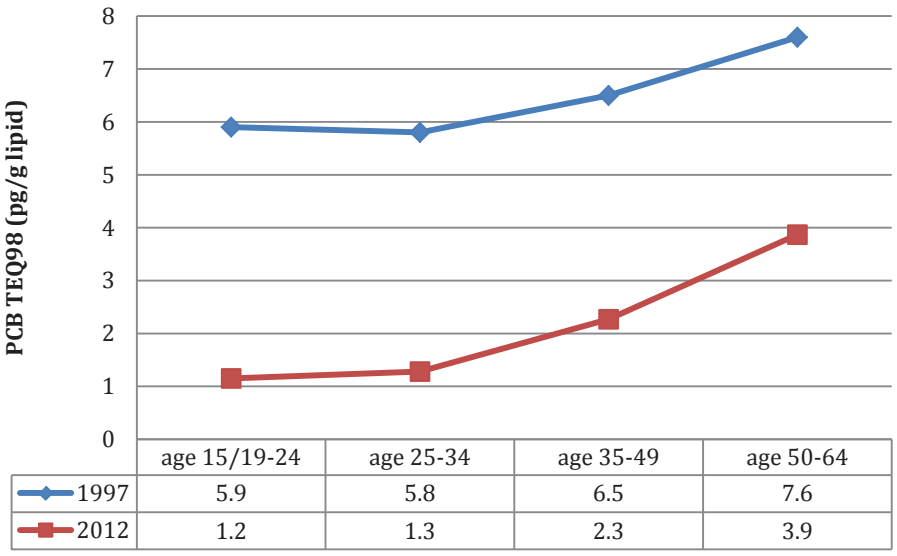
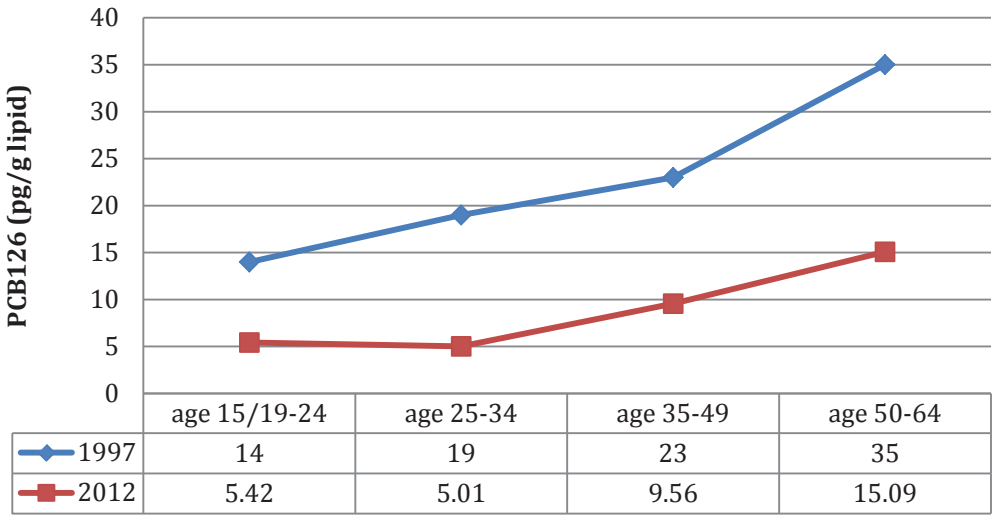


Figure 5.2. Comparison of PCBs serum concentrations between 2001 and current POPs studies (PCB TEQ_{98})

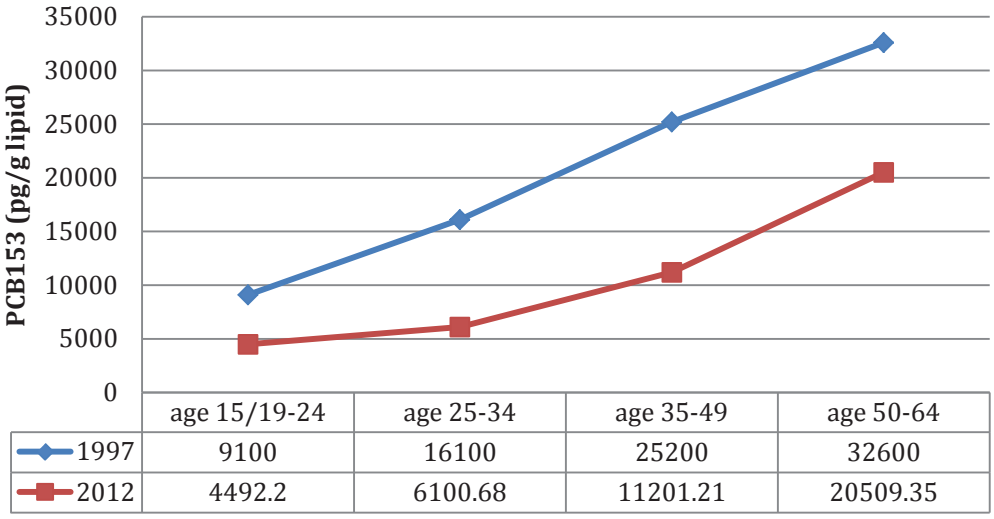
Figure 5.2 shows a substantial reduction in PCB TEQ for all age groups. The reduction was steepest for the youngest age group (81%), followed by the 25-34 year age group (78%), the 35-49 year age group (65%), and the 50-64 year age group (49%). The average age weighted reduction was 68% over a period of 15 years, which equals an average of 4% reduction in PCB TEQ per year.



	age 15/19-24	age 25-34	age 35-49	age 50-64
1997	14	19	23	35
2012	5.42	5.01	9.56	15.09

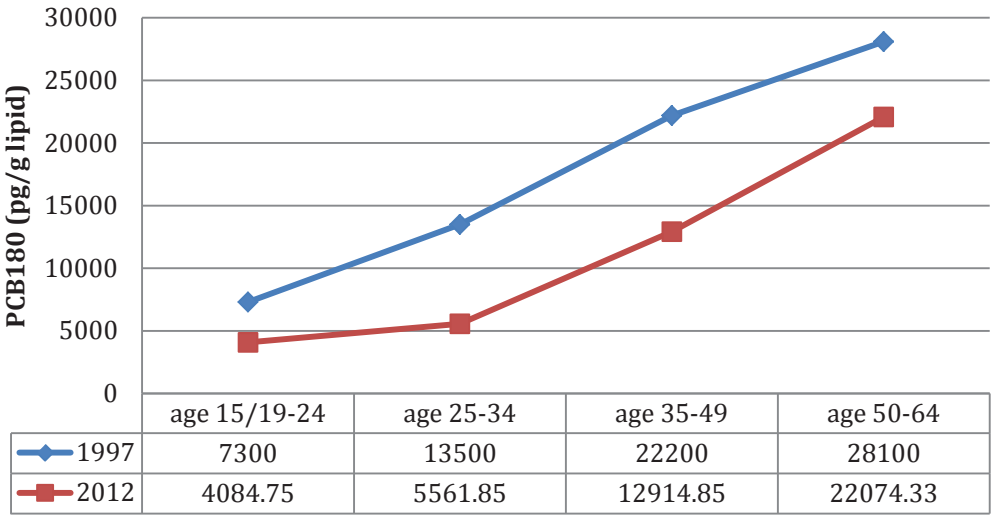
Figure 5.3. Comparison of PCB126 serum concentrations between 2001 and current POPs studies.

Figure 5.3 to Figure 5.5 show a similar substantial reduction in concentrations of PCB126, PCB153, and PCB180 for all age groups. The reduction for PCB126 was similar for all age groups, ranging from 57% for the oldest age group to 74% for the 25-34 age group. The reduction for PCB153 and PCB180 was similar for the 3 youngest ages groups (15/19-49 years) and was substantially less for the oldest age group for both PCB153 and PCB180 (37% and 21%). The average age weighted reduction was 61%, 50% and 39% for PCB126, PCB153 and PCB180 respectively, which equals an annual average reduction over 15 years of 4%, 3% and 3%.



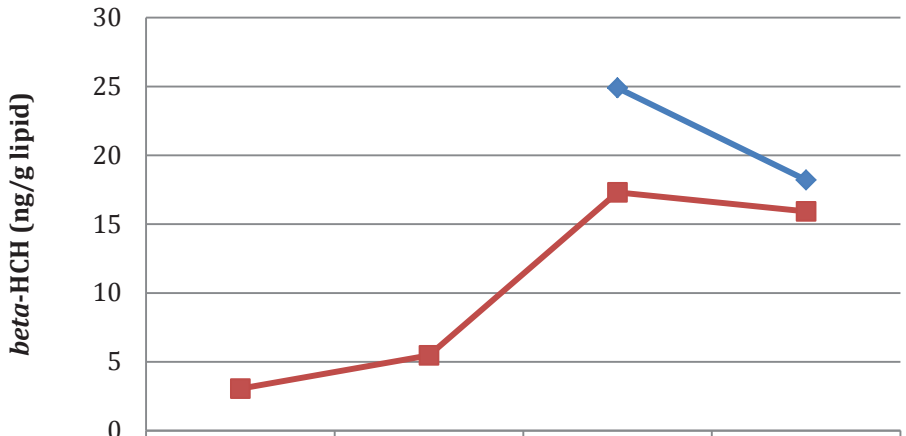
	age 15/19-24	age 25-34	age 35-49	age 50-64
1997	9100	16100	25200	32600
2012	4492.2	6100.68	11201.21	20509.35

Figure 5.4. Comparison of PCB153 serum concentrations between 2001 and current POPs studies.



	age 15/19-24	age 25-34	age 35-49	age 50-64
1997	7300	13500	22200	28100
2012	4084.75	5561.85	12914.85	22074.33

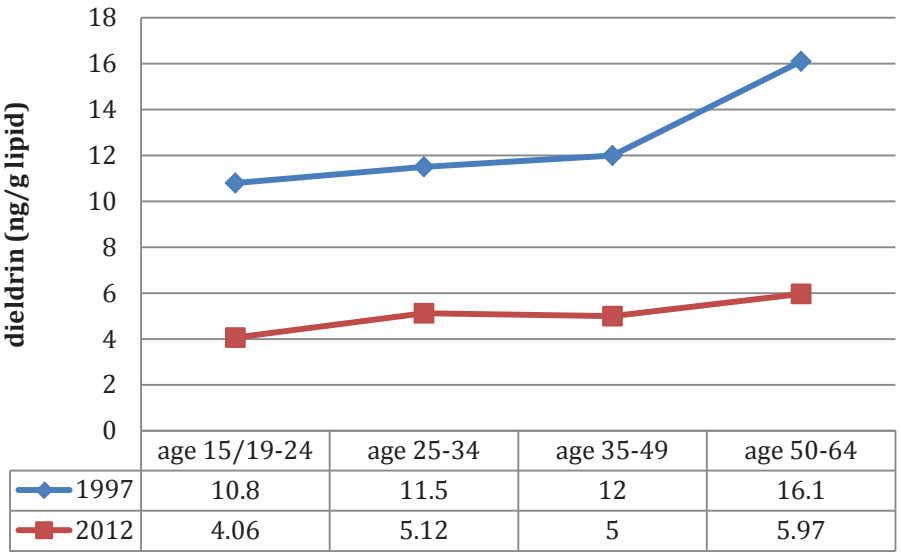
Figure 5.5. Comparison of PCB180 serum concentrations between 2001 and current POPs studies.



	age 15/19-24	age 25-34	age 35-49	age 50-64
1997			24.9	18.2
2012	3.06	5.47	17.31	15.93

Figure 5.6. Comparison of *beta*-HCH serum concentrations between 2001 and current POPs studies.

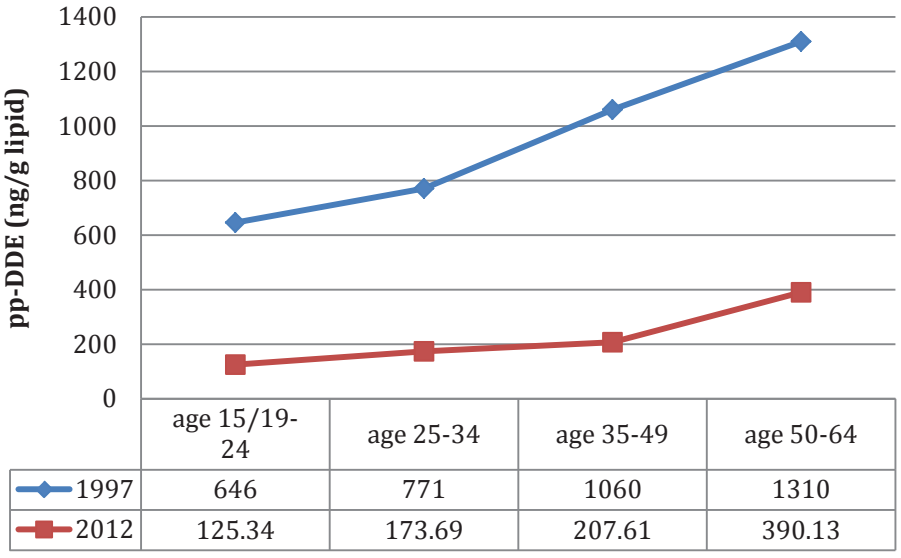
For *beta*-HCH the 2001 study did not report concentrations for the two youngest age groups, because it was detected in less than 66% of the pooled samples. The two oldest age groups indicate a reduction of 30% and 12% over a period of 15 years, an average of 1-2% per year.



	age 15/19-24	age 25-34	age 35-49	age 50-64
1997	10.8	11.5	12	16.1
2012	4.06	5.12	5	5.97

Figure 5.7. Comparison of dieldrin serum concentrations between 2001 and current POPs studies.

For dieldrin, a reduction in concentration was consistently observed for all age groups, with an average age weighted reduction of 60% over 15 years, which equals a yearly reduction of 4%.



	age 15/19-24	age 25-34	age 35-49	age 50-64
1997	646	771	1060	1310
2012	125.34	173.69	207.61	390.13

Figure 5.8. Comparison of *p,p'*-DDE serum concentrations between 2001 and current POPs studies.

For *p,p'*-DDE, a substantial reduction over 15 years was observed for all age groups (average age weighted reduction of 77%: a 5% reduction per year).

5.2. Comparison to 2001 Wellington study of PBDEs in serum

Concentrations of PBDEs were previously measured in serum of 23 donors in Wellington, New Zealand, collected in 2001 [66]. The age range of donors was 20 to 64 years of age. The results can be compared to the results of the current serum study for PBDEs as an indication of temporal trends of PBDEs in New Zealand (Table 5.2), however the results should be

interpreted with caution because of differences in the study population (i.e. the 2001 study only included a relatively small number of participants from Wellington corresponding to the Lower North Island region of the current study). In the current study we found no apparent region-related differences for PBDEs, which suggests that comparisons between the 2001 and current study can be made despite the differences in the study population. Results from the Lower North Island region of the study, which is most comparable to the results from the 2001 Wellington study, are also included in Table 5.2.

Table 5.2. Comparison with 2001 Wellington serum study.

Congener	2001 serum concentration (ng/g lipid)*	2011 – 2013 serum concentration (ng/g lipid) – All of New Zealand	2011 – 2013 serum concentration (ng/g lipid) – Lower North Island
BDE47	3.79	2.15	2.42
BDE99	0.91	1.02	0.68
BDE100	0.89	0.49	0.51
BDE153	1.21	1.34	1.23
BDE154	0.09	0.12	0.10
BDE183	0.34	0.31	0.27

* Reported as "upper bound" concentration where results below the analytical limit of detection (LOD) were assumed to be equal to the detection limit. Results from the current study use 0.5 x LOD for results below LOD.

The results in Table 5.2 indicate a marginal decrease in BDE47, BDE100, and BDE183 and no clear change in BDE99, BDE153, and BDE154 during the 11-year period 2001 to 2012 when compared to the New Zealand results. Overall, a clear pattern of any difference between the serum concentrations of the two studies could not be detected and therefore any firm conclusions about time trends for the New Zealand population cannot be made.

5.3. Comparison with international studies

Comparisons of concentrations of dioxins, PCBs, OCPs, BFRs, and PFCs between the current New Zealand study and other recent international POPs serum monitoring studies are shown in Table 5.3 to Table 5.7. We selected international POPs serum studies that included a representative adult population sample and had a comparable timeframe to the current study (i.e. samples taken after 2001).

New Zealand weighted mean results for PCDD/F were compared to results from recent studies in Australia [104] and the USA [105], shown in Table 5.3.

Table 5.3. International comparison for PCDD/F (pg/g lipid)

	New Zealand	Australia	USA
Reference	**Current study**	**Harden, 2007**	**CDC, 2009**
Years of sample collection	**2011-13**	**2003**	**2003-04**
Age of study population (years)	**19 to 64**	**<16 to >60**	**3 – 60+**
1,2,3,7,8-PeCDD	2.37	2.1	NR
1,2,3,4,7,8-HxCDD	1.16	2	NR
1,2,3,6,7,8-HxCDD	6.38	13	17.2
1,2,3,7,8,9-HxCDD	1.55	2.4	NR
1,2,3,4,6,7,8-HpCDD	13.35	24	25.3
OCDD	127.02	250	NR
2,3,7,8-TCDF	0.72	0.5	NR
1,2,3,7,8-PeCDF	0.82	0.6	NR
2,3,4,7,8-PeCDF	2.99	1.8	NR
1,2,3,4,7,8-HxCDF	1.66	1.6	NR
1,2,3,6,7,8-HxCDF	1.76	1.4	NR
2,3,4,6,7,8-HxCDF	0.43	1.3	NR
1,2,3,4,6,7,8-HpCDF	3.42	3	NR

NR – analyte was assessed but was not reported because of few detects.

Concentrations of PCDD from the current New Zealand study are generally comparable or lower than those from the 2003 Australian and 2003-04 USA studies. 1,2,3,6,7,8-HxCDD and 1,2,3,4,6,7,8-HpCDD in New Zealand are 2.7 and 1.9 times less, respectively, than those in the USA. Concentrations of 1,2,3,6,7,8-HxCDD, 1,2,3,4,6,7,8-HpCDD and OCDD in New Zealand are approximately two times less, respectively, than those in Australia, with other congeners similar between the two countries.

New Zealand weighted mean results for PCBs were compared to results from recent studies in Australia [104], USA [105], Canada [106], Spain[107], the Czech Republic[108], and Bolivia[109], shown in Table 5.4.

Table 5.4. International comparison for PCBs (ng/g lipid)

	New Zealand	Australia	USA	Canada	Spain	Czech Republic	Bolivia
Reference	**Current study**	**Harden, 2007**	**CDC, 2009**	**Health Canada, 2010**	**Porta, 2012**	**Černá, 2008**	**Arrebola 2012**
Years of sample collection	**2011-13**	**2003**	**2003-04**	**2007-09**	**2006**	**2006**	**2010**
Age of study population (years)	**19 to 64**	**<16 to >60**	**3 to 60+**	**6 to 79**	**18 to 65+**	**	**18 to 70**
PCB28	0.97		4.9	NR		14	
PCB44	0.06		2.06				
PCB49	0.03		1.29				
PCB52	0.15		2.66	NR		5	
PCB74	1.32		4.81	NR			
PCB99	0.80		4.16	NR			
PCB101	0.13		1.65	NR			
PCB105	0.36	0.76	1.2	NR			
PCB110	0.06		1.22				
PCB114	0.12	0.24					
PCB118	1.77	4.5	6	6.93	16.3	14	
PCB123	0.02	0.106					
PCB126	0.01	0.019	0.0163				
PCB138/163/164	8.72		15.1	5.03	64.29	186	33.7
PCB153	12.40		19.8	28.62	99.73	423	59.0
PCB156	1.73	2.2	2.54	4.03			
PCB157	0.33	0.49	0.605				
PCB167	0.43	0.7	0.494	NR			
PCB170	4.45		5.46	7.61			
PCB180	13.39		15.1	25.74	80.36	374	26.7
PCB183	0.85		1.45	NR			
PCB187	2.51		4.23	6.35			
PCB189	0.24	0.23	NR				
PCB194	2.49		2.69	5.25			
PCB196/203	1.71		2.61	3.62			
PCB206	0.40		2.13	NR			
PCB209	0.31		1.4				

NR – analyte was assessed but was not reported because of few detects.

** No age range was reported though the report specifies “adults”.

Concentrations of PCBs in New Zealand are up to 4-times less than those in Australia. New Zealand concentrations of PCBs are less than those in the USA, in particular for PCB49, PCB44, PCB110, PCB52, and PCB101, which are 13- to 40-times higher in the USA. New Zealand concentrations of PCBs are up to 4 times less than concentrations in Canada,. Concentrations of

PCB118, PCB153, and PCB180 were 9, 8, and 6 times less in the current New Zealand study compared to Spain. There are large differences between concentrations of PCBs between New Zealand and the Czech Republic, with 8- to 34-times higher PCB levels in the Czech study. Concentrations of PCB138, PCB153, and PCB180 were 3.9, 4.8, and 2.0 times higher, respectively, in Bolivian serum samples compared to New Zealand.

New Zealand weighted mean results for OCPs were compared to results from recent studies in the USA [105], Canada[106], Spain[107], and Bolivia[109], shown in Table 5.5.

Table 5.5. International comparison for OCPs (ng/g lipid)

	New Zealand	**USA**	**Canada**	**Spain**	**Bolivia**
Reference	**Current study**	**CDC, 2009**	**Health Canada, 2010**	**Porta, 2012**	**Arrebola, 2012**
Years of sample collection	**2011-13**	**2003**	**2003-04**	**2006**	**2010**
Age of study population (years)	**19 to 64**	**3 to 60+**	**6 to 79**	**18 to 65+**	**18 to 70**
beta-HCH	12.91	NR	36.52	130.05	
HCB	7.62	15.2	12.14	217.64	22.1
p,p'-DDE	249.80	238	326.91	527.67	267.4
p,p'-DDT	2.69	NR	NR	31.04	13.0

NR – analyte was assessed but was not reported because of few detects.

New Zealand concentrations of *beta*-HCH are 2.8 and 10 times less than that for Canada and Spain, respectively. New Zealand concentrations of HCB are 2, 1.6, 28.5, and 2.9 times less than those in USA, Canada, Spain, and Bolivia, respectively. New Zealand concentrations of p,p'-DDE are similar to that of the USA and Bolivia, and 1.3, and 2.1, times lower than that of Canada and Spain respectively. New Zealand concentrations of *p,p'*-DDT are 11.5 and 4.8 times less than those for Spain and Bolivia.

New Zealand weighted mean results for BFRs were compared to results from recent studies in the USA [105], Canada[106], Germany [110], and Spain [111], shown in Table 5.6.

Table 5.6. International comparison for BFRs (ng/g lipid)

	New Zealand	USA	Canada	Germany	Spain
References	**Current study**	**CDC, 2009**	**Health Canada, 2010**	**Fromme, 2009**	**Garí, 2013**
Years of sample collection	**2011-13**	**2003**	**2003-04**	**2005**	**2002**
Age of study population (years)	**19 to 64**	**3 to 60+**	**6 to 79**	**14 to 60**	**18 to 74**
BDE-28/33	0.12	1.19	NR		0.59
BDE-47	2.15	20.5	21.71	1.88	2.2
BDE-99	1.02			0.86	1.1
BDE-100	0.49	3.93	NR	0.81	0.75
BDE-153	1.34	5.69	NR	2.84	0.74
BDE-209	3.6				4.6
BB153	0.49	2.29			

NR – analyte was assessed but was not reported because of few detects.

Concentrations of BFRs in New Zealand range from 4.2 to 10 times lower than those in the USA and Canada. There is a large difference between New Zealand and North American concentrations of BDE47 in particular, probably due to the greater use of the penta-BDE formulation in North America [64]. Concentrations of BDEs in New Zealand are similar to that of Germany, with the exception of BDE100 and BDE153 which are 1.7 and 2.1 times less in New Zealand compared to Germany. BFR concentrations in New Zealand and Spain are similar with the exception of BDE153 which is 1.8 times higher in New Zealand.. BDE209 has not been regularly monitored in national biological monitoring studies [111, 112]. The study from Spain was the only population representative study identified that reported BDE209 serum concentrations, which reported similar concentrations as the current study.

New Zealand weighted mean results for PFCs were compared to results from recent studies in the USA [105, 113], Canada [106], Germany [110], and Australia [87], shown in Table 5.7.

Table 5.7. International comparison for PFCs (ng/mL)

	New Zealand	**USA**	**USA**	**Canada**	**Germany**	**Australia**
References	**Current study**	**CDC, 2009**	**Olsen, 2012**	**Health Canada, 2010**	**Fromme, 2009**	**Harden, 2007**
Years of sample collection	**2011-13**	**2003**	**2010**	**2003-04**	**2005**	**2002-03**
Age of study population	**19 to 64**	**3 to 60+**	**20 to 69**	**6 to 79**	**14 to 67**	**<16 to >60**
PFHxS	1.24	1.93	1.34	2.3		6.2
PFOS	3.59	20.7	8.3	8.9	13.7	20.8
PFOA	2.51	3.95	2.44	2.5	5.7	7.6
PFNA	0.69	0.966	0.83	0.82		

Concentrations of PFHxS, PFOA, and PFNA in New Zealand are generally similar to, or lower than, those in the USA, Canada, Germany, and Australia. However, PFOS concentrations in New Zealand are 2.5, 5.8, 3.8, and 5.8 times lower than those in the USA, Canada, Germany, and Australia respectively.

6. Conclusions

The main conclusions of the study are presented below. First the conclusions are grouped by the five main groups of POPs (PCDD/Fs, PCBs, OCPs, BFRs and PFCs), followed by the overall study results, comparing the results for all POPs.

6.1. Conclusions for the main groups of POPs

6.1.1. PCDD/Fs

- The weighted mean serum concentration of the PCDD/Fs TEQ_{05} was estimated to be 5.81 pg/g for the New Zealand population (age 19-64)
- 1,2,3,7,8-PeCDD was the largest contributor to the PCDD/Fs TEQ_{05}
- Highest weighted mean serum concentrations for the overall study were measured for OCDD (127 pg/g lipid)
- Serum concentrations of PCDD/Fs TEQ_{05} increased with age (3.27-4.47-4.97-8.51 pg/g for the 19-24, 25-34, 35-49, and 50-64 year age groups respectively), showing a 2.6-fold difference between the oldest and youngest age group
- The age-gradient was stronger for dioxins than for furans
- There was no clear evidence that gender, ethnicity or region were determinants of the serum concentrations of the PCDD/Fs
- Over the 15 years since the last survey, the PCDD/Fs TEQ_{98} had reduced by 49%, an average of 3% per year
- The reduction over time was less substantial for the furans compared to the dioxins
- Concentrations of PCDD/F in New Zealand were generally comparable or lower than those reported for other countries with recent data.

6.1.2. PCBs

- The weighted mean serum concentration of the PCB TEQ_{05} was estimated to be 1.54 pg/g for the New Zealand population (age 19-64)
- PCB126 was the largest contributor to the PCB TEQ_{05}
- Highest weighted mean serum concentrations were measured for PCB180 and PCB153 (13 and 12 ng/g lipid respectively)
- Serum concentrations of the PCB TEQ_{05} increased with age (0.85-0.87-1.47-2.28 pg/g for the 19-24, 25-34, 35-49, and 50-64 year age groups respectively), showing a 2.7-fold difference between the oldest and youngest age group
- The magnitude of the age-gradient was greater for the higher chlorinated PCBs, for PCB208, PCB194, PCB205, PCB206, and PCB196/203 a 7- to 9-fold difference between the oldest and youngest age group was observed
- There was no clear evidence that gender, ethnicity or region were determinants of the serum concentrations of the PCBs
- Over the 15 years since the last survey, the PCB TEQ_{98} had reduced by 64%, an average of 4% per year
- The majority of PCB congeners were present in New Zealand serum at lower concentrations than those in recent international studies.

6.1.3. OCPs

- Of the quantified OCPs, the highest serum concentrations were determined for *p,p'*-DDE (the major metabolite of insecticide DDT), with an estimated weighted mean serum concentration of 249.8 ng/g for the New Zealand population (age 19-64)
- Following *p,p'*-DDE, highest weighted mean serum concentrations were observed for *beta*-HCH (12.9 ng/g), HCB (7.6 ng/g) and dieldrin (5.2 ng/g).
- Several OCPs were not detected in any of the samples (aldrin, endrin, endosulfan, methoxychlor and toxaphene).
- Serum concentrations of OCPs increased with age, particularly for *beta*-HCH, mirex and *p,p'*-DDE. For *beta*-HCH, there was a 5.2 difference between the oldest and youngest age group. This age difference was 4.3-fold for mirex and 3.1-fold for *p,p'*-DDE. For HCB, dieldrin, and *p,p'*-DDT weak age-gradients were observed.
- For most OCPs there was no clear evidence that ethnicity was a determinant of the serum concentrations.
- Concentrations of *p,p'*-DDE appear to have a north to south gradient with serum concentrations in the South Island being 1.6 higher than the most northern region.
- Concentrations of dieldrin and mirex were marginally lower in females compared to males.
- Over the 15 years since the last survey, the largest reduction was observed for *p,p'*-DDE (77% reduction, an average of 5% per year), followed by dieldrin (60% reduction, an average of 4% per year)
- Concentrations of OCPs in New Zealand serum samples were below concentrations from recent international studies except for *p,p'*-DDE, for which the New Zealand serum concentrations were comparable to those of the US and Bolivia.

6.1.4. BFRs

- Of the quantified BFRs, the highest serum concentrations were determined for BDE209, with an estimated weighted mean serum concentration of 3.57 ng/g for the New Zealand population (age 19-64), followed by BDE47 (2.15 ng/g), BDE153 (1.34 ng/g) and BDE99 (1.02 ng/g)
- For many of the PBDE congeners, the highest concentrations were observed for the youngest age group. For BDE49 the concentrations in the 19-24 age-group were 3 times higher compared to the mean concentration of the 50-64 age group while for most other BDE congeners the concentrations of the youngest age group were between 1 and 2 times the concentration on the oldest age group.
- For BB153 a positive age-gradient was observed, with those in the 50-64 age group having 2.5 times higher concentrations compared to the 19-24 year age group.
- There was no clear evidence that ethnicity or region were determinants of the serum concentrations of the BFRs
- For many BFRs males had higher serum concentrations compared to females. On average (over all congeners), concentrations for males were 1.3 times the concentrations for females.
- BFRs were not determined in the previous serum survey. Comparison to a small serum study done in Wellington in 2001 showed no difference between the two studies. Therefore, no conclusion regarding PBDE time trends in New Zealand could be drawn from these comparisons.

- Concentrations of BFRs, particularly BDE47, in New Zealand serum were much lower than those in the USA and Canada, and similar to or less than concentrations from studies in Europe.

6.1.5. PFCs

- Of the four PFCs that could be detected in the serum samples, the highest serum concentrations were determined for PFOS, with an estimated weighted mean serum concentration of 3.59 ng/mL for the New Zealand population (age 19-64), followed by PFOA (2.51 ng/mL), PFHxS (1.24 ng/mL) and PFNA (0.69 ng/mL).
- Serum concentrations of PFCs increased with age: on average the 50-64 year age group had 1.4 times higher concentrations of PFCs compared to the 19-24 year age group.
- There was no clear evidence that ethnicity or region were determinants of the serum concentrations of PFCs.
- For the four PFCs, concentrations were marginally higher in males compared to females. For PFHxS the difference in concentrations between males and females was approximately 2-fold, for PFOS and PFOA 1.4-fold, and for PFNA 1.1-fold.
- PFCs were not determined in the previous serum survey, therefore time-trends could not be determined for these compounds
- Concentrations of PFOS in New Zealand were lower than those in recent international studies, while for PFHxS, PFOA and PFNA New Zealand serum concentrations were comparable to those reported for other countries.

6.2. Conclusions comparing all POPs.

6.2.1. Serum concentrations

- Of all the lipid-based POPs determined in this study, highest weighted mean serum concentrations were observed for the OCPs, particularly *p,p'*-DDE (249.8 ng/g), *beta*-HCH (12.9 ng/g), HCB (7.6 ng/g) and dieldrin (5.2 ng/g).
- After the OCPs, highest serum concentrations were measured for selected PCBs, particularly PCB180 and PCB153 (13 and 12 ng/g lipid respectively).
- After the OCPs and selected PCBs, highest concentrations were observed for selected PBDEs, particularly BDE209 (3.57 ng/g), BDE47 (2.15 ng/g), BDE153 (1.34 ng/g) and BDE99 (1.02 ng/g).
- Of all four main groups of lipid-based POPs, the PCDD/Fs had the lowest concentrations, among which OCDD had the highest concentration (127 pg/g, or 0.1 ng/g).

6.2.2. Age

- For many POPs age was positively associated with serum concentrations. The magnitude of the age-gradient differed among compounds and congeners.
- The largest age-gradients were observed for the higher-chlorinated PCBs, showing up to a 9-fold difference between the oldest and youngest age groups.
- For the OCPs *beta*-HCH, mirex and *p,p'*-DDE, the difference between the oldest and youngest age group was 5-fold, 4-fold and 3-fold respectively.
- The age-gradient was very similar for the PCDD/Fs TEQ_{05} and PCB TEQ_{05}: the difference between the oldest and youngest age group was 2.6-fold and 2.7-fold respectively.
- By comparison a moderate age-gradient was observed for the PFCs, for which the difference between the oldest and youngest age group was 1.4-fold on average.

- In contrast with the PCDD/Fs, PCBs, OCPs and PFCs, for many of the PBDE congeners, the highest concentrations were observed for the youngest age group.

6.2.3. Region

- For most POPs there was no evidence that serum concentrations differed by region.
- Concentrations of *p,p'*-DDE appeared to have a north to south gradient.

6.2.4. Ethnicity

- For none of the POPs was there convincing evidence that serum concentrations differed between Māori and non-Māori.

6.2.5. Gender

- For most of the POPs there was no convincing evidence that serum concentrations differed between men and women.
- Concentrations of the OCPs dieldrin and mirex were marginally higher in males compared to females.
- Concentrations of the PBDEs were marginally higher in males compared to females.
- For the four PFCs, concentrations were consistently higher in males compared to females.

6.2.6. Time-trend

- For all POPs measured in both the 2001 and current survey, a reduction in serum concentrations over time was observed.
- The reduction in serum concentrations over time was consistent over all age-groups.
- The reduction in serum concentrations over the 15 year period between the two New Zealand serum surveys was most substantial for *p,p'*-DDE (77%; an average of 5% per year) followed by the PCB TEQ (64% reduction; 4% per year), dieldrin (60%; 4% per year) and the PCDD/Fs TEQ (49%; 3% per year).
- The reduction over time was less substantial for the furans compared to the dioxins.
- For PBDEs and PFCs a conclusion regarding time-trends could not be drawn.

6.2.7. International comparison

- Overall, concentrations of POPs in New Zealand were comparable to, or lower than, concentrations of POPs in recent studies from North America, South America, Europe, Asia and Australia.
- Concentrations of PCDD/Fs were comparable to, or lower than, concentrations in Australia (2003) and the USA (2003 – 2004) measured up to 10 years ago.
- Concentrations of PCBs were lower in New Zealand than in other countries for the majority of PCB congeners.
- Concentrations of OCPs were lower than those in other countries, except for p,p'-DDE which was comparable to the USA and Bolivia.
- Concentrations of BFRs were much lower than in the USA, and similar to Europe.
- Concentrations of PFOS were lower than in other countries, while concentrations of PFHxS, PFOA, and PFNA were comparable to other countries.

7. Discussion

7.1. Methodology

This study aimed to provide an estimate of POPs serum concentrations representative of the New Zealand adult population. Individuals randomly selected from the Electoral Roll were invited to participate in the study and go to their local pathology laboratory on their own account to have a blood sample taken. Of the 14,310 individuals invited by letter, for the majority (84%) we did not receive a reply. Those individuals that did reply or were reached by phone (n=2,280), just over half chose not to participate in the study (53.7%). Of those willing to participate and meeting our eligibility criteria, 75% provided a blood sample within the time frame of the study (n=747). This relatively low participation rate (for 5.2% of invited individuals a blood sample was collected) was not surprising, given that study participation required considerable dedication of each participant to the study without any personal benefits to themselves. However, the stratified sampling method and the weighting of serum concentrations by stratum, minimised bias related to the low response rate and ensured the representativeness of the study outcome for the New Zealand adult population. For the youngest age groups the response rate was very low, and even after over-sampling this group, the young age strata included fewer participants than the older age strata. These strata were therefore further pooled over the four geographic regions to obtain a satisfactory laboratory limit of detection for PCDD/Fs, PCBs, BFRs and OCPs. This is unlikely to have biased the results of the study or representativeness of the findings for the youngest age group, but did limit the possibility to study patterns by region for the younger age groups.

The results of this study were based on determinations in pooled serum samples, with individual samples pooled if they were in the same age/gender/ethnicity/region group. This strategy has the advantage that less blood is required from each participant to reach a satisfactory laboratory limit of detection, and that analytical costs can significantly be reduced. The pooling of samples has however the disadvantage that individuals with exceptionally high serum concentrations can unduly influence the average serum concentration of the pool, resulting in POPs concentration that may not be representative for the stratum. Undue influence of individual outliers on the concentration of the pooled sample is most likely for those compounds that have high background variability in the population. An example of such a compound is *beta*-HCH, for which some strata concentrations ranged by more than a factor 10 in some cases, even within the same age group. For some of the PBDEs high variability of concentrations of pooled samples within the same age groups was also observed. In the 2008 breast milk study individual samples were analysed and the variability of the POPs in the population could be assessed, showing considerably high variability for *beta*-HCH and the PBDEs compared to the other POPs [13]. For example, for the PCDD/Fs, PCBs and most OCPs, there was an approximately 10-fold difference between the highest and lowest individual concentrations in breast milk, while for *beta*-HCH it was 114-fold and for some BDEs 25-fold.

Although individual sample concentrations were not available in this study to do a similar assessment, we did compare pooled serum concentrations for pools of the same strata but including different individuals. This showed some intra-stratum variance, with the coefficients of variation highest for the BFRs, consistent with the highly variable concentrations of BDEs in the general population compared to other compound groups, due to their different exposure routes. Therefore, for these compounds serum concentrations for individual pools (i.e.

individual strata) may not be representative for the stratum, and for these compounds it was considered more prudent to base any conclusions on concentrations averaged over multiple strata (i.e. weighted average of the four regions combined).

The relatively low New Zealand concentrations of some POPs had as a consequence that for many samples the concentration was below the limit of detection for the low concentration POPs. TCDD for example was detected in only 37% of the samples. This also impacted particularly on the youngest age groups with the lowest exposure concentration. Whether detection limits are satisfactory will need to be addressed in future studies, particularly for those studies including populations for which POPs concentrations are expected to be lower than those observed here (i.e. chlorinated POPs in younger age groups).

For analytes with low serum concentrations the influence of sample contamination on reported serum concentrations may also be substantial. For several analytes the concentrations determined in the laboratory blanks were close those reported for the serum samples, indicating that results for these compounds need to be regarded as relatively uncertain. The possibility of contamination is a particular issue for the BFRs and especially BDE209, as indoor sources such as dust and electronic equipment can contain high levels of these compounds [70]. However, the BFR concentrations were not consistently higher in bovine serum samples that were handled and stored in the same way as the human serum samples, compared to non-handled bovine serum samples, indicating that contamination was unlikely during sample handling and storage. The inter-laboratory comparison indicated that the PBDE serum concentrations reported by the New Zealand laboratory were consistently lower than those of the reference laboratory, indicating that particularly for these compounds different laboratory procedures may have a substantial impact on the reported concentrations. However, overall the inter-laboratory comparison showed good agreement between the two laboratories, and indicated that less than a two-fold difference in reported serum concentrations could be attributable to laboratory differences alone.

7.2. International comparison

We compared the New Zealand serum concentrations of POPs with those reported for other countries. Only recently conducted studies were used for comparison, given the strong, decreasing time trend observed for many POPs. A limited number of international studies reported on PCDD/Fs within the last 10 years, and for one of them [105] concentrations were below the limit of detection for most congeners. Comparison with PCDD/F serum concentrations of samples taken in Australia in 2003 indicated that for many congeners the New Zealand concentrations were comparable to, and sometimes lower than, the Australian concentrations. More international data are available for breast milk studies, for which many countries have more recently reported results, which indicate relatively low PCDD/F levels for New Zealand, particularly when compared with highly industrialized countries [13].

For PCBs more recent serum studies were reported indicating that New Zealand levels were comparable to or lower than those in Australia, but significantly lower than those reported for the US, Canada, Spain, Czech Republic and Bolivia. Concentrations of PCBs in the 2001 New Zealand serum study were similarly at the low end of the range of international values. In addition, for the lower chlorinated PCB congeners a comparison of the current study results could only be made with the USA and the Czech Republic, both of which have a relatively high amount of domestic industrial activity compared to New Zealand. Recent monitoring of breast

milk PCB concentrations also shows relatively low PCB body burdens in New Zealand compared to international studies [13].

For OCPs, New Zealand levels were below those reported for the US, Canada and Bolivia and Spain, except for *p,p'*-DDE for which New Zealand levels were comparable to those reported elsewhere, reflecting the large historical use of DDT in New Zealand. For BFRs, New Zealand serum concentrations were similar to those reported for Germany and Spain, while being below concentrations reported for US and Canada, reflecting the more extensive use of BFRs in North America [114, 115].

The PFC concentrations in serum of New Zealanders was largely comparable with those reported for the US, Canada, Germany, Japan, with the exception on PFOS, which was significantly lower than those reported elsewhere. The use of PFOS in most countries decreased significantly after the voluntary phase-out of PFOS production by the major US manufacturer in 2000 [86], and most of the international studies reviewed in this report took place during the period 2002 to 2005. It is possible that the lower New Zealand concentrations measured in samples taken during 2011 to 2013 reflect lower levels of PFOS in the environment compared to the period 2002 to 2005, resulting from a global decrease of PFOS use in consumer articles. The most recent US study of blood donors with samples taken in 2010 indicated PFOS concentrations to be closer to, but still higher than, New Zealand PFOS concentrations. The US blood donor study included a temporal trend for blood donor samples collected in 2001 and 2010, showing a 4.2 fold reduction during that period [113].

7.3. Time trends

This study had the advantage that results for chlorinated POPs (PCDD/Fs, PCBs, and OCPs) could be compared with a very similar study conducted 15 years earlier to provide time trends representative for the whole New Zealand population. This study observed a substantial reduction in the New Zealand body burdens of chlorinated POPs over the 15 years between 1997 and 2012. A similar reduction has also been observed in the New Zealand breast milk studies [70], and breast milk studies from Australia [116] and overseas [29, 117-119]. Although time trends have mainly been quantified through breast milk studies, recently serum studies, including this study, which are more representative of the population, have indicated that the decreasing trend is present in both men and women and in all age groups. For example, in a study from Barcelona a 34-56% reduction in chlorinated POPs levels was observed between 2002 and 2006 [107]. In studies from very diverse populations including Greenland [120] and West Africa [121] the same patterns were observed. These findings illustrate that the international efforts made to ban production and use of these substances and management of their disposal has had positive effects around the world. New Zealand's temporal trends compare well with those in populations with higher serum levels, indicating that in countries with relatively low serum concentrations such as New Zealand the reducing trend is continuing for the chlorinated POPs.

This study also showed that the reduction was more substantial for some POPs compared to others. The reduction was most substantial for *p,p'*-DDE (5% per year), PCB TEQ_{98} and dieldrin (4% per year) and the PCDD/Fs TEQ_{98} (3% per year). Among the PCDD/Fs, the reduction was more substantial for the dioxins compared to the furans. This may indicate that for some POPs, the reduction is slowing down (i.e. while for PCBs the temporal trend remains steep, for furans the trend appears to be leveling off).

Although the two New Zealand national serum surveys did not include the same individuals, the two studies included individuals comparable in terms of birth year. For example, the group aged 25-34 in the 2001 study would be comparable to the 35-49 age group in the current study. Comparing the serum concentrations in both groups indicates that within the same individuals, body burdens of chlorinated POPs may have reduced considerably over time. Thus, both an emissions related cohort effect (i.e. the study participants of the current survey were born on average 15 years after the participants of the 2001 survey and therefore had lower exposure levels over their lifetime due to the reduction in POPs emissions) and clearance effect (i.e. elimination of serum POPs concentrations due to metabolism and excretion of the compound outweighing new exposure to the compound) are likely to be the main drivers behind the time trend of the chlorinated POPs we observed in this study.

BFRs were not determined in the previous serum survey, and therefore time trends could only be examined through comparison with the 2001 Wellington serum study. The comparison of PBDEs in the 2001 Wellington study and the current study shows no difference, which may indicate that serum levels of PBDEs in New Zealanders have not changed over the past decade. However this comparison is made with caution because of methodological differences between the two studies. Future investigations into PBDEs in New Zealanders are needed to evaluate the temporal trend of PBDE body burdens in New Zealanders.

Because this study was the first in New Zealand to determine population levels of PFCs in serum, time trends could not be established for these compounds. In the US, recent studies generally indicate a decline in the most commonly detected PFCs (i.e. PFOS, PFOA and PFHxS), indicating that the dominant PFOS-related exposures to humans in the United States were mitigated during the phase-out period [122, 123]. Another US study showed a significant upward trend for PFNA concentrations [124]. In a study from Sweden PFOS levels tended to increase while PFOA and PFNA levels were unchanged between 1978 and 2001 [125]. Given these diverse patterns it is difficult to predict what temporal trends for PFCs will be observed for New Zealand signaling the need for future biological monitoring surveys.

7.4. Age trend

Of all the demographic factors that could be studied (age, sex, ethnicity, and region), age was the most important determinant of the serum concentrations for most POPs. A positive association with age has consistently been observed in cross-sectional studies of chlorinated POPs [21, 107, 126, 127]. We observed the largest age-gradients for the higher-chlorinated PCBs, showing an up to 9-fold difference between the oldest and youngest age groups, followed by *beta*-HCH (3-5-fold difference) and PCDD/F TEQ_{05} and PCB TEQ_{05} (2.6-2.7-fold). By comparison a moderate age-gradient was observed for the PFCs, for which the difference between the oldest and youngest age group was 1.4-fold on average.

When interpreting these age-trends it should be noted that they represent cross-sectional age trends, and do not reflect how an individual's serum concentration changes (i.e. accumulates) with their age. It is now understood that the steep age-gradients observed for chlorinated POPs in many countries reflect an emissions-related cohort effect, rather than age-dependent bio-accumulation or an age-dependent decline in metabolism [128]. In our cross-sectional population, the cohort with currently the oldest age (50-64) was born between 1948 and 1962, and will have lived through the highest emission period of chlorinated POPs. The youngest age group (19-24) was born between 1988 and 1993, after peak emission of chlorinated POPs and

peak levels in food had passed. Simulation studies indicate that as a result of the long persistence of these compounds, a positive association between age and body burden is likely to continue, even more than 70 years after peak exposure [128].

For PBDEs we observed an inverse association with age, while for BB153 a positive age-gradient was observed. A recent study from Catalonia, Spain, found a similar inverse age-dependent pattern for PBDEs [111]. Cross-sectional data from Australia for 2002–2008 also suggest a decreasing trend in serum concentrations of PBDEs with age [129]. The inverse association with age for the PBDEs may reflect the higher exposure of younger age group to these compounds (e.g. through electronic equipment use, and higher exposure to dust during youth). Because of the short half-lives of PBDEs (generally less than 1 year) [130], it has been proposed that for these compounds an inverse association with age will continue, also years after peak exposure has passed, with only the relative intensity of the maximum changing over time [128].

By contrast, BB153 has a long median half-life (estimated to be 29 years in humans) [131], which explains why a negative age-gradient, such as observed for the PBDEs, was not observed for this historical brominated flame retardant.

We observed a moderate positive association between age and serum concentrations of PFCs, a pattern also observed in other populations and age ranges. In a study from South Korea, PFC concentrations in the serum samples also increased with age [132]. In a study from the USA a nonlinear elevation in levels of PFHxS and PFOS with age was observed [133]. In a study among children age 0-12 years old serum concentrations of PFOS, PFOA, PFNA, and PFHxS also increased with age [134]. This age related increase of PFC serum concentrations is most likely the result of their long half-life, which is estimated to be 4.8, 7.3 and 3.5 years in humans for PFOS, PFHxS, and PFOA respectively [135].

7.5. Gender

We did not find large differences in POPs serum concentrations between men and women, but results indicated that for dieldrin, mirex, BFRs and PFCs serum levels were marginally higher in men compared to women. In the international literature there is inconsistent evidence of gender difference in background serum concentrations of lipophilic POPs. In a study from Barcelona, Spain, the distribution of POP concentrations tended towards higher values in women than men [107]. In a study from Sicily, Italy, PCB138, PCB153 and PCB180 concentrations were higher in males (adjusted p=0.03) in subjects >69 years old [136]. In a study including Inuit and European populations, men had higher serum concentrations of PCB153 and *p,p'*-DDE [137]. For BFRs, no gender differences were observed in a study from the USA [61]. While inconsistent associations with sex have been reported for the lipophilic POPs, the relation with sex seems to be more consistent for PFCs, with many studies reporting higher PFC serum concentrations for men compared to women. This has been reported for South Korea [132], Norway [138], Canada [139], Spain [140], Japan [141], Greece [142], China [143], and the USA [124]. By contrast, no differences in PFC concentrations were observed between young boys and girls [134]. It has been proposed that the concentration differences between adult males and females for PFCs are a result of the altered pharmacokinetics during pregnancy and breast feeding and elimination through menstruation and parity [132].

7.6. Biomonitoring of POPs in New Zealand

There are very few countries that have repeatedly conducted a POPs serum survey in a representative sample of the general population [144]. For New Zealand two such studies have now been conducted which provide information on how serum concentrations in New Zealanders change over time and how they compare with international levels. They also provide important reference values for comparison with serum levels highly exposed populations within New Zealand (e.g. populations with specific occupational, environmental or accidental exposure to these compounds). Such comparisons should be based on age and time-specific estimates as these are the two main determinants of serum concentrations of POPs in this study. Geographic variations and ethnic variations were minimal, illustrating that region- and ethnic-specific reference values will not be required.

7.7. Concluding Remarks

This study, the second national study of POPs in adult New Zealanders, provides an important reference for determining temporal trends in the "classic" POPs (dioxins, furans, PCBs, and OCPs) as well as providing benchmark values for the "new" POPs (BFRs and PFCs). The results highlight different patterns in body burdens between the various classes of POPs, particularly the influence of age in the accumulation of POPs. In particular, the study has shown a clear trend in age-related accumulation of most brominated POPs that is opposite to the trend seen with the chlorinated POPs – this is a trend that warrants further investigation in future biological monitoring studies.

New Zealand, like other countries around the world that have signed up to the Stockholm Convention, has put in place a biological monitoring programme to obtain information on the concentrations of POPs in the general population. This information can be used to guide and inform policies and other measures to control potential adverse impacts of POPs chemicals on health and the environment. The current study shows that levels of most POPs are relatively low in New Zealanders, and that the trend for many of the traditional POPs shows a marked decrease in body burdens over the past 15 years. Future biological monitoring work will enable the assessment of temporal trends for BFRs and PFCs, and to compare these trends with emerging biological monitoring information from other countries.

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Appendix A – Study recruitment materials

Invitation Letter

Information Sheet

Reply Form

Letter with blood collection kit

Consent Form

Screening Questionnaire

Clinical Form

MASSEY UNIVERSITY

25 May 2012 Ref: BC12345

Mr John Smith
123 Grafton Road
Wellington

Dear Mr John Smith

POPs Serum Study

We are inviting you to take part in a survey to measure persistent organic pollutants (POPs) in the bodies of New Zealanders. This will provide an important indicator of the quality of our New Zealand environment. In order to undertake the study we will be collecting small blood samples from 1280 people from four different regions in New Zealand. We are contacting adult New Zealanders selected randomly from the Electoral Roll and inviting them to participate in this study.

Please find enclosed an Information Sheet which explains what the study is about, and what participation would involve. If you wish to participate in the study, please complete and return the enclosed Reply Form, and a member of the study team will contact you by telephone to discuss arrangements. All information you supply is confidential, and we will not use your name. The results from this study will be published, and we will also send a summary to everyone who took part. **No individual information or names will be published.**

This project has received ethical approval from the Upper South A Regional Ethics Committee. Pooled serum samples that may remain will be stored and only used to address questions about POPs that may arise in the future, and have been given ethical approval from a Health & Disability Ethics Committee.

You have the right to:

- decline to participate,
- refuse to answer any particular questions,
- withdraw from the study if the request is made before your blood sample is pooled with other samples.

For questions about this study contact Jonathan Coakley, (04) 801-5799 extension 62421, email j.d.coakley@massey.ac.nz.

Yours sincerely

Dr Andrea 't Mannetje
Principal Investigator

MASSEY UNIVERSITY

POPs Serum Study INFORMATION SHEET

Principal Investigators:
Dr Andrea 't Mannetje, Senior Research Fellow, Centre for Public Health Research
Mr Jonathan Coakley, Research Fellow, Centre for Public Health Research
Assoc. Professor Barry Borman, Centre for Public Health Research
Adj. Professor Michael Bates, University of California, Berkeley, US
Professor Jochen Mueller, University of Queensland, Australia
Mr Howard Ellis, Ministry for the Environment
Professor Neil Pearce, Centre for Public Health Research
Professor Jeroen Douwes, Director, Centre for Public Health Research

Venue of Study:
Centre for Public Health Research, Massey University, Wellington Campus.

What is this study all about?
We are inviting you to take part in a survey to measure persistent organic pollutants (POPs) in the bodies of New Zealanders. This will provide an important indicator of the quality of our New Zealand environment.

Pollutants such as dioxins, PCBs and some pesticides are very stable compounds that can last for years before breaking down. Every human in the world carries traces of these compounds in his or her body. The past decades have seen many efforts to reduce the levels of these pollutants in our environment, such as banning certain pesticides and industrial compounds. This survey will show whether these efforts have been successful and will guide further remedial action.

In order to undertake the study we will be collecting small blood samples from 1280 people from four different regions in New Zealand. This project has received ethical approval from the Upper South A Regional Ethics Committee.

Why did you contact me?
We are contacting adult New Zealanders selected randomly from the most recent Electoral Roll and inviting them to participate in this study.

If I decide to take part in the study, what will participation mean for me?
If you are interested in hearing more about the study, a member of the research team will contact you to run through a brief screening questionnaire over the telephone. If you are eligible to take part in the study, the research nurse will send you a package with materials for the study (e.g. blood collection tubes) and arrange a time to have your blood taken at your local medical centre or pathology laboratory. To cover the cost of getting to and from the medical centre, taxi chits or a $20 petrol voucher will be provided as appropriate. At the medical centre or pathology lab, a nurse will collect 30 millilitres of blood (about six teaspoons) from the inside of your arm and store this in the tubes provided in the package.

What will happen to my blood sample?

Your sample will be transported to the laboratory at the Centre for Public Health Research, Massey University, in Wellington. It will be labelled with an ID number and stored in a special freezer. Your sample will then be pooled with other blood samples and tested for persistent organic pollutants at a New Zealand based laboratory. Because the blood samples will be pooled together, we won't be able to provide any individual results, or return your sample to you for disposal. We will store the remaining pooled samples in a confidential manner so that any questions that arise after the publication of our study can be answered without having to do a new study. Further ethical approval will be sought for any future use of samples. The blood samples will not be used for anything other than the measurement of persistent organic pollutants. All information you give us is confidential. Names and contact details will be seen by named researchers only, and when the study is completed all information will be securely stored under the authority and responsibility of the Director of the Centre for Public Health Research at Massey University. **No individual information or names will be published.**

You are under no obligation to accept this invitation. If you decide to participate you have the right to:

- decline to answer any particular question;
- withdraw from the study at any time (you will be able to withdraw your blood sample up until the point that it is pooled with other samples);
- ask any questions about the study at any time during participation;
- provide information on the understanding that your name will not be used unless you give permission to the researcher;
- be given access to a summary of the project findings when it is concluded

For questions about this study contact Jonathan Coakley, (04) 801-5799 extension 62421, email j.d.coakley@massey.ac.nz.

Thank you very much for your time in considering this study. We hope that with your help we can find out more about the quality of New Zealand's environment.

Compensation for injury

If physical injury results from your participation in this study, you should visit a treatment provider to make a claim to ACC as soon as possible. ACC cover and entitlements are not automatic and your claim will be assessed by ACC in accordance with the Injury Prevention, Rehabilitation and Compensation Act 2001. If your claim is accepted, ACC must inform you of your entitlements, and must help you access these entitlements. Entitlements may include, but not be limited to, treatment costs, travel costs for rehabilitation, loss of earnings, and/or lump sum for permanent impairment. Compensation for mental trauma may also be included, but only if this is incurred as a result of physical injury. If your ACC claim is not accepted you should immediately contact the researcher. The researcher will initiate processes to ensure you receive compensation equivalent to that which you would have been entitled had ACC accepted your claim.

If you have any questions or concerns about your rights as a participant in this research study you can contact an independent health and disability advocate. This is a free service provided under the Health and Disability Commissioner Act (Telephone: (NZ wide) 0800 555 050, Free Fax (NZ wide): 0800 2787 7678 (0800 2 SUPPORT), Email (NZ wide): advocacy@hdc.org.nz)

MASSEY UNIVERSITY

Ref: BC12345

POPs Serum Study **REPLY FORM**

A Study of Serum Levels of Persistent Organic Pollutants (POPs) in the New Zealand Population

Please circle your preferred selection:

YES PLEASE I would like to be contacted to hear more about participating in this study.

NO THANKS This study is not for me (please circle No and send your name so that we don t contact you again).

My name is: .....

My phone details:

Day: .....

Evening: .....

Mobile: .....

Thank you very much for considering this study.

Please send this form to us in the reply paid envelope provided and a member of our research team will get in touch with you soon.

MASSEY UNIVERSITY

25 May 2012 Ref: BC12345

Mr John Smith
123 Grafton Road
Wellington

Dear Mr John Smith

POPs Serum Study

Thank you for agreeing to participate in our study Your participation means that we will get a better picture of the level of persistent organic pollutants (POPs) in New Zealanders, and will guide policy to manage these chemicals in the future.

The box contains the materials that you will take to your local pathology laboratory to collect a blood sample. Please do not open the box before you go to the pathology laboratory as this may introduce contamination to the materials. Please handle the box gently as some of the materials inside are made of glass.

Your nearest pathology laboratory is:

Aotea Pathology
evel 6, 89 Courtenay Place
Wellington

If it is not convenient for you to attend this pathology laboratory you can call us and we will find a more convenient one for you. There is a short form inside the box that you will need to complete while you are at the pathology lab. Please also complete the Consent Form and return in the Freepost envelope. After your blood sample has been collected and you return the Consent Form there is nothing else you need to do. If you have any further questions about the study please contact:

Jonathan Coakley, Ph: 04 801 5799 ext 62421, E: j.d.coakley@massey.ac.nz

Yours sincerely

Dr Andrea 't Mannetje
Principal Investigator

MASSEY UNIVERSITY

BC12345

POPs Serum Study CONSENT FORM

Principal Investigators:
Dr Andrea t Mannetje, Senior Research Fellow, Centre for Public Health Research
Mr Jonathan Coakley, Research Fellow, Centre for Public Health Research
Assoc. Professor Barry Borman, Centre for Public Health Research
Adj. Professor Michael Bates, University of California, Berkeley, US
Professor Jochen Mueller, University of ueensland, Australia
Mr Howard Ellis, Ministry for the Environment
Professor Neil Pearce, Centre for Public Health Research
Professor Jeroen Douwes, Director, Centre for Public Health Research

Venue of Study:
Centre for Public Health Research, Massey University, Wellington Campus.

- I have read the Information Sheet, and I understand that I may ask questions at any time.
- I agree to participate and understand I have the right to withdraw from the study at any time. I understand that I can withdraw my sample from the study if this request is made before all the samples are pooled for analyses.
- I agree to provide information and a blood sample of 30 ml to the researchers on the understanding that my name will not be used without my permission.
- I understand that my blood sample will be pooled together with other blood samples before blood testing and that individual results will not be available
- I understand that the blood samples will not be used for anything other than the measurement of persistent organic pollutants.
- I consent to the use of my sample for future related studies, which have been given ethical approval from a Health & Disability Ethics Committee.
- I agree to participate in this study under the conditions set out in the Information Sheet.

Signed:

Name:

Date: Phone Number:

Address:

I would like to be sent a summary of the study results: ☐ Yes ☐ No

Please return this Consent Form in the Freepost envelope provided

POPs Serum Study

Screening Questionnaire | **BC**

1. **Interviewer name:**
2. **Interview date:** *dd/mm/yy*
3. **Participant's name:**
4. **Participant's year of birth:** *yyyy*
5. **The geographic region of the participant:**
6. **What is your date of birth?** *(interviewer: check with Q4)* *dd/mm/yy*
7. **Do you live in the _____ region?** Yes ☐ No ☐
8. **How long have you lived in the _____ region?**
9. **What is your current occupation?**

We are interested in whether you have ever worked or had physical contact with three types of chemicals:

10. **First, pentachlorophenol which was a chemical used for antisapstain treatment in the timber industry. Have you ever worked or had physical contact with pentachlorophenol?** Yes ☐ No ☐ Don't know ☐ Notes
11. **Second, polychlorinated biphenyls, which are known as PCBs and were widely used in electrical transformers and capacitors. Have you ever manufactured or repaired electrical transformers or capacitors?** Yes ☐ No ☐ Don't know ☐ Notes
12. **Third, organochlorine pesticides, which are chemicals used to kill insects and other pests. Have you ever worked with or had direct physical contact with any of the organochlorine pesticides? (examples: DDT, dieldrin, aldrin, lindane, HCB, heptachlor). This includes exposure to pesticides during military service (e.g. during the Vietnam War).** Yes ☐ No ☐ Don't know ☐ Notes
13. **Do you have any health issues that may prevent you from providing blood?** Yes ☐ No ☐ Don't know ☐ Notes

Interviewer: is the participant eligible? Yes ☐ No ☐

Does the participant want a $20 petrol voucher for travel costs? Yes ☐ No ☐

Thank the participant for participating in the study. Confirm their postal address is as shown in the database. Say that we will send a blood collection kit to them along with the name and address of their nearest pathology laboratory. It is best for them to visit the pathology laboratory in the morning.

POPs Serum Study - Clinical Form

Subject ID number: BC 12345

aboratory ID number:

aboratory instructions:

Participant Questions (Complete on the day of blood collection)

1. Surname:
2. Given name(s):
3. Have you been ill within the last two weeks

   ☐ No
   ☐ Yes, please describe
4. What did you have for breakfast
5. What did you have for lunch
6. What was your last meal
7. When was your last meal : AM PM

Blood Collection

8. Date blood taken:
9. Time blood taken: : AM PM
10. Who took the blood
11. Blood collection method Vacutainer collect
12. Red-top tube - tick for each tube taken:

1	2	3

Serum Collection

13. Date blood spun:
14. Time blood spun: : AM PM
15. Any of the following observations of serum

	Y	N		Y	N
Hemolyzed			ipemic		
Turbid			Icteric		

16. Notes:

Please fax this completed form to 04 380 0600 Att: Jonathan Coakley

Appendix B – Detailed list of analytes

Analyte abbreviation	Full name	CAS Number	Year of inclusion in Stockholm Convention	Inclusion in previous studies				
				Serum 2001[9]	Breast milk 1988 [10]	Breast milk 1998 [11]	Breast milk 2008 [12]	Current serum 2013
Polychlorinated dibenzodioxins (PCDDs)								
2378-TCDD	2,3,7,8-tetrachlorodibenzo-*p*-dioxin	1746-01-6	2001	X	X	X	X	X
12378-PeCDD	1,2,3,7,8-pentachlorodibenzo-*p*-dioxin	40321-76-4	2001	X	X	X	X	X
123478-HxCDD	1,2,3,4,7,8-hexachlorodibenzo-*p*-dioxin	39227-28-6	2001	X	X	X	X	X
123678-HxCDD	2,3,4,6,7,8-hexachlorodibenzo-*p*-dioxin	57653-85-7	2001	X	X	X	X	X
123789-HxCDD	1,2,3,7,8,9-hexachlorodibenzo-*p*-dioxin	19408-74-3	2001	X	X	X	X	X
1234678-HpCDD	1,2,3,4,6,7,8-heptachlorodibenzo-*p*-dioxin	35822-46-9	2001	X	X	X	X	X
OCDD	Octachlorodibenzo-*p*-dioxin	3268-87-9	2001	X	X	X	X	X
Polychlorinated dibenzofurans (PCDFs)								
2378-TCDF	2,3,7,8-tetrachlorodibenzo-*p*-furan	51207-31-9	2001	X	X	X	X	X
12378-PeCDF	1,2,3,7,8-pentachlorodibenzo-*p*-furan	57117-41-6	2001	X	NR	X	X	X
23478-PeCDF	2,3,4,7,8-pentachlorodibenzo-*p*-furan	57117-31-4	2001	X	X	X	X	X
123478-HxCDF	1,2,3,4,7,8-hexachlorodibenzo-*p*-furan	70648-26-9	2001	X	X	X	X	X
123678-HxCDF	1,2,3,6,7,8-hexachlorodibenzo-*p*-furan	57117-44-9	2001	X	X	X	X	X
234678-HxCDF	2,3,4,6,7,8-hexachlorodibenzo-*p*-furan	60851-34-5	2001	X	X	X	X	X
123789-HxCDF	1,2,3,7,8,9-hexachlorodibenzo-*p*-furan	72918-21-9	2001	X	NR	X	X	X
1234678-HpCDF	1,2,3,4,6,7,8-heptachlorodibenzo-*p*-furan	67562-39-4	2001	X	X	X	X	X
1234789-HpCDF	1,2,3,4,7,8,9-heptachlorodibenzo-*p*-furan	55673-89-7	2001	X	NR	X	X	X
OCDF	Octachlorodibenzo-*p*-furan	39001-02-0	2001	X	NR	X	X	X
Polychlorinated biphenyls (PCBs)								
Mono-CBs								
PCB1	2-Chlorobiphenyl	2051-60-7	2001					X
PCB3	4-Chlorobiphenyl	2050-62-9	2001					X
Di-CBs								
PCB4	2,2'-Dichlorobiphenyl	13029-08-8	2001				X	X
PCB15	4,4'-Dichlorobiphenyl	2050-68-2	2001				X	X
Tri-CBs								

Analyte abbreviation	Full name	CAS Number	Year of inclusion in Stockholm Convention	Inclusion in previous studies				
				Serum 2001[9]	Breast milk 1988 [10]	Breast milk 1998 [11]	Breast milk 2008 [12]	Current serum 2013
PCB19	2,2',6-Trichlorobiphenyl	38444-73-4	2001				X	X
PCB28	2,4,4'-Trichlorobiphenyl	7012-37-5	2001	X	NR	X	X	X
PCB37	3,4,4'-Trichlorobiphenyl	38444-90-5	2001				X	X
Tetra-CBs								
PCB44	2,2',3,5'-Tetrachlorobiphenyl	41464-39-5	2001	X		X	X	X
PCB49	2,2',4,5'-Tetrachlorobiphenyl	41464-40-8	2001	X		X	X	X
PCB52	2,2',5,5'-Tetrachlorobiphenyl	35693-99-3	2001	X		X	X	X
PCB54	2,3',4,4'-Tetrachlorobiphenyl	15968-05-5	2001				X	X
PCB70	2,3',4',5-Tetrachlorobiphenyl	32598-11-1	2001			X	X	X
PCB74	2,4,4',5-Tetrachlorobiphenyl	32690-93-0	2001	X	NR	X	X	X
PCB77	3,3',4,4'-Tetrachlorobiphenyl	32598-13-3	2001	X		X	X	X
PCB81	3,4,4',5-Tetrachlorobiphenyl	70362-50-4	2001	X		X	X	X
Penta-CBs								
PCB99	2,2',4,4',5-Pentachlorobiphenyl	38380-01-7	2001	X	NR	X	X	X
PCB101	2,2',4,5,5'-Pentachlorobiphenyl	37680-73-2	2001	X		X	X	X
PCB104	2,2',4,6,6'-Pentachlorobiphenyl	56558-16-8	2001				X	X
PCB105	2,3,3',4,4'-Pentachlorobiphenyl	32598-14-4	2001	X		X	X	X
PCB110	2,3,3',4',6-Pentachlorobiphenyl	38380-03-9	2001	X		X	X	X
PCB114	2,3,4,4',5-Pentachlorobiphenyl	74472-37-0	2001			X	X	X
PCB118	2,3',4,4',5-Pentachlorobiphenyl	31508-00-6	2001	X	NR	X	X	X
PCB123	2,3',4,4',5'-Pentachlorobiphenyl	65510-44-3	2001			X	X	X
PCB126	3,3',4,4',5-Pentachlorobiphenyl	57465-28-8	2001	X		X	X	X
Hexa-CBs								
PCB138	2,2',3,4,4',5'- Hexachlorobiphenyl	35065-28-2	2001	X	X	X	X	X
PCB153	2,2',4,4',5,5',-Hexachlorobiphenyl	35065-27-1	2001	X	X	X	X	X
PCB155	2,2',4,4',6,6'-Hexachlorobiphenyl	33979-03-2	2001				X	X
PCB156	2,3,3',4,4',5-Hexachlorobiphenyl	38380-08-4	2001	X		X	X	X

Analyte abbreviation	Full name	CAS Number	Year of inclusion in Stockholm Convention	Inclusion in previous studies				
				Serum 2001[9]	Breast milk 1988 [10]	Breast milk 1998 [11]	Breast milk 2008 [12]	Current serum 2013
PCB157	2,3,3',4,4',5'-Hexachlorobiphenyl	69782-90-7	2001	X		X	X	X
PCB167	2,3',4,4',5,5'-Hexachlorobiphenyl	52663-72-6	2001	X		X	X	X
PCB169	3,3',4,4',5,5'-Hexachlorobiphenyl	32774-16-6	2001	X		X	X	X
Hepta-CBs								
PCB170	2,2',3,3',4,4',5-Heptachlorobiphenyl	35065-30-6	2001	X	NR	X	X	X
PCB180	2,2',3,4,4',5,5'-Heptachlorobiphenyl	35065-29-3	2001	X	X	X	X	X
PCB183	2,2',3,4,4',5',6-Heptachlorobiphenyl	52663-69-1	2001	X	NR	X	X	X
PCB187	2,2',3,4',5,5',6-Heptachlorobiphenyl	52663-68-0	2001	X	NR	X	X	X
PCB188	2,2',3,4',5,6,6'-Heptachlorobiphenyl	74487-85-7	2001				X	X
PCB189	2,3,3',4,4',5,5'-Heptachlorobiphenyl	39635-31-9	2001	X		X	X	X
Octa-CBs								
PCB194	2,2',3,3',4,4',5,5'-Octachlorobiphenyl	35694-08-7	2001	X	NR	X	X	X
PCB196	2,2',3,3',4,4',5,6'- Octachlorobiphenyl	42740-50-1	2001	X	NR		X	X
PCB200	2,2',3,3',4,5,6,6'-Octachlorobiphenyl	52663-73-7	2001				X	X
PCB202	2,2',3,3',5,5',6,6'-Octachlorobiphenyl	2136-99-4	2001		NR	X	X	X
PCB205	2,3,3',4,4',5,5',6-Octachlorobiphenyl	74472-53-0	2001				X	X
Nona-CBs								
PCB206	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	40186-72-9	2001	X		X	X	X
PCB208	2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl	52663-77-1	2001			X	X	X
Deca-CB								
PCB209	2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl	2051-24-3	2001	X		X	X	X
Brominated Flame Retardants (BFRs)								
Dibromodiphenyl ethers								
BDE7	2,4-Dibromodiphenyl ether	171977-44-9	Not included				X	X
BDE15	4,4'- Dibromodiphenyl ether	2050-47-7	Not included				X	X
Tribromodiphenyl ethers								
BDE17	2,2',4-Tribromodiphenyl ether	147217-75-2	Not included				X	X

Analyte abbreviation	Full name	CAS Number	Year of inclusion in Stockholm Convention	Inclusion in previous studies				
				Serum 2001[9]	Breast milk 1988 [10]	Breast milk 1998 [11]	Breast milk 2008 [12]	Current serum 2013
BDE28	2,4,4'-Tribromodiphenyl ether	41318-75-6	Not included				X	X
BDE30	2,4,6-Tribromodiphenyl ether	155999-95-4	Not included				X	X
Tetrabromodiphenyl ethers								
BDE47	2,2',4,4'-Tetrabromodiphenyl ether	5436-43-1	2009				X	X
BDE49	2,2',4,5'-Tetrabromodiphenyl ether	243982-82-3	2009				X	X
BDE66	2,3',4,4'-Tetrabromodiphenyl ether	189084-61-5	2009				X	X
BDE71	2,3',4',6-Tetrabromodiphenyl ether	189084-62-6	2009				X	X
BDE77	3,3',4,4'-Tetrabromodiphenyl ether	93703-48-1	2009				X	X
Pentabromodiphenyl ethers								
BDE85	2,2',3,4,4'-Pentabromodiphenyl ether	182346-21-0	2009				X	X
BDE99	2,2',4,4',5-Pentabromodiphenyl ether	60348-60-9	2009				X	X
BDE100	2,2',4,4',6-Pentabromodiphenyl ether	189084-64-8	2009				X	X
BDE119	2,3',4,4',6-Pentabromodiphenyl ether	189084-66-0	2009				X	X
BDE126	3,3',4,4',5-Pentabromodiphenyl ether	366791-32-4	2009				X	X
Hexabromodiphenyl ethers								
BDE138	2,2',3,4,4',5'-Hexabromodiphenyl ether	182677-30-1	2009				X	X
BDE139	2,2',3,4,4',6-Hexabromodiphenyl ether	446254-96-2	2009				X	X
BDE140	2,2',3,4,4',6'-Hexabromodiphenyl ether	243982-83-4	2009				X	X
BDE153	2,2',4,4',5,5'-Hexabromodiphenyl ether	68631-49-2	2009				X	X
BDE154	2,2',4,4',5',6-Hexabromodiphenyl ether	207122-15-4	2009				X	X
BDE156	2,3,3',4,4',5-Hexabromodiphenyl ether		2009				X	X
BDE169	3,3',4,4',5,5'-Hexabromodiphenyl ether		2009				X	X
Heptabromodiphenyl ethers								
BDE171	2,2'3,3',4,4',6-Heptabromodiphenyl ether		2009				X	X
BDE180	2,2',3,4,4',5,5'-Heptabromodiphenyl ether		2009				X	X
BDE183	2,2',3,4,4',5',6-Heptabromodiphenyl ether	207122-16-5	2009				X	X
BDE184	2,2',3,4,4',6,6'-Heptabromodiphenyl ether		2009				X	X

Analyte abbreviation	Full name	CAS Number	Year of inclusion in Stockholm Convention	Inclusion in previous studies				
				Serum 2001[9]	Breast milk 1988 [10]	Breast milk 1998 [11]	Breast milk 2008 [12]	Current serum 2013
BDE191	2,3,3',4,4',5',6-Heptabromodiphenyl ether	446255-30-7	2009				X	X
Octabromodiphenyl ethers								
BDE196	2,2',3,3',4,4',5,6'-Octabromodiphenyl ether		Not included				X	X
BDE197	2,2',3,3',4,4',6,6'-Octabromodiphenyl ether	117964-21-3	Not included				X	X
BDE201	2,2',3,3',4,5',6,6'-Octabromodiphenyl ether		Not included				X	X
BDE203	2,2',3,4,4',5,5',6-Octabromodiphenyl ether	446255-54-5	Not included				X	X
BDE204	2,2',3,4,4',5,6,6'-Octabromodiphenyl ether	337513-72-1	Not included				X	X
BDE205	2,3,3',4,4',5,5',6-Octabromodiphenyl ether	446255-56-7	Not included				X	X
Nonabromodiphenyl ethers								
BDE206	2,2',3,3',4,4',5,5',6-Nonabromodiphenyl ether	63936-56-1	Not included				X	X
BDE207	2,2',3,3',4,4',5,6,6' Nonabromodiphenyl ether	437701-79-6	Not included				X	X
BDE208	2,2',3,3',4,5,5',6,6' Nonabromodiphenyl ether		Not included				X	X
Decabromodiphenyl ether								
BDE209	Decabromodiphenyl ether	1163-19-5	Not included				X	X
Hexabromobiphenyls (HBBs)								
BB153	2,2',4,4',5,5'-hexabromobiphenyl	59080-40-9	2009				X	X
Other BFRs								
PBEB	Pentabromoethylbenzene	85-22-3	Not included				X	X
DBDPE	Decabromodiphenylethane	84852-53-9	Not included				X	NR
HBB	Hexabromobenzene	87-82-1	Not included				X	X
Organochlorine pesticides (OCPs)								
Aldrin		309-00-2	2001	X		X	X	X
alpha-HCH	alpha-Hexachlorocyclohexane	319-84-6	2009			X	X	X
beta-HCH	beta-Hexachlorocyclohexane	319-85-7	2009	X		X	X	X

Analyte abbreviation	Full name	CAS Number	Year of inclusion in Stockholm Convention	Inclusion in previous studies				
				Serum 2001[9]	Breast milk 1988 [10]	Breast milk 1998 [11]	Breast milk 2008 [12]	Current serum 2013
gamma-HCH	gamma-Hexachlorocyclohexane (lindane)	58-89-9	2009	X		X	X	X
delta-HCH	delta-Hexachlorocyclohexane	319-86-8	Not included				X	X
	alpha-Chlordane	5103-71-9	2001			X	X	X
	gamma-Chlordane	5103-74-2	2001			X	X	X
o,p'-DDD	*o,p'*-Dichlorodiphenyldichloroethane	53-19-0	Not included				X	X
p,p'-DDD	*p,p'*-Dichlorodiphenyldichloroethane	72-54-8	Not included			X	X	X
o,p'-DDE	*o,p'*-Dichlorodiphenyldichloroethylene	3424-82-6	Not included				X	X
p,p'-DDE	*p,p'*-Dichlorodiphenyldichloroethylene	72-55-9	Not included	X	X	X	X	X
o,p'-DDT	*o,p'*-Dichlorodiphenyltrichloroethane	789-02-6	2001	X		X	X	X
p,p'-DDT	*p,p'*-Dichlorodiphenyltrichloroethane	50-29-3	2001	X	X	X	X	X
	Chlordecone (kepone)	143-50-0	2009					NQ
	Dieldrin	60-57-1	2001	X	X	X	X	X
	alpha-endosulfan	959-98-8	2011					X
	beta-endosulfan	33213-65-9	2011					X
	Endosulfan sulfate	1031-07-8	Not included				X	NR
	Endrin	72-20-8	2001	X			X	X
	Endrin aldehyde	7421-93-4	Not included				X	NR
	Endrin ketone	53494-70-5	Not included				X	NR
	Heptachlor	76-44-8	2001			X	X	X
	Heptachlor epoxide	1024-57-3	Not included	X		X	X	X
HCB	Hexachlorobenzene	118-74-1	2001	X	X	X	X	X
	Methoxychlor	72-43-5	Not included					X
	Mirex	2385-85-5	2001	X			X	X
	cis-Nonachlor	5103-73-1	2001					X
	trans-Nonachlor	39765-80-5	2001	X			X	X
	Oxychlordane	27304-13-8	2001	X			X	X
	Pentachlorobenzene	608-93-5	2009				X	X

Analyte abbreviation	Full name	CAS Number	Year of inclusion in Stockholm Convention	Inclusion in previous studies				
				Serum 2001[9]	Breast milk 1988 [10]	Breast milk 1998 [11]	Breast milk 2008 [12]	Current serum 2013
	Toxaphene (Parlar 26)	142534-71-2	2001					X
	Toxaphene (Parlar 50)	66860-80-8	2001					X
	Toxaphene (Parlar 62)	154159-06-5	2001					X
Perfluorinated compounds (PFCs)								
PFBS	Perfluorobutanesulfonic acid	375-73-5	Not included					X
PFHxS	Perfluohexanesulfonic acid	355-46-4	Not included					X
PFOS	Perfluorooctanesulfonic acid and its salts (including PFOSF)	1763-23-1	2009					X
PFDS	Perfluorodecanesulfonic acid	335-77-3	Not included					X
PFHxA	Perfluorohexanoic acid	307-24-4	Not included					X
PFHpA	Perfluoroheptanoic acid	375-85-9	Not included					X
PFOA	Perfluorooctanoic acid	335-67-1	Not included					X
PFNA	Perfluorononanoic acid	375-95-1	Not included					X
PFDA	Perfluorodecanoic acid	335-76-2	Not included					X
PFUnA	Perfluoroundecanoic acid	2058-94-8	Not included					X
PFDoA	Perfluorododecanoic acid	307-55-1	Not included					X
PFTrDA	Perfluorotridecanoic acid	72629-94-8	Not included					X
PFTeDA	Perfluorotetradecanoic acid	376-06-7	Not included					X
PFOSA	Perfluorooctanesulfonamide	754-91-6	Not included					X
NMeFOSAA	2-(N-methylperfluoro-1-octanesulfonamido)-ethanol	2355-31-9	Not included					X
NEtFOSAA	2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol	2991-50-6	Not included					X
Other POPs that are being considered for inclusion in the Stockholm Convention								
HBCD	Hexabromocyclododecane	25637-99-4	2013					
	Short-chained chlorinated paraffins	85535-84-8	Proposed for inclusion					

Analyte abbreviation	Full name	CAS Number	Year of inclusion in Stockholm Convention	Inclusion in previous studies				
				Serum 2001[9]	Breast milk 1988 [10]	Breast milk 1998 [11]	Breast milk 2008 [12]	Current serum 2013
	Chlorinated naphthalenes	Various	Proposed for inclusion					
HCBD	Hexachlorobutadiene	87-68-3	Proposed for inclusion					
PCP	Pentachlorophenol and its salts and esters (sodium pentachlorophenate, sodium pentachlorophenate monohydrate, pentachloroanisole, pentachlorophenyl laurate.	87-86-5 131-52-2 27735-64-4 1825-21-4 3772-94-9	Proposed for inclusion					

NR – analyte was assessed but not reported because of low detection frequency or analytical difficulties.

Appendix C – Detailed concentration data

Appendix C1 – Complete PCDD/F PCB results

Appendix C2 – Complete BFR results

Appendix C3 – Complete OCP results

Appendix C4 – Complete PFC results

Appendix C5 – Results graphs for all regions combined

Appendix C6 – Region-specific results graphs

Ethnicity	Gender	Region	Age	N	Comments	Units	2378TCDD	12378PeCDD	123478HxCDD	123678HxCDD	123789HxCDD	1234678HpCDD	OCDD	2378TCDF	12378PeCDF	23478PeCDF	123478HxCDF	123678HxCDF	123789HxCDF	234678HxCDF	1234678HpCDF
Maori	Male	All	19-24	5		pg/g	(0.76)	(0.89)	(1.28)	(1.26)	(1.3)	4.29	95.2	(0.87)	(0.6)	1.63	(0.67)	(0.67)	(1.18)	(0.76)	(1.18)
Maori	Male	All	25-34	13		pg/g	(0.34)	1.93	*0.98*	4.25	*1.25*	7.94	67.9	*0.88*	*0.58*	2.47	1.30	1.32	(0.4)	*0.53*	2.61
Maori	Male	Northland/Auckland	35-49	8		pg/g	(0.47)	2.58	1.56	6.67	*1.52*	13.40	109.0	*1.20*	0.91	3.44	2.07	2.15	(0.39)	*0.85*	7.09
Maori	Male	Waikato/Bay of Plenty	35-49	8		pg/g	(0.4)	3.21	*1.38*	7.17	2.01	12.90	115.0	*0.88*	1.10	3.69	1.85	1.76	(0.4)	*0.73*	2.27
Maori	Male	Lower North Island	35-49	10		pg/g	(0.64)	2.62	1.69	7.33	1.94	13.40	98.7	*0.99*	1.23	3.96	2.19	2.60	(0.58)	1.10	3.78
Maori	Male	South Island	35-49	6		pg/g	(0.51)	2.40	*1.14*	5.33	*1.25*	9.99	82.6	*0.79*	*0.82*	3.33	1.63	1.67	(0.36)	*0.81*	2.80
Maori	Male	Northland/Auckland	50-64	16		pg/g	(0.68)	3.55	1.91	10.50	(1.29)	22.80	134.0	(0.31)	(0.29)	3.86	1.47	1.76	(0.42)	(0.32)	3.16
Maori	Male	Waikato/Bay of Plenty	50-64	13		pg/g	(0.9)	2.89	3.43	15.00	2.02	22.80	189.0	(0.5)	(0.31)	3.81	2.41	3.11	(0.72)	(0.47)	3.51
Maori	Male	Lower North Island	50-64	11		pg/g	*1.27*	3.18	1.68	11.30	2.16	17.30	159.0	(0.27)	0.97	3.27	1.43	2.30	(0.69)	(0.47)	4.01
Maori	Male	South Island	50-64	11		pg/g	(0.57)	4.19	1.69	10.90	1.62	15.80	160.0	1.44	0.99	4.28	2.86	2.23	(0.35)	(0.41)	3.80
Maori	Female	All	19-24	20		pg/g	(0.36)	1.21	(0.25)	2.08	*0.83*	8.25	85.5	(0.35)	(0.2)	1.52	*0.72*	0.83	(0.27)	*0.40*	2.83
Maori	Female	Northland/Auckland	25-34	12		pg/g	(0.31)	1.27	(0.33)	4.04	*1.42*	8.98	118.0	(0.31)	*0.55*	1.69	0.96	0.89	(0.3)	*0.84*	6.80
Maori	Female	Waikato/Bay of Plenty	25-34	11		pg/g	(0.39)	1.51	(0.47)	3.97	*1.09*	9.65	108.0	*0.57*	(0.25)	1.47	*0.85*	1.16	(0.35)	(0.21)	2.37
Maori	Female	Lower North Island	25-34	14		pg/g	(0.28)	1.54	(0.32)	3.42	*1.08*	10.30	81.6	*0.63*	*0.64*	1.96	1.15	0.87	(0.37)	*0.54*	3.16
Maori	Female	South Island	25-34	8		pg/g	(0.26)	1.98	*0.93*	3.55	*1.39*	9.88	88.6	*0.53*	1.56	2.42	1.29	1.52	(0.32)	*0.59*	*1.83*
Maori	Female	Northland/Auckland	35-49	12		pg/g	(0.41)	1.40	(0.54)	6.52	1.96	11.90	125.0	*0.70*	(0.24)	2.11	1.29	1.27	(0.39)	*0.56*	1.94
Maori	Female	Waikato/Bay of Plenty	35-49	12		pg/g	(0.36)	2.53	*1.44*	6.91	1.79	16.80	125.0	*0.55*	*0.52*	2.01	1.32	1.27	(0.38)	*0.60*	2.74
Maori	Female	Lower North Island	35-49	9		pg/g	(0.44)	2.89	(0.51)	6.93	2.18	15.70	175.0	(0.32)	(0.24)	2.78	1.83	2.11	(0.41)	*0.66*	4.22
Maori	Female	South Island	35-49	20		pg/g	(0.86)	1.94	(0.57)	4.73	2.03	13.40	149.0	(0.37)	(0.4)	2.61	1.49	1.31	(0.48)	(0.39)	3.43
Maori	Female	Northland/Auckland	50-64	18		pg/g	1.84	3.91	*1.34*	10.10	2.64	18.50	155.0	(0.32)	*0.64*	3.46	1.94	1.75	(0.22)	(0.3)	2.22
Maori	Female	Waikato/Bay of Plenty	50-64	14		pg/g	*1.29*	4.24	2.57	14.20	2.91	12.80	164.0	(0.24)	*0.55*	2.93	2.63	2.21	(0.71)	(0.51)	3.41
Maori	Female	Lower North Island	50-64	13		pg/g	2.77	3.55	1.99	11.90	2.74	19.30	239.0	(0.39)	0.87	3.82	1.84	1.33	(0.63)	(0.43)	2.63
Maori	Female	South Island	50-64	16		pg/g	*1.22*	2.91	*1.27*	8.78	1.67	13.70	157.0	*0.74*	1.01	3.19	1.89	1.98	(0.3)	*0.56*	2.48
Non-Maori	Male	All	19-24	25		pg/g	(0.34)	1.47	(0.38)	2.24	*1.18*	7.70	75.3	(0.31)	(0.19)	1.49	*0.79*	1.01	(0.33)	(0.21)	2.02
Non-Maori	Male	All	25-34	26		pg/g	(0.41)	2.01	(0.42)	3.38	*1.04*	9.68	79.5	*0.93*	1.72	2.76	2.16	2.37	(0.26)	*0.76*	4.36
Non-Maori	Male	Northland/Auckland	35-49	11		pg/g	*0.58*	2.38	*0.87*	5.23	*1.43*	12.70	143.0	*0.62*	*0.58*	3.10	1.52	1.97	(0.36)	*0.55*	2.68
Non-Maori	Male	Waikato/Bay of Plenty	35-49	18		pg/g	*1.11*	1.96	1.91	5.78	1.89	9.28	98.1	*0.77*	1.08	2.70	1.40	(0.42)	(0.88)	(0.46)	2.65
Non-Maori	Male	Lower North Island	35-49	15		pg/g	(0.35)	1.60	(0.49)	4.47	*0.88*	13.50	104.0	(0.27)	(0.21)	2.81	1.60	1.42	(0.38)	*0.53*	2.35
Non-Maori	Male	South Island	35-49	10		pg/g	(1.17)	2.36	(0.9)	4.75	(0.93)	8.13	82.4	(0.51)	(0.57)	2.88	1.62	1.98	(0.57)	(0.44)	2.84
Non-Maori	Male	Northland/Auckland	50-64	17		pg/g	*1.27*	2.21	1.55	8.28	1.75	17.00	147.0	*0.71*	*0.52*	3.72	1.58	1.68	(0.21)	*0.64*	2.23
Non-Maori	Male	Waikato/Bay of Plenty	50-64	19		pg/g	(0.48)	2.86	1.57	12.40	2.05	18.30	106.0	(0.28)	(0.33)	3.47	2.38	1.85	(0.54)	(0.37)	3.49
Non-Maori	Male	Lower North Island	50-64	20		pg/g	(0.4)	3.00	*1.45*	9.76	*1.48*	10.40	120.0	(0.3)	(0.34)	4.04	1.00	1.60	(0.7)	(0.48)	3.71
Non-Maori	Male	South Island	50-64	16		pg/g	2.39	5.63	2.80	12.20	2.81	16.20	145.0	2.12	4.12	5.68	3.73	3.68	(0.37)	1.43	7.97
Non-Maori	Female	Northland/Auckland	19-24	8		pg/g	(0.56)	1.50	(0.4)	2.09	(0.4)	8.55	94.5	*0.96*	(0.39)	2.28	0.91	*0.55*	(0.38)	(0.38)	2.88
Non-Maori	Female	Waikato/Bay of Plenty	19-24	15		pg/g	(0.39)	1.50	(0.37)	2.20	*1.42*	9.14	89.2	(0.4)	(0.28)	1.18	*0.66*	0.91	(0.31)	(0.37)	2.74
Non-Maori	Female	Lower North Island	19-24	14		pg/g	*0.76*	1.33	*0.46*	2.65	*1.42*	9.33	97.2	1.41	1.08	2.80	2.28	1.94	(0.37)	1.05	5.52
Non-Maori	Female	South Island	19-24	10		pg/g	(0.47)	1.70	(1.54)	(1.45)	(1.57)	9.66	81.3	(0.54)	(0.43)	1.71	(0.5)	1.49	(0.96)	(0.54)	10.10
Non-Maori	Female	Northland/Auckland	25-34	12		pg/g	(0.41)	1.50	*0.64*	4.07	*1.37*	14.10	152.0	(0.52)	*0.48*	2.61	1.09	1.21	(0.28)	*0.84*	6.12
Non-Maori	Female	Waikato/Bay of Plenty	25-34	14		pg/g	*1.04*	3.09	*1.42*	4.52	1.69	8.36	90.1	1.76	3.20	3.58	2.69	2.30	(0.39)	*0.85*	3.27
Non-Maori	Female	Lower North Island	25-34	17		pg/g	(0.44)	1.75	(0.05)	2.99	(0.5)	16.60	118.0	*0.98*	0.88	2.08	1.20	1.16	(0.84)	*0.81*	3.34
Non-Maori	Female	South Island	25-34	16		pg/g	*1.15*	1.91	(0.49)	2.60	1.63	11.20	102.0	1.26	1.08	2.33	1.18	1.65	(0.32)	(0.32)	3.19
Non-Maori	Female	Northland/Auckland	35-49	14		pg/g	(0.35)	1.28	(0.64)	3.27	(0.66)	11.40	101.0	*0.80*	*0.50*	2.18	1.15	1.25	(0.33)	(0.34)	*1.72*
Non-Maori	Female	Waikato/Bay of Plenty	35-49	22		pg/g	*1.12*	3.42	2.05	8.12	2.61	19.50	211.0	1.45	1.07	3.68	1.75	1.96	(0.36)	*0.68*	3.90
Non-Maori	Female	Lower North Island	35-49	18		pg/g	*1.18*	1.34	*1.21*	3.85	*1.30*	13.60	114.0	(0.31)	(0.27)	2.44	1.54	1.42	(0.46)	(0.3)	3.48
Non-Maori	Female	South Island	35-49	18		pg/g	(0.4)	2.00	*0.69*	4.73	1.55	15.20	163.0	*0.76*	*0.47*	2.16	1.49	1.41	(0.22)	(0.28)	3.63
Non-Maori	Female	Northland/Auckland	50-64	23		pg/g	*1.30*	2.72	*1.26*	9.85	1.65	18.30	168.0	(0.29)	*0.62*	3.33	1.50	1.49	(0.37)	(0.25)	2.47
Non-Maori	Female	Northland/Auckland	50-64	23	Pool Duplicate	pg/g	*1.12*	2.80	*1.19*	8.10	2.12	15.90	163.0	(0.34)	(0.24)	3.46	0.98	1.52	(0.59)	(0.39)	2.46
Non-Maori	Female	Waikato/Bay of Plenty	50-64	11		pg/g	3.15	4.76	3.71	20.30	2.46	24.90	263.0	(0.38)	(0.24)	4.44	2.24	3.35	(0.57)	0.90	2.81
Non-Maori	Female	Waikato/Bay of Plenty	50-64	11	Pool Replicate	pg/g	2.48	3.63	2.00	8.37	1.64	17.70	149.0	1.54	2.59	4.81	2.28	2.26	(0.33)	1.01	3.14
Non-Maori	Female	Lower North Island	50-64	20		pg/g	*1.29*	2.35	*1.14*	9.81	1.93	12.00	180.0	(0.29)	(0.28)	3.16	1.46	2.14	(0.56)	(0.35)	2.76
Non-Maori	Female	South Island	50-64	20		pg/g	1.65	3.46	2.19	10.20	2.80	20.40	163.0	*0.95*	1.19	4.62	3.05	2.71	(0.63)	1.26	3.37
Method blank						pg/g	(0.61)	(0.5)	(0.55)	(0.54)	(0.56)	(0.6)	*6.22*	*0.81*	(0.37)	1.08	(0.35)	(0.34)	(0.74)	(0.36)	(0.49)
Bovine blank						pg/g	(0.48)	(0.39)	(0.33)	(0.31)	(0.34)	*1.44*	*7.08*	(0.31)	(0.31)	(0.27)	(0.31)	(0.32)	(0.52)	(0.35)	(0.37)
Lab blank						pg/g	(0.59)	(0.39)	(0.5)	(0.51)	(0.52)	(0.42)	5.52	(0.22)	(0.27)	(0.25)	(0.41)	(0.41)	(0.69)	(0.45)	(0.45)
Lab blank						pg/g	(0.78)	(0.54)	(0.56)	(0.57)	(0.58)	0.88	4.53	0.62	(0.41)	(0.38)	(0.26)	(0.25)	(0.39)	(0.28)	0.97
Lab blank						pg/g	(0.47)	(0.42)	(0.74)	(0.68)	(0.75)	(0.71)	5.69	0.65	(0.32)	(0.28)	(0.37)	(0.35)	(0.76)	(0.39)	(1.3)
Lab blank						pg/g	(0.43)	(0.45)	(0.39)	(0.36)	(0.4)	(0.32)	5.42	(0.28)	(0.22)	(0.18)	(0.23)	(0.22)	(0.41)	(0.22)	(0.29)
Lab blank						pg/g	(0.54)	(0.32)	(0.38)	(0.35)	(0.4)	(0.68)	8.92	(0.38)	(0.26)	(0.21)	(0.25)	(0.25)	(0.44)	(0.26)	(0.36)
Lab blank						pg/g	(0.31)	(0.24)	(0.36)	(0.36)	(0.37)	(0.29)	3.38	(0.24)	(0.26)	(0.21)	(0.2)	(0.2)	(0.35)	(0.22)	(0.29)
Lab blank						pg/g	(0.41)	(0.37)	(0.64)	(0.59)	(0.66)	(0.62)	4.96	0.57	(0.28)	(0.24)	(0.32)	(0.3)	(0.66)	(0.34)	(1.13)
Lab blank						pg/g	(0.46)	(0.47)	(0.41)	(0.38)	(0.42)	(0.34)	5.71	(0.3)	(0.23)	(0.19)	(0.24)	(0.23)	(0.43)	(0.23)	(0.31)

Values in brackets are <LOD, reported as 0.5LOD

Results shaded and in italics are < 3 x average lab blank

Ethnicity	Gender	Region	Age	N	Comments	Units	1234789HpCDF	OCDF
Maori	Male	All	19-24	5		pg/g	(2.19)	(3.03)
Maori	Male	All	25-34	13		pg/g	(0.65)	(0.66)
Maori	Male	Northland/Auckland	35-49	8		pg/g	(0.62)	(0.53)
Maori	Male	Waikato/Bay of Plenty	35-49	8		pg/g	(0.49)	(0.43)
Maori	Male	Lower North Island	35-49	10		pg/g	(0.75)	(0.69)
Maori	Male	South Island	35-49	6		pg/g	(0.64)	(0.84)
Maori	Male	Northland/Auckland	50-64	16		pg/g	(0.88)	(0.92)
Maori	Male	Waikato/Bay of Plenty	50-64	13		pg/g	(0.9)	(1.89)
Maori	Male	Lower North Island	50-64	11		pg/g	(0.84)	(1.39)
Maori	Male	South Island	50-64	11		pg/g	(0.36)	(0.55)
Maori	Female	All	19-24	20		pg/g	(0.7)	(0.43)
Maori	Female	Northland/Auckland	25-34	12		pg/g	(0.31)	(0.31)
Maori	Female	Waikato/Bay of Plenty	25-34	11		pg/g	(1.63)	(0.65)
Maori	Female	Lower North Island	25-34	14		pg/g	(0.61)	(0.37)
Maori	Female	South Island	25-34	8		pg/g	(0.53)	(0.37)
Maori	Female	Northland/Auckland	35-49	12		pg/g	(0.75)	(1.09)
Maori	Female	Waikato/Bay of Plenty	35-49	12		pg/g	(0.63)	(0.62)
Maori	Female	Lower North Island	35-49	9		pg/g	(0.79)	(0.59)
Maori	Female	South Island	35-49	20		pg/g	(0.58)	(0.84)
Maori	Female	Northland/Auckland	50-64	18		pg/g	(0.23)	(0.39)
Maori	Female	Waikato/Bay of Plenty	50-64	14		pg/g	(1.01)	(1.75)
Maori	Female	Lower North Island	50-64	13		pg/g	(1.03)	(1.12)
Maori	Female	South Island	50-64	16		pg/g	(0.24)	(0.36)
Non-Maori	Male	All	19-24	25		pg/g	(0.84)	(0.52)
Non-Maori	Male	All	25-34	26		pg/g	(0.69)	(0.6)
Non-Maori	Male	Northland/Auckland	35-49	11		pg/g	(0.59)	(0.88)
Non-Maori	Male	Waikato/Bay of Plenty	35-49	18		pg/g	(1.26)	(1.77)
Non-Maori	Male	Lower North Island	35-49	15		pg/g	(0.55)	(0.71)
Non-Maori	Male	South Island	35-49	10		pg/g	(1.26)	(1.55)
Non-Maori	Male	Northland/Auckland	50-64	17		pg/g	(0.24)	(0.29)
Non-Maori	Male	Waikato/Bay of Plenty	50-64	19		pg/g	(0.64)	(1.62)
Non-Maori	Male	Lower North Island	50-64	20		pg/g	(0.72)	(1.71)
Non-Maori	Male	South Island	50-64	16		pg/g	(0.52)	(0.55)
Non-Maori	Female	Northland/Auckland	19-24	8		pg/g	(1.53)	(1.26)
Non-Maori	Female	Waikato/Bay of Plenty	19-24	15		pg/g	(0.86)	(0.57)
Non-Maori	Female	Lower North Island	19-24	14		pg/g	(0.71)	(0.29)
Non-Maori	Female	South Island	19-24	10		pg/g	(2.48)	(1.24)
Non-Maori	Female	Northland/Auckland	25-34	12		pg/g	(0.37)	(0.36)
Non-Maori	Female	Waikato/Bay of Plenty	25-34	14		pg/g	(1.05)	(1.15)
Non-Maori	Female	Lower North Island	25-34	17		pg/g	(0.64)	(0.77)
Non-Maori	Female	South Island	25-34	16		pg/g	(1.11)	(0.68)
Non-Maori	Female	Northland/Auckland	35-49	14		pg/g	(0.59)	(0.71)
Non-Maori	Female	Waikato/Bay of Plenty	35-49	22		pg/g	(0.81)	(0.56)
Non-Maori	Female	Lower North Island	35-49	18		pg/g	(1.33)	(1.02)
Non-Maori	Female	South Island	35-49	18		pg/g	(0.4)	(0.46)
Non-Maori	Female	Northland/Auckland	50-64	23		pg/g	(0.54)	(1.1)
Non-Maori	Female	Northland/Auckland	50-64	23	Pool Duplicate	pg/g	(0.5)	(1.09)
Non-Maori	Female	Waikato/Bay of Plenty	50-64	11		pg/g	(1)	(1.29)
Non-Maori	Female	Waikato/Bay of Plenty	50-64	11	Pool Replicate	pg/g	(0.39)	(0.51)
Non-Maori	Female	Lower North Island	50-64	20		pg/g	(0.77)	(1.31)
Non-Maori	Female	South Island	50-64	20		pg/g	(0.62)	(0.7)
Method blank						pg/g	(1.05)	(2.15)
Bovine blank						pg/g	(0.72)	(1.31)
Lab blank						pg/g	(0.75)	(1.95)
Lab blank						pg/g	(0.43)	(0.93)
Lab blank						pg/g	(2.42)	(1.76)
Lab blank						pg/g	(0.57)	(0.7)
Lab blank						pg/g	(0.74)	(0.83)
Lab blank						pg/g	(0.54)	(0.65)
Lab blank						pg/g	(2.11)	(1.53)
Lab blank						pg/g	(0.6)	(0.73)

Values in brackets are <LOD, reported as 0.5LOD

Results shaded and in italics are < 3 x average lab blank

Ethnicity	Gender	Region	Age	N	Comments	Units	PCB1	PCB3	PCB4/10	PCB15	PCB19	PCB28	PCB37	PCB44	PCB49	PCB52	PCB54	PCB70	PCB74	PCB77	PCB81	PCB99	PCB101	PCB104	PCB105	PCB110	PCB114	PCB118	PCB123	PCB126
Maori	Male	All	19-24	5		pg/g	*59.90*	*62.30*	(23.65)	70.90	(15.25)	650	(14.65)	93.70	71.60	*183*	(11.1)	(14.95)	494	(10.25)	(10.25)	372	126.00	(6.75)	142	*73.70*	(8.2)	640	(7.8)	(10.1)
Maori	Male	All	25-34	13		pg/g	*17.30*	*21.50*	*43.10*	(8.35)	(5.45)	454	*17.50*	*35.90*	*22.80*	*111*	(3.81)	*26.70*	671	(4.52)	(4.9)	454	*81.70*	(1.76)	197	*35.20*	55.80	777	15.60	(4.97)
Maori	Male	Northland/Auckland	35-49	8		pg/g	*20.40*	*25.70*	*28.60*	*19.10*	*10.20*	610	*17.10*	*50.40*	*22.00*	*126*	(4.03)	*35.50*	862	(4.3)	(4.03)	639	*108.00*	(2.51)	230	*35.30*	89.00	1340	14.50	(4.54)
Maori	Male	Waikato/Bay of Plenty	35-49	8		pg/g	*17.30*	*25.60*	*31.60*	*26.70*	*9.79*	802	*18.40*	*45.60*	*31.20*	*162*	(6.1)	*42.20*	1160	(3.41)	(3.59)	826	179.00	(1.25)	445	*70.20*	105.00	2020	23.60	21.70
Maori	Male	Lower North Island	35-49	10		pg/g	*18.00*	*25.70*	*27.50*	*16.90*	*7.90*	721	*20.70*	*38.40*	*28.90*	*105*	(3.65)	*38.90*	1160	(3.64)	(3.64)	907	*92.60*	(1.78)	405	*56.40*	117.00	1940	14.60	*11.30*
Maori	Male	South Island	35-49	6		pg/g	*13.40*	*29.80*	*60.60*	*49.20*	*20.20*	839	*27.00*	*75.70*	*58.10*	*181*	(11.25)	*76.30*	1120	(4.84)	(4.67)	760	126.00	(4.13)	322	*56.50*	102.00	1520	18.00	(5.35)
Maori	Male	Northland/Auckland	50-64	16		pg/g	*13.50*	*18.30*	(18.6)	(19.1)	(8.7)	829	(13.4)	*65.50*	*41.40*	*126*	(13.45)	(9.05)	1520	(5.35)	(5.45)	1090	135.00	(4.22)	517	*55.10*	200.00	2590	22.50	17.60
Maori	Male	Waikato/Bay of Plenty	50-64	13		pg/g	*19.20*	*21.60*	(30)	(31.4)	(13.3)	1000	(22.7)	*54.60*	*29.60*	*118*	(11)	(14.75)	1330	(4.84)	(5)	1170	128.00	(6.8)	531	*74.30*	184.00	3040	(8.2)	24.70
Maori	Male	Lower North Island	50-64	11		pg/g	*18.20*	*22.10*	(20.35)	(22.35)	(16.6)	573	(26.2)	88.40	*48.80*	199	(10.25)	*52.70*	1120	(4.18)	(4.19)	1040	169.00	(6.35)	325	84.70	134.00	1900	30.90	(7.55)
Maori	Male	South Island	50-64	11		pg/g	*19.90*	*29.40*	*47.80*	*27.40*	(9.05)	2230	(10.05)	102.00	*34.80*	228	(11.25)	*54.90*	1850	(4.74)	(4.5)	1050	185.00	(3.32)	594	117.00	196.00	2780	31.50	17.10
Maori	Female	All	19-24	20		pg/g	*11.60*	*14.30*	(15.7)	(17.75)	(9.05)	944	(15.15)	*44.00*	*32.90*	*187*	(12.6)	(15.3)	704	(4.9)	(5)	440	164.00	(4.65)	207	110.00	36.60	970	(5.6)	(6.1)
Maori	Female	Northland/Auckland	25-34	12		pg/g	*9.93*	*21.50*	(11.3)	(12.2)	(15.1)	614	(12.6)	*44.50*	*32.90*	*108*	(7.3)	*48.40*	727	(5.85)	(5.55)	447	*90.90*	(5.75)	229	*49.10*	48.30	1050	21.10	(4.91)
Maori	Female	Waikato/Bay of Plenty	25-34	11		pg/g	*16.00*	*27.00*	*32.70*	(12.75)	(11.3)	581	(8.95)	*42.80*	*23.60*	*92*	(8.5)	*28.60*	607	(7.35)	(7.35)	457	*83.70*	(4.4)	208	*40.30*	43.30	857	(11.9)	(4.37)
Maori	Female	Lower North Island	25-34	14		pg/g	*16.00*	*16.10*	*45.20*	(11.8)	(4.79)	961	(9.1)	*34.60*	*23.50*	*125*	(7.6)	*25.30*	2430	(4.07)	(4.64)	579	*96.20*	(4.28)	419	*44.90*	73.20	1390	(6.3)	(4.3)
Maori	Female	South Island	25-34	8		pg/g	*13.60*	*27.80*	(17.4)	(17.4)	(13.6)	775	(9.6)	*51.10*	*53.90*	*121*	(10.9)	*52.60*	761	(6.8)	(6.5)	452	*121.00*	(3.95)	227	*62.50*	49.10	1080	13.60	(4.09)
Maori	Female	Northland/Auckland	35-49	12		pg/g	*19.20*	*28.80*	*36.10*	(15.9)	(4.14)	798	*19.60*	*47.20*	*29.00*	*99*	(4.47)	*34.40*	1200	(4.97)	(4.83)	795	*115.00*	(1.93)	405	*50.20*	107.00	1770	22.80	(5.05)
Maori	Female	Waikato/Bay of Plenty	35-49	12		pg/g	*19.20*	*24.60*	*30.60*	(10.5)	(5.85)	633	*20.10*	*36.60*	*26.90*	*111*	(5.85)	*45.30*	861	(5.65)	(5.8)	523	139.00	(2.65)	298	*71.80*	78.00	1680	16.30	*11.50*
Maori	Female	Lower North Island	35-49	9		pg/g	*19.00*	*26.30*	*37.00*	(9.1)	(6.9)	1050	*14.90*	*50.80*	*33.30*	*134*	(5.3)	*39.60*	1790	(4.23)	(3.94)	863	*107.00*	(2.27)	419	*44.20*	120.00	2150	15.40	*14.60*
Maori	Female	South Island	35-49	20		pg/g	*14.00*	*12.70*	(19.75)	(19.4)	(10.75)	777	(22.7)	*62.10*	*32.70*	*167*	(10.55)	*47.80*	1060	(5.15)	(4.85)	660	*108.00*	(5.15)	291	*52.40*	101.00	1530	(9.3)	*11.00*
Maori	Female	Northland/Auckland	50-64	18		pg/g	*12.80*	*17.40*	(8.3)	(8.7)	(5.05)	664	(8)	*45.20*	*29.50*	*138*	(7.45)	*48.70*	2300	(3.97)	(3.82)	1160	154.00	(2.32)	471	*63.20*	205.00	2730	30.30	17.90
Maori	Female	Waikato/Bay of Plenty	50-64	14		pg/g	*20.30*	*19.50*	(18.35)	(19)	(15)	852	(21.8)	(20.45)	(18.5)	*103*	(14.3)	*33.80*	2180	(4.66)	(4.46)	1540	*124.00*	(6.45)	623	*64.20*	184.00	3420	38.90	20.00
Maori	Female	Lower North Island	50-64	13		pg/g	*14.90*	*15.90*	(34.55)	(31.1)	(9.25)	963	(25.6)	*69.10*	*35.30*	214	(11.8)	*42.00*	1970	(6.6)	(6.35)	1150	261.00	(6.95)	544	85.60	216.00	2950	32.30	17.30
Maori	Female	South Island	50-64	16		pg/g	*10.70*	*22.30*	(8.95)	*20.70*	(6.85)	973	(7.95)	*41.00*	*33.50*	*145*	(8.05)	*35.40*	2020	(4.14)	(4.09)	1030	127.00	(3.25)	414	*52.40*	138.00	2180	23.20	*14.10*
Non-Maori	Male	All	19-24	25		pg/g	*14.20*	*12.20*	*51.40*	(13.4)	(9.1)	574	(9.7)	*38.10*	(11.4)	*98*	(9.05)	(9)	537	(5)	(5.2)	330	*91.80*	(3.44)	148	*39.30*	39.50	729	(5.95)	(4.08)
Non-Maori	Male	All	25-34	26		pg/g	*16.80*	*17.10*	*45.00*	(12.15)	(7.5)	1460	(10.6)	107.00	*55.90*	301	(7.7)	*40.60*	1170	(4.86)	(4.87)	690	191.00	(2.88)	299	151.00	71.50	1320	20.60	(4.7)
Non-Maori	Male	Northland/Auckland	35-49	11		pg/g	*19.30*	*24.40*	*39.90*	(7)	(3.9)	563	*17.10*	*48.40*	*39.20*	*113*	(3.21)	*33.60*	1150	(6.15)	(5.9)	652	*116.00*	(1.91)	271	*45.90*	122.00	1420	21.90	*12.40*
Non-Maori	Male	Waikato/Bay of Plenty	35-49	18		pg/g	*10.90*	*14.30*	*40.50*	(10.1)	*11.10*	634	(4.77)	*39.70*	*27.30*	*119*	(4.2)	*20.10*	939	(5.6)	(5.7)	641	*85.20*	(2.65)	252	*39.70*	83.10	1300	13.40	(3.56)
Non-Maori	Male	Lower North Island	35-49	15		pg/g	*16.80*	*18.60*	*42.90*	*27.00*	(3.66)	1280	(4.8)	86.80	*44.10*	248	(3.81)	*34.10*	1220	(3.51)	(3.54)	1040	160.00	(1.97)	340	80.10	110.00	1620	19.70	(5.1)
Non-Maori	Male	South Island	35-49	10		pg/g	*14.90*	*23.10*	(21.9)	(22.1)	(10.6)	614	(16.45)	*73.50*	(15.15)	*147*	(11.3)	*43.60*	854	(4.46)	(4.56)	667	*113.00*	(6.4)	228	*45.80*	78.70	1180	19.60	(5.9)
Non-Maori	Male	Northland/Auckland	50-64	17		pg/g	*11.90*	*30.10*	*31.80*	*32.50*	(7.65)	1240	(8.7)	*65.90*	*40.10*	*161*	(6.15)	*45.20*	1860	(4.67)	(4.66)	1100	130.00	(3.09)	570	*56.60*	173.00	2470	43.80	17.30
Non-Maori	Male	Waikato/Bay of Plenty	50-64	19		pg/g	*18.20*	*24.50*	(27.85)	(29.5)	(17.55)	997	(29.8)	(27.15)	(24.55)	*121*	(18.2)	*28.10*	1820	(4.63)	(4.64)	1500	*116.00*	(7.85)	562	*44.20*	244.00	2580	31.90	15.40
Non-Maori	Male	Lower North Island	50-64	20		pg/g	*16.60*	*20.70*	(25.8)	(25.55)	(17.15)	3050	(30.8)	178.00	87.80	363	(16.4)	*50.20*	2690	(4.28)	(4.49)	2090	187.00	(8.7)	723	78.50	241.00	3450	39.30	*12.40*
Non-Maori	Male	South Island	50-64	16		pg/g	*11.60*	*18.80*	*27.10*	*33.10*	(8.65)	758	*27.70*	*51.30*	(15.1)	*117*	(11.3)	*30.60*	1470	(5.2)	(4.94)	989	139.00	(2.78)	414	77.10	184.00	1940	23.30	*14.30*
Non-Maori	Female	Northland/Auckland	19-24	8		pg/g	*26.70*	*31.30*	(17.5)	(18.75)	(14.5)	904	(24.35)	(14.35)	*38.90*	*139*	(10.55)	(13.05)	636	(8.45)	(7.8)	408	135.00	(5.2)	187	*57.10*	55.60	919	(7.4)	(5.85)
Non-Maori	Female	Waikato/Bay of Plenty	19-24	15		pg/g	*15.60*	*18.90*	*43.90*	*22.00*	(9)	806	(10.85)	(17.25)	(15.6)	*84*	(12.4)	*23.20*	616	(3.97)	(3.98)	313	*82.80*	(3.57)	161	*46.00*	34.40	834	(10.45)	(5.9)
Non-Maori	Female	Lower North Island	19-24	14		pg/g	*16.50*	*17.80*	*47.40*	(14.2)	(10.1)	1200	(13.25)	*68.30*	*35.90*	*119*	(11.25)	*47.10*	744	(3.5)	(3.54)	491	*117.00*	(4.13)	202	*66.10*	36.80	968	(4.23)	(4.92)
Non-Maori	Female	South Island	19-24	10		pg/g	*28.40*	*31.60*	*58.70*	(12)	(8.25)	954	(8.95)	*63.50*	*39.50*	*125*	(6.45)	*42.30*	874	(4.88)	(5)	404	*124.00*	(3.33)	193	*57.80*	74.90	921	18.80	(5.05)
Non-Maori	Female	Northland/Auckland	25-34	12		pg/g	*12.80*	*30.30*	(8.55)	(9.7)	(6.95)	680	(8.85)	*38.00*	*25.30*	*90*	(6.85)	*36.10*	839	(5.4)	(4.97)	469	*91.90*	(2.83)	248	*44.20*	70.80	1160	(10.5)	(4.02)
Non-Maori	Female	Waikato/Bay of Plenty	25-34	14		pg/g	*21.90*	*25.50*	*58.90*	(10.7)	(5.55)	691	(8.3)	(7.7)	(6.95)	*128*	(5.7)	*38.90*	762	(4.56)	(4.94)	469	*122.00*	(3.12)	224	*59.90*	60.20	1100	(7.2)	(8.1)
Non-Maori	Female	Lower North Island	25-34	17		pg/g	*14.40*	*12.60*	*46.50*	(9.35)	*18.70*	633	(9.15)	*50.60*	(11.5)	*120*	(8.5)	(7.55)	705	(3.21)	(3.5)	472	*117.00*	(4.12)	265	*49.60*	38.00	1090	14.10	(5.55)
Non-Maori	Female	South Island	25-34	16		pg/g	*10.40*	*18.70*	*50.20*	(8.8)	(7.7)	1340	(6.45)	*41.50*	*20.50*	*82*	(6.6)	*25.70*	889	(3.9)	(4.24)	457	*107.00*	(2.76)	231	*52.70*	47.20	1120	(5.65)	(6.05)
Non-Maori	Female	Northland/Auckland	35-49	14		pg/g	*20.10*	*25.20*	(9.1)	*31.90*	*12.60*	711	*15.20*	*37.20*	*29.20*	*93*	(4.11)	*44.30*	1000	(4.19)	(4.11)	530	*74.50*	(2.19)	289	*41.90*	76.00	1400	17.00	*8.89*
Non-Maori	Female	Waikato/Bay of Plenty	35-49	22		pg/g	*23.00*	*32.10*	*34.70*	*19.30*	*9.65*	1230	*22.50*	*45.50*	*29.80*	*111*	(3.07)	*52.50*	1520	(4.93)	(4.77)	840	137.00	(2.64)	433	*62.50*	145.00	2270	32.50	21.40
Non-Maori	Female	Lower North Island	35-49	18		pg/g	*22.00*	*27.30*	*35.50*	(9.85)	*10.90*	1050	*24.70*	*52.60*	*33.90*	*155*	(4.1)	*45.30*	1430	(4.67)	(4.35)	677	132.00	(2.89)	373	*63.60*	104.00	1710	21.40	*8.74*
Non-Maori	Female	South Island	35-49	18		pg/g	*12.80*	*21.60*	(12.1)	(12.65)	(9.95)	683	(9.8)	*35.60*	(12.4)	*113*	(9.85)	*42.00*	1020	(6.85)	(6.45)	581	*72.70*	(3.46)	264	*43.00*	103.00	1520	21.50	*8.87*
Non-Maori	Female	Northland/Auckland	50-64	23		pg/g	*15.80*	*17.70*	*31.00*	(11.5)	(5.85)	835	(7.3)	*34.60*	(12.5)	*95*	(10.45)	*27.80*	2200	(3.91)	(4.07)	1030	*96.60*	(2.73)	586	*47.20*	229.00	3020	36.90	15.60
Non-Maori	Female	Northland/Auckland	50-64	23	Pool Duplicate	pg/g	*17.10*	*20.00*	*30.80*	(13.35)	(6.05)	864	(8.95)	*36.80*	*22.80*	*106*	(6.25)	*31.50*	2120	(4.58)	(4.63)	993	*108.00*	(2.54)	524	*43.20*	204.00	2840	26.10	20.90
Non-Maori	Female	Waikato/Bay of Plenty	50-64	11		pg/g	*17.40*	*19.70*	(13.25)	(14.95)	(8.5)	1190	(13.05)	*63.20*	77.10	213	(8.95)	*54.50*	2350	(4.74)	(4.79)	1330	276.00	(4.07)	664	138.00	227.00	3430	48.00	19.20
Non-Maori	Female	Waikato/Bay of Plenty	50-64	11	Pool Replicate	pg/g	*18.10*	*24.40*	(11.95)	(11.6)	(6.45)	935	*16.20*	*55.20*	*39.20*	*152*	(8.5)	*51.70*	1600	(6)	(6.4)	764	132.00	(3.48)	328	*53.40*	155.00	2020	34.20	15.90
Non-Maori	Female	Lower North Island	50-64	20		pg/g	*15.00*	*18.50*	(21.5)	(21.7)	(15.95)	1490	(27.9)	*52.00*	(24.5)	*145*	(19.55)	(20.45)	2060	(6.7)	(6.85)	1000	*108.00*	(7.35)	451	*50.60*	158.00	2260	24.50	*12.50*
Non-Maori	Female	South Island	50-64	20		pg/g	*9.67*	*16.80*	*38.40*	*33.20*	(5.25)	869	*17.90*	*53.70*	(39.15)	*142*	(29.85)	*40.30*	2200	(3.85)	(3.82)	1260	*117.00*	(3.14)	463	*52.30*	166.00	3100	28.50	*11.90*
Method blank						pg/g	*32.30*	*32.90*	*60.70*	(17.7)	(10.1)	*41.10*	(11.6)	(12.55)	(11.35)	*51.80*	(9.2)	*34.20*	(10.5)	(6.2)	(6.35)	(9.25)	*41.20*	(5.15)	(8.25)	*26.60*	(8.3)	*26.80*	(8)	(5.05)
Bovine blank						pg/g	*30.60*	*29.10*	*61.00*	*32.50*	(12.55)	*89.60*	(12.6)	*30.00*	*32.10*	*62.20*	(7.8)	*38.30*	*18.60*	(5.55)	(5.3)	(5.95)	*26.50*	(3.44)	(6.15)	*20.50*	(5.95)	*29.00*	(5.9)	(3.7)
Lab blank						pg/g	24.8	24.7	(14.7)	(14.4)	(10.5)	39.8	(13.35)	(12.6)	(11.4)	40.9	(9.35)	25.4	(8.55)	(4.96)	(5.1)	(10.25)	32.2	(3.4)	(4.24)	24.6	(4.37)	8.39	(4.08)	(4.79)
Lab blank						pg/g	18.5	25.8	(13.35)	(12.9)	(8.15)	70.8	(9.5)	40.6	(8.15)	76.3	(6.95)	54.9	(7.85)	(4.06)	(4.11)	(6)	43.3	(3.22)	(4.46)	29	(4.13)	20	(4)	(4.91)
Lab blank						pg/g	48	49.6	104	(27.8)	(15.3)	50.2	(11.65)	(16.4)	(14.85)	55.1	(12.85)	24.7	(11)	(4.92)	(4.45)	(11.35)	(11.4)	(5.6)	(4.83)	(9.85)	(4.74)	9.69	(4.47)	(5.9)
Lab blank						pg/g	11.4	25.7	(18.9)	(17.45)	(14.95)	54.9	(14)	36.1	(13.4)	60.3	(11.35)	34.2	(10.7)	(6.2)	(6.2)	(9.2)	30	(4.85)	(4.06)	21.9	(4.43)	16.9	(3.97)	(4.72)
Lab blank						pg/g	12.4	9.73	(24.95)	(26.7)	(14.9)	41.1	(19)	(17.3)	46	46.4	(12.25)	34.1	(14.5)	(3.07)	(3.15)	(15.5)	44	(7.45)	(6.1)	(13.5)	(6.4)	59	(5.75)	(3.89)
Lab blank						pg/g	23.8	30	40.1	(8.7)	(6.4)	66.5	17.4	53	(44.9)	131	(5.5)	(31.3)	71.3	(5.65)	(5.85)	93.6	133	(3.06)	30	70.6	(4.28)	120	(4.2)	(4.98)
Lab blank						pg/g	41.8	43.2	90.6	(24.25)	(13.35)	43.7	(10.15)	(14.3)	(12.9)	48	(11.2)	21.6	(9.6)	(4.29)	(3.88)	(9.85)	(9.95)	(4.89)	(4.2)	(8.6)	(4.13)	8.44	(3.89)	(5.15)
Lab blank						pg/g	12	27	(19.9)	(18.4)	(15.75)	57.9	(14.75)	38.1	(14.1)	63.6	(11.95)	36.1	(11.3)	(6.5)	(6.55)	(9.7)	31.6	(5.1)	(4.28)	23.1	(4.67)	17.8	(4.18)	(4.98)

Values in brackets are <LOD, reported as 0.5LOD

Results shaded and in italics are < 3 x average lab blank

Ethnicity	Gender	Region	Age	N	Comments	Units	PCB138/163/164	PCB153	PCB155	PCB156	PCB157	PCB167	PCB169	PCB170	PCB180	PCB183	PCB187	PCB188	PCB189	PCB194	PCB196/203	PCB200	PCB202	PCB205	PCB206	PCB208	PCB209
Maori	Male	All	19-24	5		pg/g	3940	5220	(4.74)	625	114	171	(13)	1290	4000	348.00	852.00	(9.85)	72.10	416.00	429	(8.05)	68.70	(12.2)	100.00	(6.2)	135.00
Maori	Male	All	25-34	13		pg/g	5040	6850	(2.2)	937	160	188	(6.3)	2470	7500	485.00	1330.00	(4.63)	153.00	1110.00	756	(3.13)	114.00	23.90	130.00	30.70	154.00
Maori	Male	Northland/Auckland	35-49	8		pg/g	8800	11900	(1.31)	1720	334	339	(9.2)	4960	13600	765.00	2600.00	(3.85)	297.00	2510.00	1660	(2.39)	280.00	54.40	332.00	111.00	221.00
Maori	Male	Waikato/Bay of Plenty	35-49	8		pg/g	10300	12700	(2.34)	1740	295	459	20.20	4760	13100	971.00	2530.00	(4.12)	264.00	2190.00	1500	(1.84)	197.00	47.80	224.00	75.10	183.00
Maori	Male	Lower North Island	35-49	10		pg/g	12400	17300	(0.88)	2610	412	497	21.80	6740	19300	1130.00	3730.00	(4.4)	388.00	3130.00	1990	(2.39)	318.00	62.10	379.00	116.00	255.00
Maori	Male	South Island	35-49	6		pg/g	9320	13700	*7.03*	1950	348	421	(17.9)	4570	13900	812.00	2400.00	(9.9)	277.00	2350.00	1500	(6.3)	246.00	50.80	249.00	81.20	316.00
Maori	Male	Northland/Auckland	50-64	16		pg/g	15700	22100	(2.63)	3440	558	826	22.80	8030	24300	1490.00	4540.00	(13.9)	398.00	4530.00	3020	(3.89)	473.00	90.00	649.00	202.00	405.00
Maori	Male	Waikato/Bay of Plenty	50-64	13		pg/g	17500	25300	(5.35)	3460	638	978	28.10	10600	29000	1750.00	6280.00	(11.9)	544.00	5100.00	3430	(10.3)	587.00	89.40	700.00	279.00	340.00
Maori	Male	Lower North Island	50-64	11		pg/g	13700	19400	(4.6)	2800	480	565	(7.6)	7860	24200	1450.00	4970.00	(17.65)	403.00	5540.00	3610	(9.8)	776.00	98.50	1170.00	402.00	398.00
Maori	Male	South Island	50-64	11		pg/g	15400	20900	(3.08)	3480	675	742	28.10	9000	24200	1470.00	4840.00	(10.05)	456.00	4390.00	2910	(7.85)	442.00	67.20	567.00	196.00	417.00
Maori	Female	All	19-24	20		pg/g	3170	3550	(3.29)	506	92	179	(7.2)	1010	2690	240.00	586.00	(11)	32.40	384.00	236	(6)	51.70	(9.4)	60.60	(6.4)	119.00
Maori	Female	Northland/Auckland	25-34	12		pg/g	3530	4540	(4.01)	624	132	200	(6.95)	1250	3460	296.00	780.00	(7.95)	66.80	541.00	422	(6.3)	73.90	(8.1)	84.20	34.20	140.00
Maori	Female	Waikato/Bay of Plenty	25-34	11		pg/g	4080	5380	(1.78)	641	130	190	(8.8)	1510	4130	362.00	805.00	(5.35)	79.90	526.00	413	(6)	68.70	(7.8)	70.10	27.00	125.00
Maori	Female	Lower North Island	25-34	14		pg/g	4690	5700	(3.28)	717	132	192	(8.15)	1600	4290	352.00	855.00	(6.2)	65.00	547.00	352	(4.02)	63.70	(5.85)	90.40	28.20	128.00
Maori	Female	South Island	25-34	8		pg/g	3790	4900	(2.58)	730	161	195	(7.9)	1540	4280	301.00	817.00	(6.2)	70.10	665.00	478	(4.75)	73.00	*19.50*	125.00	43.30	162.00
Maori	Female	Northland/Auckland	35-49	12		pg/g	7890	11000	(1.39)	1400	268	431	(8.55)	3320	9490	715.00	2050.00	(5.25)	173.00	1620.00	1220	(2.76)	194.00	42.10	251.00	71.40	209.00
Maori	Female	Waikato/Bay of Plenty	35-49	12		pg/g	8750	11200	(1.73)	1510	228	487	(8.2)	4040	11100	792.00	2460.00	(3.56)	208.00	1690.00	1210	(2.8)	182.00	38.70	215.00	59.30	176.00
Maori	Female	Lower North Island	35-49	9		pg/g	12000	14700	(1.51)	2020	312	623	19.70	5140	14400	1170.00	3080.00	(3.79)	269.00	2160.00	1730	(2.03)	229.00	55.40	327.00	107.00	254.00
Maori	Female	South Island	35-49	20		pg/g	6000	8070	(3.77)	1140	228	312	(7.05)	2980	8840	597.00	1750.00	(7)	169.00	1600.00	1110	(9.35)	145.00	21.80	261.00	79.60	241.00
Maori	Female	Northland/Auckland	50-64	18		pg/g	15300	21000	(3.03)	2650	523	710	19.70	6640	19500	1340.00	4360.00	(8.6)	326.00	3540.00	2530	(4.45)	442.00	70.20	563.00	188.00	324.00
Maori	Female	Waikato/Bay of Plenty	50-64	14		pg/g	19700	25600	(7.7)	2920	523	984	(7.85)	7920	22700	2060.00	5120.00	(18.3)	382.00	3560.00	3110	(9.3)	484.00	83.90	616.00	237.00	281.00
Maori	Female	Lower North Island	50-64	13		pg/g	14700	18800	(3.57)	2450	452	865	(10.45)	5950	18200	1290.00	4040.00	(12.85)	274.00	3020.00	2430	(18)	383.00	66.20	536.00	200.00	346.00
Maori	Female	South Island	50-64	16		pg/g	11500	15000	(3.61)	2250	400	607	17.20	5560	16800	1160.00	3510.00	(3.9)	276.00	3070.00	2420	(4.12)	368.00	80.20	625.00	242.00	423.00
Non-Maori	Male	All	19-24	25		pg/g	3110	4170	11.40	652	122	139	(6.2)	1600	4110	279.00	773.00	(8.65)	61.90	582.00	440	(3.9)	105.00	(8.05)	127.00	42.30	134.00
Non-Maori	Male	All	25-34	26		pg/g	4930	6770	(5.75)	965	164	189	*12.00*	2240	6160	481.00	1280.00	(7.1)	75.70	951.00	648	(5)	104.00	(24.45)	96.50	(5.75)	183.00
Non-Maori	Male	Northland/Auckland	35-49	11		pg/g	9210	15600	(1.45)	2170	431	390	20.60	6670	21700	965.00	3260.00	(4.98)	369.00	3730.00	2570	(2.72)	441.00	69.60	456.00	185.00	369.00
Non-Maori	Male	Waikato/Bay of Plenty	35-49	18		pg/g	8340	12800	(1.54)	1810	338	339	(9.15)	4640	14500	689.00	2470.00	(4.49)	267.00	2610.00	1630	(2.03)	298.00	48.80	330.00	120.00	305.00
Non-Maori	Male	Lower North Island	35-49	15		pg/g	8450	12500	(1)	1610	310	314	*16.00*	4150	13300	907.00	2840.00	(3.74)	227.00	2380.00	1830	(1.61)	383.00	47.90	448.00	198.00	432.00
Non-Maori	Male	South Island	35-49	10		pg/g	6620	9630	(3.87)	1320	259	315	*14.20*	3680	12200	745.00	1970.00	(19.45)	242.00	2500.00	1500	(5.25)	229.00	47.60	327.00	132.00	329.00
Non-Maori	Male	Northland/Auckland	50-64	17		pg/g	11800	17100	(2.3)	2510	491	561	17.70	6550	19700	1150.00	3710.00	(8.1)	362.00	4260.00	2800	(4.6)	527.00	69.80	662.00	246.00	383.00
Non-Maori	Male	Waikato/Bay of Plenty	50-64	19		pg/g	15600	23100	(5.9)	3530	732	743	(14.05)	7990	25000	1320.00	4530.00	(17.15)	530.00	5310.00	2830	(9.4)	536.00	90.80	589.00	193.00	365.00
Non-Maori	Male	Lower North Island	50-64	20		pg/g	21400	32500	(9.6)	3980	726	853	23.30	10200	32700	2590.00	6400.00	(15.6)	532.00	7140.00	4980	(16.35)	869.00	103.00	1190.00	447.00	768.00
Non-Maori	Male	South Island	50-64	16		pg/g	12400	18100	(3.06)	2980	524	654	23.10	8510	23200	1150.00	4020.00	(6.35)	475.00	4460.00	2830	(7.5)	505.00	51.80	653.00	242.00	471.00
Non-Maori	Female	Northland/Auckland	19-24	8		pg/g	4910	5870	(3.18)	813	149	290	(11.4)	2010	5500	426.00	1000.00	(10.8)	89.80	565.00	510	(8.7)	67.20	(8.75)	60.50	21.50	114.00
Non-Maori	Female	Waikato/Bay of Plenty	19-24	15		pg/g	2820	3540	(4.27)	466	92	171	(11)	1030	3000	250.00	583.00	(4.99)	26.30	376.00	257	(3)	41.10	(12)	78.60	*11.50*	127.00
Non-Maori	Female	Lower North Island	19-24	14		pg/g	3510	4530	(3.31)	589	118	181	(5.8)	1220	3550	237.00	531.00	(11.1)	42.10	378.00	337	(5.5)	52.90	(11.6)	65.30	(9.55)	102.00
Non-Maori	Female	South Island	19-24	10		pg/g	3320	4580	*6.04*	809	181	205	(7.4)	1470	4550	263.00	784.00	(6.8)	80.50	563.00	448	(3.79)	92.60	*10.70*	84.90	30.40	127.00
Non-Maori	Female	Northland/Auckland	25-34	12		pg/g	4030	5480	(2.09)	713	153	243	(6.8)	1780	5150	352.00	1070.00	(6.95)	89.10	919.00	791	(4.04)	209.00	*17.70*	333.00	140.00	160.00
Non-Maori	Female	Waikato/Bay of Plenty	25-34	14		pg/g	4380	6280	(1.95)	816	179	218	(10.75)	1800	5620	413.00	1110.00	(3.32)	104.00	898.00	663	(4.73)	134.00	*17.20*	214.00	57.50	171.00
Non-Maori	Female	Lower North Island	25-34	17		pg/g	3590	4590	(1.95)	625	133	197	(8.25)	1330	3880	268.00	740.00	(8.7)	78.50	650.00	488	(3.45)	84.90	(6.25)	95.10	31.30	143.00
Non-Maori	Female	South Island	25-34	16		pg/g	4800	6070	(2.11)	773	151	259	(9.5)	1890	5270	454.00	1100.00	(3.76)	101.00	770.00	646	(4.39)	94.30	24.20	132.00	42.60	198.00
Non-Maori	Female	Northland/Auckland	35-49	14		pg/g	5280	7270	(1.66)	1070	202	303	(6.25)	2570	8350	528.00	1570.00	(4.08)	146.00	1710.00	1290	(1.87)	241.00	33.90	472.00	224.00	350.00
Non-Maori	Female	Waikato/Bay of Plenty	35-49	22		pg/g	9570	13300	(1.21)	1700	314	543	*12.00*	4020	12700	906.00	2490.00	(2.94)	219.00	2170.00	1630	(1.02)	256.00	50.50	370.00	132.00	341.00
Non-Maori	Female	Lower North Island	35-49	18		pg/g	6660	9020	(1.7)	1270	224	332	(7.8)	2810	8760	575.00	1610.00	(3.66)	140.00	1520.00	1220	(3.03)	176.00	31.90	301.00	114.00	310.00
Non-Maori	Female	South Island	35-49	18		pg/g	6530	9480	(2.78)	1320	241	380	*12.30*	3500	11100	747.00	2060.00	(7.05)	175.00	2170.00	1520	(4.49)	220.00	48.80	343.00	91.00	330.00
Non-Maori	Female	Northland/Auckland	50-64	23		pg/g	12700	18200	(2.36)	2560	492	742	*16.00*	6180	19100	1190.00	4030.00	(5.95)	320.00	4080.00	2820	(3.85)	487.00	83.90	751.00	260.00	414.00
Non-Maori	Female	Northland/Auckland	50-64	23	Pool Duplicate	pg/g	13100	19000	(1.5)	2550	473	811	(7.6)	6160	18100	1160.00	3870.00	(4.15)	338.00	3740.00	2680	(3.34)	457.00	73.70	729.00	254.00	411.00
Non-Maori	Female	Waikato/Bay of Plenty	50-64	11		pg/g	15800	21500	(3.08)	2940	560	910	21.00	7790	22300	1330.00	4500.00	(10.25)	409.00	3720.00	2440	(31.45)	387.00	98.10	523.00	147.00	306.00
Non-Maori	Female	Waikato/Bay of Plenty	50-64	11	Pool Replicate	pg/g	9580	14600	(3.78)	2120	430	634	22.10	6130	19800	1020.00	3640.00	(9.1)	372.00	4400.00	2780	(13.45)	452.00	74.50	658.00	253.00	584.00
Non-Maori	Female	Lower North Island	50-64	20		pg/g	10200	13700	(6.45)	2000	413	505	(9.05)	5180	15700	1010.00	2940.00	(18.1)	283.00	3370.00	2330	(8.5)	412.00	55.10	618.00	208.00	352.00
Non-Maori	Female	South Island	50-64	20		pg/g	16400	23100	(1.98)	2920	559	890	*16.50*	7880	22200	1580.00	3870.00	(7)	408.00	3580.00	2610	(3.53)	381.00	64.30	504.00	183.00	490.00
Method blank						pg/g	*32.90*	*48.60*	(2.59)	(5.85)	(5.6)	(6.2)	(5.8)	(8.4)	*22.60*	(6.2)	(6.35)	(4.91)	(6.65)	(8.1)	(4.91)	(3.31)	(2.85)	(5.9)	(2.47)	(3.2)	(1.36)
Bovine blank						pg/g	*53.60*	*72.10*	(1.71)	(4.74)	(4.47)	(4.53)	(4.85)	(12.35)	*25.20*	(8.95)	(9.15)	(7)	(9.8)	(7.65)	(4.28)	(2.88)	(2.49)	(5.65)	(3.34)	(4.29)	(1.39)
Lab blank						pg/g	(5.4)	15.8	(1.86)	(4.98)	(4.67)	(4.51)	(7.45)	(7.75)	(6.95)	(5.4)	(5.55)	(4.13)	(6.15)	(8.1)	(6.9)	(4.66)	(4.02)	(5.75)	(4.87)	(6.4)	(2.24)
Lab blank						pg/g	(5.35)	(4.75)	(2.94)	(4.66)	(4.5)	(4.54)	(6.1)	(8.8)	(8.7)	(6.8)	(6.95)	(5.55)	(6.95)	(6.65)	(6.3)	(4.24)	(3.66)	(4.77)	(2.11)	(2.71)	(1.83)
Lab blank						pg/g	(5.8)	(5.15)	(4.42)	(4.82)	(4.66)	(4.63)	(4.51)	(11.45)	(10.8)	(8.4)	(8.6)	(6.5)	(4.53)	(10.85)	(7.35)	(4.95)	(4.27)	(7.6)	(3.03)	(4.02)	(2.34)
Lab blank						pg/g	27.8	21.8	(2.91)	(4.41)	(4.16)	(4.27)	(6.35)	(10.05)	(9.75)	(7.55)	(7.75)	(6.05)	(3.98)	(14.3)	(8.2)	(5.5)	(4.76)	(9.85)	(3.33)	(4.09)	(3.18)
Lab blank						pg/g	(8.6)	55.6	(3.69)	(4.24)	(4.46)	(4.99)	(4.31)	(15.45)	(14.9)	(11.6)	(11.85)	(9.2)	(5.9)	(12.25)	(10.85)	(7.3)	(6.3)	(8.7)	(5.7)	(7.15)	(3.22)
Lab blank						pg/g	107	132	(1.72)	8.17	(3.1)	(3.3)	(4.81)	16.6	72.5	13.5	32.6	(3.02)	(3.96)	10.8	21.6	(2.42)	(2.09)	(3.02)	(1.51)	(1.87)	3.87
Lab blank						pg/g	(5.05)	(4.49)	(3.85)	(4.2)	(4.06)	(4.04)	(3.93)	(10)	(9.4)	(7.3)	(7.5)	(5.7)	(3.95)	(9.45)	(6.4)	(4.31)	(3.72)	(6.6)	(2.64)	(3.5)	(2.04)
Lab blank						pg/g	29.3	23	(3.06)	(4.65)	(4.38)	(4.5)	(6.65)	(10.6)	(10.25)	(8)	(8.15)	(6.35)	(4.19)	(15.05)	(8.6)	(5.8)	(5)	(10.35)	(3.51)	(4.31)	(3.35)

Values in brackets are <LOD, reported as 0.5LOD

Results shaded and in italics are < 3 x average lab blank

Ethnicity	Gender	Age	Region	N	Comments	Units	ALPHA HCH	BETA HCH	GAMMA HCH	DELTA HCH	PeCB	HCB	ALDRIN	DIELDRIN	ENDRIN	ENDRIN KETONE	ENDRIN ALDEHYDE	HEPTACHLOR	HEPTACHLOR EPOXIDE	ALPHA CHLORDANE
Maori	Male	19-24	All	5		ng/g	(0.64)	*1.09*	(0.64)	(0.52)	*2.7*	7.54	(0.59)	5.4	(0.55)	NQ	NQ	(0.4)	(0.55)	(0.31)
Maori	Male	25-34	All	13		ng/g	(0.21)	3.16	(0.22)	(0.17)	*0.51*	6.6	(0.14)	4.16	(0.14)	NQ	NQ	(0.15)	(0.14)	(0.18)
Maori	Male	35-49	Northland/Auckland	8		ng/g	(1.05)	3.72	(1.07)	(0.81)	*1.5*	7.86	(0.41)	7.22	(0.6)	NQ	NQ	(0.49)	(0.64)	(0.36)
Maori	Male	35-49	Waikato/Bay of Plenty	8		ng/g	(1.07)	3.43	(1.08)	(0.71)	*1.12*	8.99	(0.45)	7.28	(0.49)	NQ	NQ	(0.51)	(0.43)	(0.43)
Maori	Male	35-49	Lower North Island	10		ng/g	(0.44)	3.57	(0.5)	(0.34)	*0.47*	8.24	(0.23)	5.46	(0.26)	NQ	NQ	(0.13)	(0.2)	(0.2)
Maori	Male	35-49	South Island	6		ng/g	(0.8)	5	(0.8)	(0.58)	*1.91*	11	(0.49)	7.2	(0.45)	NQ	NQ	(0.29)	(0.32)	0.73
Maori	Male	50-64	Northland/Auckland	16		ng/g	(0.31)	4.85	(0.31)	(0.29)	*1.17*	7.96	(0.19)	10.8	(0.18)	NQ	NQ	(0.14)	*0.48*	(0.22)
Maori	Male	50-64	Waikato/Bay of Plenty	13		ng/g	(0.38)	5.55	(0.42)	(0.31)	*0.96*	10.3	(0.22)	6.49	(0.22)	NQ	NQ	(0.13)	*0.36*	(0.16)
Maori	Male	50-64	Lower North Island	11		ng/g	(0.45)	4.18	(0.49)	(0.48)	*1.88*	9.74	(0.29)	8.09	(0.48)	NQ	NQ	(0.13)	(0.17)	(0.2)
Maori	Male	50-64	South Island	11		ng/g	(0.29)	5.41	(0.34)	(0.31)	*0.78*	8.97	(0.26)	6.92	(0.27)	NQ	NQ	(0.2)	*0.36*	(0.23)
Maori	Female	19-24	All	20		ng/g	(0.26)	1.65	(0.27)	(0.24)	*0.73*	5.66	(0.16)	3.9	(0.2)	NQ	NQ	(0.15)	(0.18)	(0.15)
Maori	Female	25-34	Northland/Auckland	12		ng/g	(0.25)	2.11	(0.3)	(0.29)	*0.69*	4.78	(0.17)	2.77	(0.26)	NQ	NQ	(0.2)	(0.26)	(0.26)
Maori	Female	25-34	Waikato/Bay of Plenty	11		ng/g	(0.42)	1.9	(0.54)	(0.33)	*0.55*	6.14	(0.21)	6.49	(0.26)	NQ	NQ	(0.16)	(0.23)	(0.18)
Maori	Female	25-34	Lower North Island	14		ng/g	(0.26)	1.63	(0.23)	(0.22)	*0.5*	5.67	(0.2)	3.87	(0.22)	NQ	NQ	(0.15)	(0.21)	(0.18)
Maori	Female	25-34	South Island	8		ng/g	(0.54)	2.16	(0.66)	(0.41)	*0.97*	6.83	(0.36)	3.84	(0.41)	NQ	NQ	(0.51)	(0.34)	(0.37)
Maori	Female	35-49	Northland/Auckland	12		ng/g	(0.21)	3.04	(0.27)	(0.29)	*0.41*	7.14	(0.28)	3.39	(0.33)	NQ	NQ	(0.22)	(0.18)	(0.19)
Maori	Female	35-49	Waikato/Bay of Plenty	12		ng/g	(0.2)	3.87	1.88	(0.16)	*0.64*	6.11	(0.21)	5.4	(0.19)	NQ	NQ	(0.17)	(0.17)	(0.2)
Maori	Female	35-49	Lower North Island	9		ng/g	(0.4)	4.44	(0.45)	(0.45)	*1.02*	11	(0.6)	10.1	(0.25)	NQ	NQ	(0.67)	(0.49)	(0.4)
Maori	Female	35-49	South Island	20		ng/g	(0.55)	4.48	(0.55)	(0.39)	*1.29*	8.19	(0.22)	6.33	(0.35)	NQ	NQ	(0.17)	(0.16)	(0.14)
Maori	Female	50-64	Northland/Auckland	18		ng/g	(0.39)	6.95	(0.44)	(0.38)	*1.03*	13.1	(0.19)	5.55	(0.31)	NQ	NQ	(0.15)	*0.38*	(0.22)
Maori	Female	50-64	Waikato/Bay of Plenty	14		ng/g	(0.37)	5.89	(0.41)	(0.34)	*1.22*	11.2	(0.3)	7.6	(0.38)	NQ	NQ	(0.14)	*0.48*	(0.16)
Maori	Female	50-64	Lower North Island	13		ng/g	(0.22)	6.19	(0.24)	(0.21)	*1.05*	9.94	(0.18)	5.11	(0.25)	NQ	NQ	(0.17)	*0.37*	(0.13)
Maori	Female	50-64	South Island	16		ng/g	(0.2)	4.77	(0.2)	(0.16)	*0.5*	9.51	(0.17)	4.66	(0.16)	NQ	NQ	(0.15)	*0.34*	(0.1)
Maori	Female	50-64	South Island	8	Pool replicate	ng/g	(0.37)	6.21	(0.44)	(0.42)	*0.7*	10.5	(0.29)	5.32	(0.37)	NQ	NQ	(0.18)	(0.16)	(0.19)
Non-Maori	Male	19-24	All	25		ng/g	(0.35)	1.67	(0.47)	(0.39)	*0.62*	5.71	(0.25)	3.19	(0.23)	NQ	NQ	(0.28)	(0.17)	(0.28)
Non-Maori	Male	25-34	All	26		ng/g	(0.23)	4.88	(0.34)	(0.36)	*0.56*	8.26	(0.3)	6.75	(0.2)	NQ	NQ	(0.14)	(0.18)	(0.2)
Non-Maori	Male	35-49	Northland/Auckland	11		ng/g	(0.5)	35.2	(0.59)	(0.52)	*1.28*	7.94	(0.41)	4.04	(0.48)	NQ	NQ	*0.43*	*0.64*	(0.36)
Non-Maori	Male	35-49	Waikato/Bay of Plenty	18		ng/g	(0.2)	3.44	(0.23)	(0.22)	*0.73*	5.72	(0.13)	3.07	(0.15)	NQ	NQ	*0.25*	*0.39*	(0.1)
Non-Maori	Male	35-49	Lower North Island	15		ng/g	(0.36)	55.4	(0.37)	(0.27)	*0.51*	5.95	(0.15)	16.2	(0.2)	NQ	NQ	(0.2)	*0.32*	(0.15)
Non-Maori	Male	35-49	South Island	10		ng/g	(0.34)	4.05	(0.32)	(0.25)	*1.12*	7.46	(0.22)	4.18	(0.23)	NQ	NQ	(0.22)	(0.14)	(0.18)
Non-Maori	Male	50-64	Northland/Auckland	17		ng/g	(0.27)	64.5	(0.39)	(0.39)	*1.37*	7.37	(0.18)	4.35	(0.29)	NQ	NQ	(0.13)	*0.51*	(0.13)
Non-Maori	Male	50-64	Waikato/Bay of Plenty	19		ng/g	(0.2)	4.95	(0.28)	(0.27)	*1.12*	8.86	(0.22)	10.4	(0.39)	NQ	NQ	(0.13)	(0.18)	(0.17)
Non-Maori	Male	50-64	Lower North Island	20		ng/g	(0.27)	7.23	(0.29)	(0.22)	*0.67*	7.28	(0.16)	4.5	(0.22)	NQ	NQ	(0.22)	(0.16)	(0.18)
Non-Maori	Male	50-64	South Island	16		ng/g	(0.18)	5.12	(0.19)	(0.16)	*0.88*	8.61	(0.14)	8.61	(0.15)	NQ	NQ	(0.16)	*0.46*	(0.18)
Non-Maori	Female	19-24	Northland/Auckland	8		ng/g	(0.54)	9.24	(0.54)	(0.73)	*2.05*	6.11	(0.62)	4.16	(0.62)	NQ	NQ	(0.54)	(0.54)	(0.46)
Non-Maori	Female	19-24	Waikato/Bay of Plenty	15		ng/g	(0.22)	3.62	(0.25)	(0.26)	*1.02*	4.07	(0.27)	2.54	(0.19)	NQ	NQ	(0.19)	(0.26)	(0.16)
Non-Maori	Female	19-24	Lower North Island	14		ng/g	(0.37)	2.29	(0.33)	(0.24)	*0.9*	5.1	(0.16)	4.23	(0.24)	NQ	NQ	(0.27)	(0.27)	(0.18)
Non-Maori	Female	19-24	South Island	10		ng/g	(1.19)	2.73	(0.98)	(0.85)	*2.84*	6.91	(0.78)	6.8	(0.6)	NQ	NQ	(0.78)	(0.7)	(0.52)
Non-Maori	Female	25-34	Northland/Auckland	12		ng/g	(0.31)	7.08	(0.33)	(0.26)	*0.41*	5.07	(0.25)	3.24	(0.18)	NQ	NQ	(0.23)	(0.24)	(0.14)
Non-Maori	Female	25-34	Waikato/Bay of Plenty	14		ng/g	(0.24)	2.4	(0.29)	(0.27)	*0.58*	5.38	(0.19)	3.61	(0.18)	NQ	NQ	(0.21)	(0.21)	(0.25)
Non-Maori	Female	25-34	Lower North Island	17		ng/g	(0.24)	17.7	(0.28)	(0.27)	*0.43*	5.15	(0.2)	3.55	(0.28)	NQ	NQ	(0.15)	(0.17)	(0.16)
Non-Maori	Female	25-34	South Island	16		ng/g	(0.39)	2.23	(0.48)	(0.35)	*0.54*	5.4	(0.19)	5.94	(0.3)	NQ	NQ	(0.17)	(0.23)	(0.16)
Non-Maori	Female	35-49	Northland/Auckland	14		ng/g	(0.26)	7.29	(0.25)	(0.39)	(0.47)	5.1	(0.18)	1.7	(0.2)	NQ	NQ	(0.13)	(0.13)	(0.13)
Non-Maori	Female	35-49	Waikato/Bay of Plenty	22		ng/g	(0.28)	59	(0.3)	(0.22)	*0.52*	8.43	(0.2)	3.32	(0.22)	NQ	NQ	(0.18)	(0.38)	(0.23)
Non-Maori	Female	35-49	Lower North Island	18		ng/g	(0.48)	4.65	(0.48)	(0.29)	(0.39)	6.21	(0.27)	3.32	(0.3)	NQ	NQ	(0.16)	(0.26)	(0.26)
Non-Maori	Female	35-49	South Island	18	Pool duplicate	ng/g	(0.27)	3.73	(0.32)	(0.23)	*2.1*	7.56	(0.14)	4.41	(0.22)	NQ	NQ	(0.21)	*0.38*	(0.23)
Non-Maori	Female	35-49	South Island	18		ng/g	(0.33)	3.73	(0.34)	(0.25)	*0.98*	6.96	(0.2)	5.45	(0.22)	NQ	NQ	(0.14)	(0.19)	(0.13)
Non-Maori	Female	50-64	Northland/Auckland	23		ng/g	(0.32)	12.7	(0.42)	(0.35)	*0.84*	9.04	(0.27)	3.94	(0.39)	NQ	NQ	(0.16)	(0.16)	(0.2)
Non-Maori	Female	50-64	Waikato/Bay of Plenty	11		ng/g	(0.31)	7.83	(0.37)	(0.31)	*1.09*	15.7	(0.27)	5.69	(0.28)	NQ	NQ	(0.12)	(0.16)	(0.17)
Non-Maori	Female	50-64	Lower North Island	20		ng/g	(0.23)	5.22	(0.23)	(0.2)	*0.74*	7.96	(0.13)	4.85	(0.17)	NQ	NQ	(0.15)	(0.2)	(0.15)
Non-Maori	Female	50-64	South Island	20		ng/g	(0.18)	10.1	(0.14)	(0.21)	*0.61*	13	(0.15)	5.99	(0.15)	NQ	NQ	(0.13)	*0.61*	(0.1)
Method blank						ng/g	(0.41)	(0.35)	(0.42)	(0.37)	*0.76*	*0.68*	(0.25)	(0.4)	(0.37)	NQ	NQ	(0.14)	(0.14)	(0.14)
Bovine blank						ng/g	(0.41)	(0.29)	(0.42)	(0.29)	*0.87*	*0.68*	(0.24)	(0.33)	(0.37)	NQ	NQ	(0.24)	(0.14)	(0.24)
Lab blank						ng/g	(1.05)	(1.1)	(1.09)	(0.94)	2.04	1.34	(0.66)	1.85	(0.45)	NQ	NQ	(0.34)	(0.21)	(0.34)
Lab blank						ng/g	(0.51)	(0.54)	(0.53)	(0.46)	0.99	0.65	(0.32)	0.9	(0.22)	NQ	NQ	(0.16)	(0.1)	(0.16)
Lab blank						ng/g	(0.23)	(0.29)	(0.2)	(0.29)	1	0.62	(0.23)	(0.23)	(0.22)	NQ	NQ	(0.23)	(0.17)	(0.14)
Lab blank						ng/g	(0.2)	(0.23)	(0.23)	(0.2)	0.49	0.32	(0.13)	(0.17)	(0.16)	NQ	NQ	(0.14)	(0.19)	(0.12)
Lab blank						ng/g	(0.27)	(0.35)	(0.24)	(0.34)	1.18	0.73	(0.27)	(0.27)	(0.26)	NQ	NQ	(0.27)	(0.2)	(0.16)
Lab blank						ng/g	(0.77)	(0.97)	(0.66)	(0.94)	3.31	2.03	(0.77)	(0.77)	(0.74)	NQ	NQ	(0.77)	(0.56)	(0.46)
Lab blank						ng/g	(0.59)	(0.65)	(0.67)	(0.57)	1.42	0.93	(0.37)	(0.49)	(0.45)	NQ	NQ	(0.41)	(0.55)	(0.35)
Lab blank						ng/g	(0.25)	(0.28)	(0.28)	(0.24)	0.6	0.4	(0.16)	(0.21)	(0.19)	NQ	NQ	(0.17)	(0.23)	(0.15)
Lab blank						ng/g	(0.81)	(0.56)	(0.92)	(0.61)	1.34	1.11	(0.35)	(0.44)	(0.46)	NQ	NQ	(0.44)	(0.42)	(0.38)
Lab blank						ng/g	(0.32)	(0.22)	(0.37)	(0.25)	0.54	0.45	(0.14)	(0.18)	(0.18)	NQ	NQ	(0.18)	(0.17)	(0.15)

Values in brackets are <LOD, reported as 0.5LOD
NQ - not quantified
Results shaded and in italics are < 3 x average lab blank

Ethnicity	Gender	Age	Region	N	Comments	Units	GAMMA CHLORDANE	OXYCHLORDANE	TRANS NONACHLOR	CIS NONACHLOR	OP DDT	PP DDT	OP DDD	PP DDD	OP DDE	PP DDE	MIREX	ENDOSULFAN A	ENDOSULFAN B	ENDOSULFAN SULFATE	KEPONE
Maori	Male	19-24	All	5		ng/g	(0.24)	(0.64)	(1)	(0.59)	(0.47)	2.09	(0.4)	(0.4)	(0.52)	90.3	(0.24)	(1.42)	(1.76)	NQ	NQ
Maori	Male	25-34	All	13		ng/g	(0.15)	(0.32)	(0.32)	(0.25)	(0.21)	1.76	(0.23)	(0.18)	(0.21)	187	0.81	(0.47)	(0.69)	NQ	NQ
Maori	Male	35-49	Northland/Auckland	8		ng/g	(0.28)	(0.64)	(2.55)	(0.77)	1.28	2.65	0.98	*0.86*	(0.58)	210	1.07	(3.7)	(1.99)	NQ	NQ
Maori	Male	35-49	Waikato/Bay of Plenty	8		ng/g	(0.37)	(0.77)	(1.72)	(0.6)	(0.56)	3.88	(0.37)	(0.43)	(0.51)	324	0.71	(2.35)	(1.91)	NQ	NQ
Maori	Male	35-49	Lower North Island	10		ng/g	(0.17)	(0.3)	(0.74)	(0.32)	(0.13)	5.52	(0.22)	(0.2)	(0.15)	530	2.77	(1.11)	(1.04)	NQ	NQ
Maori	Male	35-49	South Island	6		ng/g	0.83	(0.69)	(1.59)	(0.62)	(0.29)	3.57	(0.29)	(0.48)	(0.32)	537	1.46	(1.93)	(1.93)	NQ	NQ
Maori	Male	50-64	Northland/Auckland	16		ng/g	(0.19)	*1.02*	3.16	(0.31)	(0.25)	3.14	(0.22)	(0.22)	(0.15)	312	0.97	(0.61)	(0.92)	NQ	NQ
Maori	Male	50-64	Waikato/Bay of Plenty	13		ng/g	(0.08)	*0.7*	3.06	(0.34)	(0.21)	4.04	(0.2)	(0.17)	(0.21)	546	1.57	(1.12)	(0.91)	NQ	NQ
Maori	Male	50-64	Lower North Island	11		ng/g	(0.17)	(0.54)	2.94	(0.84)	(0.21)	3.48	(0.22)	(0.17)	(0.26)	419	1.32	(1.53)	(2.46)	NQ	NQ
Maori	Male	50-64	South Island	11		ng/g	(0.23)	*0.83*	(0.69)	(0.45)	(0.17)	4.07	(0.17)	(0.15)	(0.2)	430	*0.56*	(1.27)	(1.32)	NQ	NQ
Maori	Female	19-24	All	20		ng/g	(0.12)	(0.21)	(0.69)	(0.35)	(0.15)	2.25	(0.15)	(0.27)	(0.18)	127	*0.2*	(1.07)	(1.08)	NQ	NQ
Maori	Female	25-34	Northland/Auckland	12		ng/g	(0.23)	(0.24)	(0.7)	(0.44)	(0.22)	2.58	(0.19)	(0.19)	(0.2)	97.6	*0.42*	(0.84)	(1.28)	NQ	NQ
Maori	Female	25-34	Waikato/Bay of Plenty	11		ng/g	(0.17)	(0.51)	(0.67)	(0.44)	(0.26)	2.47	(0.27)	(0.21)	(0.28)	170	*0.27*	(1.03)	(1.15)	NQ	NQ
Maori	Female	25-34	Lower North Island	14		ng/g	(0.15)	(0.36)	(0.69)	(0.37)	(0.16)	2.01	(0.15)	(0.27)	(0.16)	198	*0.32*	(1.06)	(1.17)	NQ	NQ
Maori	Female	25-34	South Island	8		ng/g	(0.32)	(0.73)	(1.51)	(0.69)	(0.32)	2.99	(0.56)	(0.51)	(0.43)	280	*0.52*	(2.17)	(1.96)	NQ	NQ
Maori	Female	35-49	Northland/Auckland	12		ng/g	(0.16)	(0.56)	(1.39)	(0.65)	(0.22)	2.06	(0.23)	(0.18)	(0.15)	164	1.61	(1)	(1.91)	NQ	NQ
Maori	Female	35-49	Waikato/Bay of Plenty	12		ng/g	(0.17)	(0.35)	(0.58)	(0.26)	(0.2)	1.93	(0.14)	(0.17)	(0.21)	158	*0.58*	(0.88)	(0.93)	NQ	NQ
Maori	Female	35-49	Lower North Island	9		ng/g	(0.38)	(1.45)	(0.82)	(0.47)	(0.56)	5.78	(0.56)	(0.45)	(0.22)	346	0.62	(1.16)	(1.42)	NQ	NQ
Maori	Female	35-49	South Island	20		ng/g	(0.25)	(0.46)	(1.04)	(0.56)	(0.19)	3.16	(0.19)	(0.18)	(0.21)	346	*0.46*	(1.62)	(1.7)	NQ	NQ
Maori	Female	50-64	Northland/Auckland	18		ng/g	(0.2)	(0.48)	*2.4*	(0.49)	(0.16)	2.94	(0.15)	(0.15)	(0.24)	474	0.94	(1.08)	(1.62)	NQ	NQ
Maori	Female	50-64	Waikato/Bay of Plenty	14		ng/g	(0.14)	*1.09*	(1.1)	(0.71)	(0.2)	4.42	(0.16)	(0.16)	(0.33)	676	1.02	(1.71)	(2.03)	NQ	NQ
Maori	Female	50-64	Lower North Island	13		ng/g	(0.22)	(0.4)	*1.7*	(0.45)	(0.17)	3.14	(0.17)	(0.14)	(0.25)	435	0.63	(1.14)	(1.36)	NQ	NQ
Maori	Female	50-64	South Island	16		ng/g	(0.1)	(0.2)	(0.45)	(0.26)	(0.22)	3.46	(0.17)	(0.2)	(0.18)	473	*0.52*	(0.66)	(0.92)	NQ	NQ
Maori	Female	50-64	South Island	8	Pool replicate	ng/g	(0.16)	(0.65)	(0.7)	(0.48)	(0.13)	1.7	(0.19)	(0.19)	(0.24)	353	*0.58*	(1.09)	(1.45)	NQ	NQ
Non-Maori	Male	19-24	All	25		ng/g	(0.25)	(0.37)	(0.69)	(0.41)	(0.18)	2.05	(0.17)	(0.16)	(0.19)	152	*0.24*	(1.05)	(1.37)	NQ	NQ
Non-Maori	Male	25-34	All	26		ng/g	(0.17)	(0.48)	(0.55)	(0.99)	(0.2)	3.11	(0.2)	(0.16)	(0.16)	226	*0.37*	(0.94)	(1.25)	NQ	NQ
Non-Maori	Male	35-49	Northland/Auckland	11		ng/g	(0.3)	*1.1*	(1.37)	(0.66)	(0.36)	1.81	(0.36)	(0.23)	(0.39)	179	0.64	(2.01)	(1.99)	NQ	NQ
Non-Maori	Male	35-49	Waikato/Bay of Plenty	18		ng/g	(0.1)	*0.71*	(0.49)	(0.24)	(0.17)	1.24	(0.15)	(0.12)	(0.15)	164	*0.54*	(0.79)	(0.67)	NQ	NQ
Non-Maori	Male	35-49	Lower North Island	15		ng/g	(0.13)	*0.68*	(0.63)	(0.28)	(0.18)	2.81	(0.15)	(0.13)	(0.13)	268	1.28	(0.88)	(0.76)	NQ	NQ
Non-Maori	Male	35-49	South Island	10		ng/g	(0.16)	(0.34)	(0.67)	(0.34)	(0.18)	1.81	(0.18)	(0.14)	(0.18)	250	*0.48*	(1.07)	(1.04)	NQ	NQ
Non-Maori	Male	50-64	Northland/Auckland	17		ng/g	(0.24)	1.88	4.34	(0.42)	(0.18)	3.99	(0.17)	(0.16)	(0.2)	270	1.12	(1.18)	(1.52)	NQ	NQ
Non-Maori	Male	50-64	Waikato/Bay of Plenty	19		ng/g	(0.09)	(0.56)	(1.25)	(0.67)	(0.15)	3.16	(0.17)	(0.2)	(0.26)	383	2.56	(1.65)	(2.04)	NQ	NQ
Non-Maori	Male	50-64	Lower North Island	20		ng/g	(0.16)	*1.06*	*1.36*	(0.38)	(0.16)	2.53	(0.16)	(0.14)	(0.16)	429	0.8	(0.93)	(1.06)	NQ	NQ
Non-Maori	Male	50-64	South Island	16		ng/g	(0.16)	*0.82*	3.06	(0.25)	(0.22)	3.86	(0.22)	(0.18)	(0.14)	428	0.69	(0.91)	(0.79)	NQ	NQ
Non-Maori	Female	19-24	Northland/Auckland	8		ng/g	(0.46)	(0.71)	(1.54)	(0.62)	(0.54)	2.27	(0.54)	(0.46)	(0.49)	116	(0.27)	(2.27)	(2.08)	NQ	NQ
Non-Maori	Female	19-24	Waikato/Bay of Plenty	15		ng/g	(0.12)	(0.28)	(0.46)	(0.19)	(0.22)	1.33	(0.22)	(0.19)	(0.17)	75.3	*0.17*	(0.67)	(0.61)	NQ	NQ
Non-Maori	Female	19-24	Lower North Island	14		ng/g	(0.15)	(0.29)	(0.62)	(0.41)	(0.23)	1.55	(0.23)	(0.21)	(0.12)	100	*0.14*	(1.03)	(1.32)	NQ	NQ
Non-Maori	Female	19-24	South Island	10		ng/g	(0.52)	(1.14)	(1.63)	(0.9)	(0.7)	1.65	(0.52)	(0.52)	(0.46)	119	(0.26)	(2.53)	(2.89)	NQ	NQ
Non-Maori	Female	25-34	Northland/Auckland	12		ng/g	(0.25)	(0.54)	(0.62)	(0.34)	(0.21)	2.03	(0.21)	(0.17)	(0.2)	86.7	*0.48*	(0.85)	(0.94)	NQ	NQ
Non-Maori	Female	25-34	Waikato/Bay of Plenty	14		ng/g	(0.21)	(0.47)	(0.48)	(0.35)	(0.17)	1.42	(0.25)	(0.28)	(0.26)	79.1	*0.34*	(0.68)	(1.06)	NQ	NQ
Non-Maori	Female	25-34	Lower North Island	17		ng/g	(0.15)	(0.47)	(0.62)	(0.46)	(0.2)	4.23	(0.16)	(0.17)	(0.17)	155	*0.38*	(0.77)	(1.35)	NQ	NQ
Non-Maori	Female	25-34	South Island	16		ng/g	(0.28)	(0.57)	(0.81)	(0.44)	(0.19)	2.55	(0.21)	(0.16)	(0.24)	183	*0.24*	(1.17)	(1.37)	NQ	NQ
Non-Maori	Female	35-49	Northland/Auckland	14		ng/g	(0.23)	*0.76*	(0.68)	(0.28)	(0.23)	1.32	(0.13)	(0.18)	(0.15)	125	*0.25*	(1.13)	(0.88)	NQ	NQ
Non-Maori	Female	35-49	Waikato/Bay of Plenty	22		ng/g	(0.23)	(1.45)	(0.57)	(0.29)	(0.19)	1.9	(0.23)	(0.15)	(0.19)	173	*0.43*	(0.83)	(0.87)	NQ	NQ
Non-Maori	Female	35-49	Lower North Island	18		ng/g	(0.24)	(0.35)	(0.77)	(0.39)	(0.15)	1.77	(0.24)	(0.24)	(0.21)	154	*0.3*	(1.19)	(1.1)	NQ	NQ
Non-Maori	Female	35-49	South Island	18	Pool duplicate	ng/g	(0.21)	(0.35)	(0.81)	(0.38)	(0.14)	2.4	(0.14)	(0.23)	(0.18)	249	*0.38*	(1.02)	(1.18)	NQ	NQ
Non-Maori	Female	35-49	South Island	18		ng/g	(0.23)	(0.32)	(0.64)	(0.38)	(0.21)	2.41	(0.17)	(0.21)	(0.17)	245	*0.42*	(0.91)	(1.15)	NQ	NQ
Non-Maori	Female	50-64	Northland/Auckland	23		ng/g	(0.18)	(0.65)	(0.85)	(0.6)	(0.14)	3.14	(0.18)	(0.21)	(0.32)	300	0.69	(1.31)	(1.77)	NQ	NQ
Non-Maori	Female	50-64	Waikato/Bay of Plenty	11		ng/g	(0.17)	(0.35)	*2.38*	(0.55)	(0.17)	2.87	(0.18)	(0.15)	(0.2)	568	1.2	(1.45)	(1.65)	NQ	NQ
Non-Maori	Female	50-64	Lower North Island	20		ng/g	(0.13)	*0.77*	(0.65)	(0.28)	(0.13)	6.05	(0.2)	(0.22)	(0.14)	300	1.08	(1.03)	(1.04)	NQ	NQ
Non-Maori	Female	50-64	South Island	20		ng/g	*0.17*	*1.15*	(0.47)	(0.17)	(0.18)	3.43	(0.18)	(0.15)	(0.17)	451	*0.52*	(0.65)	(0.52)	NQ	NQ
Method blank						ng/g	(0.14)	(0.3)	(1.07)	(0.49)	(0.18)	(0.14)	(0.14)	(0.24)	(0.21)	*1.19*	(0.08)	(1.48)	(1.69)	NQ	NQ
Bovine blank						ng/g	(0.21)	(0.34)	(0.8)	(0.43)	(0.14)	(0.14)	(0.14)	(0.21)	(0.21)	*1.2*	(0.08)	(1.34)	(1.1)	NQ	NQ
Lab blank						ng/g	(0.3)	(0.85)	(1.52)	(0.72)	(0.29)	(0.29)	(0.24)	(0.21)	(0.48)	(0.43)	(0.18)	(1.83)	(1.74)	NQ	NQ
Lab blank						ng/g	(0.15)	(0.41)	(0.74)	(0.35)	(0.14)	(0.14)	(0.12)	(0.1)	(0.23)	(0.21)	(0.09)	(0.89)	(0.84)	NQ	NQ
Lab blank						ng/g	(0.13)	(0.13)	(0.63)	(0.36)	(0.14)	(0.23)	(0.21)	(0.21)	(0.17)	1.02	(0.1)	(0.91)	(0.96)	NQ	NQ
Lab blank						ng/g	(0.21)	(0.3)	(0.46)	(0.27)	(0.12)	(0.21)	(0.12)	(0.19)	(0.13)	(0.13)	(0.19)	(0.71)	(0.76)	NQ	NQ
Lab blank						ng/g	(0.16)	(0.16)	(0.75)	(0.43)	(0.16)	(0.27)	(0.25)	(0.25)	(0.2)	1.2	(0.12)	(1.08)	(1.14)	NQ	NQ
Lab blank						ng/g	(0.43)	(0.43)	(2.09)	(1.2)	(0.46)	(0.77)	(0.69)	(0.69)	(0.56)	3.36	(0.33)	(3)	(3.18)	NQ	NQ
Lab blank						ng/g	(0.61)	(0.87)	(1.32)	(0.79)	(0.35)	(0.61)	(0.35)	(0.55)	(0.39)	(0.37)	(0.55)	(2.05)	(2.19)	NQ	NQ
Lab blank						ng/g	(0.26)	(0.37)	(0.56)	(0.34)	(0.15)	(0.26)	(0.15)	(0.23)	(0.16)	(0.16)	(0.23)	(0.87)	(0.93)	NQ	NQ
Lab blank						ng/g	(0.33)	(0.61)	(1.04)	(0.58)	(0.44)	(0.44)	(0.44)	(0.33)	(0.42)	(0.44)	(0.12)	(1.99)	(1.88)	NQ	NQ
Lab blank						ng/g	(0.13)	(0.25)	(0.41)	(0.23)	(0.18)	(0.18)	(0.18)	(0.13)	(0.17)	(0.18)	(0.05)	(0.8)	(0.75)	NQ	NQ

Values in brackets are <LOD, reported as 0.5LOD
NQ - not quantified
Results shaded and in italics are < 3 x average lab blank

Ethnicity	Gender	Age	Region	N	Comments	Units	METHOXYCHLOR	TOXAPHENE (PARLAR26)	TOXAPHENE (PARLAR50)	TOXAPHENE (PARLAR62)
Maori	Male	19-24	All	5		ng/g	(0.47)	(1.65)	(0.85)	(0.94)
Maori	Male	25-34	All	13		ng/g	(0.23)	(1.49)	(0.65)	(0.88)
Maori	Male	35-49	Northland/Auckland	8		ng/g	(0.36)	(1.54)	(1.68)	(1.7)
Maori	Male	35-49	Waikato/Bay of Plenty	8		ng/g	(0.24)	(1.82)	(1.59)	(1.75)
Maori	Male	35-49	Lower North Island	10		ng/g	(0.12)	(0.77)	(0.61)	(0.66)
Maori	Male	35-49	South Island	6		ng/g	(0.27)	(1.59)	(0.63)	(0.76)
Maori	Male	50-64	Northland/Auckland	16		ng/g	(0.19)	(1.1)	(0.76)	(0.91)
Maori	Male	50-64	Waikato/Bay of Plenty	13		ng/g	(0.2)	(1.01)	(0.75)	(0.88)
Maori	Male	50-64	Lower North Island	11		ng/g	(0.17)	(1.23)	(0.65)	(0.72)
Maori	Male	50-64	South Island	11		ng/g	(0.25)	(1.06)	(0.92)	(1.02)
Maori	Female	19-24	All	20		ng/g	(0.24)	(1.15)	(0.88)	(1.02)
Maori	Female	25-34	Northland/Auckland	12		ng/g	(0.16)	(0.93)	(0.78)	(0.83)
Maori	Female	25-34	Waikato/Bay of Plenty	11		ng/g	(0.18)	(1.86)	(0.92)	(1)
Maori	Female	25-34	Lower North Island	14		ng/g	(0.16)	(1.15)	(1.29)	(1.09)
Maori	Female	25-34	South Island	8		ng/g	(0.32)	(1.53)	(0.96)	(0.92)
Maori	Female	35-49	Northland/Auckland	12		ng/g	(0.14)	(0.92)	(0.73)	(0.68)
Maori	Female	35-49	Waikato/Bay of Plenty	12		ng/g	(0.15)	(1.09)	(0.96)	(1.03)
Maori	Female	35-49	Lower North Island	9		ng/g	(0.6)	(1.62)	(0.81)	(1.07)
Maori	Female	35-49	South Island	20		ng/g	(0.17)	(1.2)	(0.89)	(0.95)
Maori	Female	50-64	Northland/Auckland	18		ng/g	(0.15)	(0.89)	(0.66)	(0.78)
Maori	Female	50-64	Waikato/Bay of Plenty	14		ng/g	(0.14)	(1.02)	(0.69)	(0.78)
Maori	Female	50-64	Lower North Island	13		ng/g	(0.12)	(1.74)	(1.07)	(1.35)
Maori	Female	50-64	South Island	16		ng/g	(0.17)	(0.95)	(1.16)	(1.35)
Maori	Female	50-64	South Island	8	Pool replicate	ng/g	(0.16)	(0.69)	(0.69)	(0.69)
Non-Maori	Male	19-24	All	25		ng/g	(0.17)	(0.8)	(0.78)	(0.93)
Non-Maori	Male	25-34	All	26		ng/g	(0.21)	(0.87)	(0.73)	(0.65)
Non-Maori	Male	35-49	Northland/Auckland	11		ng/g	(0.3)	(1.71)	(1.29)	(1.27)
Non-Maori	Male	35-49	Waikato/Bay of Plenty	18		ng/g	(0.1)	(1.2)	(0.5)	(0.45)
Non-Maori	Male	35-49	Lower North Island	15		ng/g	(0.13)	(0.69)	(0.6)	(0.63)
Non-Maori	Male	35-49	South Island	10		ng/g	(0.24)	(0.82)	(0.77)	(0.9)
Non-Maori	Male	50-64	Northland/Auckland	17		ng/g	(0.16)	(0.95)	(0.76)	(0.63)
Non-Maori	Male	50-64	Waikato/Bay of Plenty	19		ng/g	(0.16)	(1.22)	(0.87)	(0.64)
Non-Maori	Male	50-64	Lower North Island	20		ng/g	(0.22)	(1.39)	(0.8)	(0.89)
Non-Maori	Male	50-64	South Island	16		ng/g	(0.16)	(1.11)	(1.14)	(1.29)
Non-Maori	Female	19-24	Northland/Auckland	8		ng/g	(0.62)	(1.74)	(0.83)	(1.01)
Non-Maori	Female	19-24	Waikato/Bay of Plenty	15		ng/g	(0.16)	(1.11)	(0.92)	(1.04)
Non-Maori	Female	19-24	Lower North Island	14		ng/g	(0.15)	(1.16)	(1.13)	(0.86)
Non-Maori	Female	19-24	South Island	10		ng/g	(0.44)	(2.28)	(0.96)	(1.09)
Non-Maori	Female	25-34	Northland/Auckland	12		ng/g	(0.19)	(1.55)	(0.77)	(1.03)
Non-Maori	Female	25-34	Waikato/Bay of Plenty	14		ng/g	(0.17)	(1.72)	(0.75)	(0.84)
Non-Maori	Female	25-34	Lower North Island	17		ng/g	(0.22)	(1.7)	(1.06)	(0.86)
Non-Maori	Female	25-34	South Island	16		ng/g	(0.19)	(1.83)	(0.67)	(0.77)
Non-Maori	Female	35-49	Northland/Auckland	14		ng/g	(0.21)	(0.73)	(0.64)	(0.65)
Non-Maori	Female	35-49	Waikato/Bay of Plenty	22		ng/g	(0.23)	(0.72)	(0.64)	(0.68)
Non-Maori	Female	35-49	Lower North Island	18		ng/g	(0.15)	(0.89)	(0.76)	(0.78)
Non-Maori	Female	35-49	South Island	18	Pool duplicate	ng/g	(0.13)	(0.82)	(0.7)	(0.74)
Non-Maori	Female	35-49	South Island	18		ng/g	(0.13)	(0.75)	(0.76)	(0.84)
Non-Maori	Female	50-64	Northland/Auckland	23		ng/g	(0.21)	(1.16)	(0.66)	(0.79)
Non-Maori	Female	50-64	Waikato/Bay of Plenty	11		ng/g	(0.13)	(0.97)	(0.62)	(0.8)
Non-Maori	Female	50-64	Lower North Island	20		ng/g	(0.17)	(0.71)	(0.98)	(0.81)
Non-Maori	Female	50-64	South Island	20		ng/g	(0.15)	(0.82)	(0.92)	(0.99)
Method blank						ng/g	(0.1)	(0.98)	(0.83)	(0.79)
Bovine blank						ng/g	(0.1)	(1.07)	(0.8)	(0.79)
Lab blank						ng/g	(0.24)	(2.85)	(0.91)	(0.98)
Lab blank						ng/g	(0.12)	(1.43)	(0.91)	(0.57)
Lab blank						ng/g	(0.18)	(1.3)	(0.71)	(0.78)
Lab blank						ng/g	(0.19)	(0.68)	(0.35)	(0.36)
Lab blank						ng/g	(0.21)	(1.54)	(0.71)	(0.78)
Lab blank						ng/g	(0.59)	(4.02)	(1.08)	(1.32)
Lab blank						ng/g	(0.55)	(1.96)	(1.02)	(1.05)
Lab blank						ng/g	(0.23)	(0.84)	(0.43)	(0.44)
Lab blank						ng/g	(0.19)	(1.64)	(1.36)	(1.25)
Lab blank						ng/g	(0.08)	(0.66)	(0.55)	(0.5)

Values in brackets are <LOD, reported as 0.5LOD
NQ - not quantified
Results shaded and in italics are < 3 x average lab blank

Ethnicity	Gender	Age	Region	N	Comments	Units	BDE7	BDE15	BDE17	BDE28/33	BDE30	BDE47	BDE49	BDE66	BDE71	BDE77	BDE85	BDE99	BDE100	BDE119/120	BDE126	BDE138/166	BDE139	BDE140	BDE153	BDE154	BDE156/169	BDE171
Maori	Male	19-24	All	5		pg/g	(19.5)	36.8	74.3	139	(14.1)	3640	135	65.2	(9.35)	(6.05)	204	5070	1460	(11.7)	(8.75)	(30.8)	(26.3)	(26)	1720	414	(28.1)	(20.2)
Maori	Male	25-34	All	13		pg/g	(3.22)	28.8	(3.67)	113	(4.89)	2740	111	52	(3.98)	(3.2)	63.3	862	498	(5.2)	(4.68)	(12.2)	(9.15)	(8.5)	1530	85	(11.7)	(14.5)
Maori	Male	35-49	Northland/Auckland	8		pg/g	(5.1)	54.4	(5.1)	122	37.9	1660	129	43.3	(4.68)	(3.45)	47.7	492	417	(5.35)	(4.44)	(15.4)	25.4	(10.7)	1190	72.2	(14.7)	(17)
Maori	Male	35-49	Waikato/Bay of Plenty	8		pg/g	(3.18)	63.8	(3.89)	146	26	2190	93	44.6	(5.5)	(4.02)	40.1	620	693	(4.86)	(4.03)	(11.1)	47.1	(7.75)	1830	94.9	(10.6)	(13.8)
Maori	Male	35-49	Lower North Island	10		pg/g	(4.49)	49.7	(4.11)	148	39.8	2830	56.2	31.7	(3.8)	(2.77)	53.4	1050	730	(6.4)	(5.45)	(12)	43.3	(8.35)	1860	128	(11.5)	(17.1)
Maori	Male	35-49	South Island	6		pg/g	(9.2)	48.9	*11.8*	144	(26.6)	2520	*35.1*	30.6	(5)	(3.15)	112	1230	1070	(13.1)	(9.15)	31.9	85	(13)	6490	187	(14)	(19.1)
Maori	Male	50-64	Northland/Auckland	16		pg/g	(5)	46.9	(5.8)	171	(7.75)	2520	*25*	38	(5.2)	(3.67)	43.5	705	495	(5.55)	(4.64)	(14.3)	26.5	(9.95)	1730	101	(13.7)	(19.1)
Maori	Male	50-64	Waikato/Bay of Plenty	13		pg/g	(7.85)	93.4	(6.7)	138	(8.9)	2120	*24.5*	(8.65)	(7.3)	(5.1)	42.4	755	751	(6.15)	(4.83)	(13.2)	(9.9)	(9.2)	1840	226	(12.6)	(24.1)
Maori	Male	50-64	Lower North Island	11		pg/g	(4.76)	66.6	(5.3)	268	(7.05)	2530	(3.38)	31.8	(2.85)	(2)	37	570	474	(3.29)	(2.53)	(10.9)	(8.2)	(7.6)	1070	79.9	(10.5)	(9.55)
Maori	Male	50-64	South Island	11		pg/g	(7.25)	93.3	(4.58)	229	(6.1)	3310	*42.5*	37.4	(4.11)	(2.97)	79.5	1050	649	(4.34)	(3.48)	(7.95)	*22.8*	*15.9*	1330	125	(7.6)	(18.2)
Maori	Female	19-24	All	20		pg/g	(6.7)	39.4	(6.05)	142	(8.05)	3240	45.8	(7.65)	(5.85)	(4.53)	70.7	1070	587	(6.15)	(5.4)	(16.4)	(12.4)	(11.5)	948	112	(15.7)	(18.2)
Maori	Female	25-34	Northland/Auckland	12		pg/g	(1.14)	40.2	(0.52)	127	*11.6*	2950	*35.7*	36.4	(1.27)	(0.88)	239	1820	726	(2.01)	(1.56)	152	181	49	1380	367	(2.29)	*17*
Maori	Female	25-34	Waikato/Bay of Plenty	11		pg/g	(1.64)	29.5	(0.86)	122	*13.5*	2330	*21.3*	23.3	(1.63)	(1.08)	40.7	615	509	(2.02)	(1.59)	(5.1)	32.9	*11.9*	804	70.4	(4.36)	*24.7*
Maori	Female	25-34	Lower North Island	14		pg/g	(5.1)	42.4	(4.73)	192	(6.3)	3670	69.4	51.9	(6.45)	(5.1)	74.7	1100	610	(5.05)	(4.28)	(8.35)	(6.25)	(5.8)	808	113	(7.95)	(14.2)
Maori	Female	25-34	South Island	8		pg/g	(2.2)	31.5	*5.89*	97	*15.4*	1740	*18.8*	21.2	(1.67)	(1.1)	24.6	*375*	353	(2.43)	(2.04)	(5.65)	(4.85)	(4.89)	919	49.9	(4.83)	(10.4)
Maori	Female	35-49	Northland/Auckland	12		pg/g	(6.85)	55.6	(7.2)	120	45.3	1670	76.8	37.8	(5.75)	(4.34)	36.2	414	363	(8.35)	(7.75)	(20)	(15.1)	(14)	1110	76.9	(19.2)	(20)
Maori	Female	35-49	Waikato/Bay of Plenty	12		pg/g	(4.76)	40.7	(5.05)	173	29.5	2200	76.6	37.8	(4.31)	(3.3)	37.3	639	445	(6.3)	(5.4)	(17.5)	(13.2)	(12.2)	931	94.4	(16.8)	(26.4)
Maori	Female	35-49	Lower North Island	9		pg/g	(5.9)	31.7	(7.6)	102	43.3	1230	*40.5*	(7.35)	(5.75)	(4.35)	*18.4*	*380*	287	(7.2)	(6)	(17.5)	(13.2)	(12.2)	738	60.6	(16.8)	(19.5)
Maori	Female	35-49	South Island	20		pg/g	(4.98)	54.2	(5.25)	146	(7)	2600	46.9	18.7	(4.83)	(3.48)	59.4	800	519	(5.75)	(4.72)	(9.9)	*20.7*	(6.9)	988	99	(9.5)	(16.7)
Maori	Female	50-64	Northland/Auckland	18		pg/g	(2.41)	31	(2.7)	112	(3.58)	1960	*27.7*	23.8	(3.91)	(2.47)	45.6	750	430	(2.97)	(2.8)	(7.9)	*22.4*	(5.5)	783	87.9	(7.55)	(7.95)
Maori	Female	50-64	Waikato/Bay of Plenty	14		pg/g	(6.1)	75.7	(5.3)	282	(7.1)	4650	*42.5*	41.9	(6.1)	(4.36)	74.1	1010	720	(6.4)	(4.96)	(12.1)	(9.1)	(8.4)	745	107	(11.6)	(14.5)
Maori	Female	50-64	Lower North Island	13		pg/g	(4.03)	34.2	(5.65)	94.2	(7.5)	1120	*31.2*	18.5	(5.4)	(3.91)	30	*386*	270	(4.63)	(3.61)	(14)	(10.6)	(9.8)	925	76.7	(13.4)	(11.7)
Maori	Female	50-64	South Island	16		pg/g	(3.05)	39.5	(3.11)	81.4	(4.13)	1390	*23.2*	*16.6*	(2.87)	(1.81)	47.3	1060	471	(3.14)	(2.85)	(6.3)	*20.7*	(4.4)	769	144	(6.05)	(13.4)
Non-Maori	Male	19-24	All	25		pg/g	(7.7)	25.7	(3.93)	131	(5.2)	2570	55.1	29.3	(5.3)	(4.19)	46.7	752	471	(5.35)	(4.62)	(8.6)	(6.45)	(6)	1040	97.8	(8.2)	(14.1)
Non-Maori	Male	25-34	All	26		pg/g	(8.05)	47.7	(8.2)	120	(10.9)	2630	*34.6*	21.2	(7.25)	(5.8)	(11.1)	752	452	(7.5)	(8.1)	(24.7)	(18.6)	(17.2)	1210	52.8	(23.6)	(25)
Non-Maori	Male	35-49	Northland/Auckland	11		pg/g	(20.6)	38.2	(11.1)	91.4	(18.2)	1070	77.2	23.2	(15.3)	(10.2)	*20*	*311*	238	(12.4)	(9.25)	(12.6)	(10.7)	(10.6)	2280	60.6	(11.5)	57.4
Non-Maori	Male	35-49	Waikato/Bay of Plenty	18		pg/g	(4.64)	69.4	*11.2*	149	(14)	2000	*32.9*	22.9	(4.74)	(3.03)	40.9	633	468	(7.15)	(5.2)	(10.7)	25.6	(9)	1490	76.6	(9.75)	*20.1*
Non-Maori	Male	35-49	Lower North Island	15		pg/g	(2.93)	48.2	19.5	174	(15.9)	3480	52.2	30.7	(2.61)	(1.62)	52.5	807	615	(3.42)	(2.48)	*17.3*	31.9	*11.9*	1450	104	(4.42)	34.6
Non-Maori	Male	35-49	South Island	10		pg/g	(3.76)	20.7	(4.71)	86	(6.25)	1860	*20.6*	18.7	(4.22)	(3.25)	54.4	623	389	(5.45)	(4.55)	(10.7)	27.6	(7.45)	2140	118	(10.2)	82.4
Non-Maori	Male	50-64	Northland/Auckland	17		pg/g	(3.17)	74.3	(2.12)	145	76.8	1830	*26*	21.4	(2.56)	(1.7)	73.9	989	487	(3.48)	(2.8)	55.4	74.4	28.5	1940	191	(4.62)	37.9
Non-Maori	Male	50-64	Waikato/Bay of Plenty	19		pg/g	(6.6)	34.9	(5.25)	85.1	(7)	1040	*21.2*	(6.9)	(5.35)	(4.07)	(8.25)	*330*	279	(7.1)	(6)	(12.2)	(9.2)	(8.5)	917	56.9	(11.7)	(17.3)
Non-Maori	Male	50-64	Lower North Island	20		pg/g	(3.85)	101	(4.84)	204	(6.45)	4140	*43.2*	46.7	(4.09)	(3.15)	67.7	1130	844	(4.46)	(3.51)	(11)	(8.25)	(7.65)	1760	150	(10.5)	(19)
Non-Maori	Male	50-64	South Island	16		pg/g	(4.77)	31.7	(3.56)	97.5	(4.73)	1680	*18.4*	(4.61)	(3.66)	(2.72)	30.6	454	288	(5.5)	(4.55)	(9.3)	*18.7*	(6.5)	845	*44.9*	(8.9)	(16.7)
Non-Maori	Female	19-24	Northland/Auckland	8		pg/g	(12.8)	44.1	62.2	125	(15.4)	2750	98.6	40.7	(10.6)	(7.15)	58.2	834	637	(33.3)	(7.25)	(20.8)	32.5	(8.75)	1290	100	(19)	(10.9)
Non-Maori	Female	19-24	Waikato/Bay of Plenty	15		pg/g	(6.35)	42.2	(3.47)	232	(4.61)	6710	110	71.7	(5.2)	(4.04)	181	2340	1200	(6.15)	(5)	(9)	47.3	(6.3)	1410	300	(8.6)	(15.1)
Non-Maori	Female	19-24	Lower North Island	14		pg/g	(4.79)	51.2	(7.45)	153	(9.95)	3530	46.3	23.9	(5.3)	(4.25)	60	842	647	(5.15)	(4.38)	(12.3)	(9.25)	(8.55)	1250	119	(11.8)	(14.6)
Non-Maori	Female	19-24	South Island	10		pg/g	(7.65)	67.4	37.3	162	(13.5)	2640	78.8	39.2	(9.65)	(5.95)	54.4	886	531	(8)	(5.85)	(16.1)	32.6	(13.6)	1570	131	(14.7)	(14.5)
Non-Maori	Female	25-34	Northland/Auckland	12		pg/g	(2.33)	41.3	(2.03)	91.7	21.7	1380	54.7	24.4	(2.63)	(1.65)	30.5	*345*	277	(2.66)	*7.67*	(7.2)	*23.8*	(6.25)	819	55.3	(6.15)	*26.9*
Non-Maori	Female	25-34	Waikato/Bay of Plenty	14		pg/g	(3.65)	38.4	44.7	131	(6.9)	2470	209	60.6	(5.95)	12.5	53.6	859	401	(5.5)	(4.82)	(10.3)	(7.7)	(7.15)	1230	128	(9.8)	(15.8)
Non-Maori	Female	25-34	Lower North Island	17		pg/g	(4.87)	37.3	*15.8*	117	30.2	4350	112	102	(7.8)	(5.85)	1140	20000	3150	(6.85)	(5.7)	228	212	(10.9)	2550	1780	(15)	(18.3)
Non-Maori	Female	25-34	South Island	16		pg/g	(5.45)	41.9	(3.99)	98.6	(5.3)	1890	*38.3*	19.6	(5.75)	(4.41)	(7.15)	535	315	(6.2)	(5.2)	(9.1)	(6.85)	(6.35)	902	70.9	(8.7)	(14.3)
Non-Maori	Female	35-49	Northland/Auckland	14		pg/g	(5.2)	56.9	(4.66)	145	25.5	2440	73	27.9	(4.71)	(3.65)	58.8	657	564	(8.45)	(7.3)	(15.3)	(11.5)	(10.7)	1490	85.4	(14.6)	(17.6)
Non-Maori	Female	35-49	Waikato/Bay of Plenty	22		pg/g	(5.55)	59.9	(3.7)	102	44.6	1250	99.7	29.9	(9.6)	(7.05)	28.7	567	336	(4.91)	(4)	(12.4)	(9.3)	(8.65)	892	81.4	(11.9)	(17.7)
Non-Maori	Female	35-49	Lower North Island	18		pg/g	(4.68)	52.4	(6.05)	96.3	31.3	1600	51.7	23.1	(3.74)	(2.87)	28.2	455	394	(5.45)	(4.37)	(13.9)	(10.5)	(9.7)	878	66.2	(13.3)	(15.6)
Non-Maori	Female	35-49	South Island	18		pg/g	(3.1)	33.5	(2.66)	127	(3.54)	2130	*33.7*	20.1	(3.26)	(2.31)	39	576	424	(3.33)	(2.83)	(7.4)	*22.8*	(5.15)	855	70.1	(7.05)	(9.95)
Non-Maori	Female	50-64	Northland/Auckland	23		pg/g	(5.2)	59.4	(4.62)	76.5	(6.15)	1370	*22.7*	(5.45)	(4.59)	(3.24)	27.4	513	348	(4.81)	(3.57)	(8.65)	(6.5)	(6)	940	86.4	(8.25)	(12.9)
Non-Maori	Female	50-64	Northland/Auckland	23	Pool duplicate	pg/g	(5)	55.5	(4.29)	79.3	(5.7)	1310	*37.8*	*17.5*	(4.64)	(3.37)	32.2	466	332	(4.87)	(3.83)	(10.9)	(8.2)	(7.6)	866	88.5	(10.5)	(13.4)
Non-Maori	Female	50-64	Waikato/Bay of Plenty	11		pg/g	(5.65)	45.7	(5.05)	63.2	(6.75)	1000	*23.7*	(10.7)	(8.85)	(6.3)	27.8	*334*	199	(4.81)	(4.02)	(9.25)	(6.95)	(6.45)	1880	(6)	(8.85)	(13.9)
Non-Maori	Female	50-64	Waikato/Bay of Plenty	11	Pool replicate	pg/g	(3.33)	39.4	(3.11)	105	(4.13)	2200	*39*	23.2	(3.13)	(2.37)	51.5	648	434	(3.76)	(3.69)	(5.95)	*18.3*	(4.14)	811	78.4	(5.65)	(9.8)
Non-Maori	Female	50-64	Lower North Island	20		pg/g	(5.1)	56.4	(4.61)	84.8	(6.15)	1090	*20*	*13.4*	(4.2)	(3.01)	30.8	455	280	(4.05)	(3.22)	(12)	(9.05)	(8.4)	963	94.1	(11.5)	(16.5)
Non-Maori	Female	50-64	South Island	20		pg/g	(2.28)	36.1	(3.26)	93.2	(4.34)	1630	*21.2*	18.7	(2.92)	(2.18)	30.5	484	284	(3.53)	(2.96)	(6.65)	(5)	(4.63)	799	71.8	(6.35)	(8.45)
Method blank						pg/g	(7.4)	(4.61)	(4.4)	40.9	(5.45)	*319*	121	31.2	(6.95)	(4.42)	*20*	*308*	*52*	(5.1)	(3.79)	(11.5)	(9.75)	(9.7)	*55.3*	*36.9*	(10.5)	(8.5)
Bovine blank						pg/g	(2.99)	(1.87)	*11.2*	*15*	(1.86)	*272*	*21.7*	(5.15)	(4.74)	(2.96)	(6.65)	*176*	*35.9*	(6.35)	(4.63)	(9.65)	(8.2)	(8.15)	163	56.7	(8.8)	*13.3*
Lab blank						pg/g	(6.8)	(4.13)	(6)	(5.9)	(8)	108	(6.55)	(6.75)	(5.5)	(3.98)	(5.45)	60.5	16.9	(4.82)	(3.97)	(9.7)	(7.3)	(6.75)	(5.6)	(6.1)	(9.3)	(11.7)
Lab blank						pg/g	(3.97)	(2.41)	(4.04)	(3.97)	(5.35)	141	(4.12)	(4.35)	(3.47)	(2.57)	(4.97)	74.9	12.3	(4.05)	(3.61)	(10)	(7.5)	(6.95)	(4.96)	(5.3)	(9.55)	(11)
Lab blank						pg/g	(11.1)	(6.9)	(6.6)	(6.35)	(8.2)	283	17.3	(6.75)	(5.9)	(3.88)	(7.45)	143	36.7	(6.8)	(5.2)	(11.1)	(9.4)	(9.3)	31.4	17.5	(10.1)	(10.4)
Lab blank						pg/g	(1.43)	4.38	5.76	10.2	(0.8)	153	8.32	4.5	(0.96)	(0.63)	8.16	138	31.4	(2.43)	(1.95)	NQ	9.62	8.04	NQ	NQ	(2.95)	NQ
Lab blank						pg/g	(8.2)	(4.97)	(6)	26.3	(8)	856	35.6	(8.95)	(6.8)	(5.3)	(8.5)	338	86	(7.4)	(6.15)	(10.8)	(8.1)	(7.5)	66.6	33	(10.3)	(13.9)
Lab blank						pg/g	(4.71)	(2.86)	(4.93)	(4.85)	(6.55)	102	19.5	(4.83)	(3.71)	(2.86)	(4.82)	61.9	12.4	(4.15)	(3.51)	(8.8)	(6.6)	(6.15)	(4.67)	13.2	(8.4)	(9.6)
Lab blank						pg/g	(9.65)	(6)	(5.75)	(5.5)	(7.15)	247	15.1	(5.9)	(5.15)	(3.38)	(6.5)	125	31.9	(5.9)	(4.53)	(9.6)	(8.2)	(8.1)	27.4	15.3	(8.75)	(9)
Lab blank						pg/g	(1.5)	4.61	6.07	10.7	(0.84)	162	8.77	4.74	(1.01)	(0.67)	8.6	145	33.1	(2.56)	(2.05)	NQ	10.1	8.48	NQ	NQ	(3.11)	NQ

Values in brackets are <LOD, reported as 0.5LOD

NQ - not quantified

Results shaded and in italics are < 3 x average lab blank

Ethnicity	Gender	Age	Region	N	Comments	Units	BDE180	BDE183/175	BDE184	BDE191	BDE196	BDE197	BDE201	BDE203	BDE204	BDE205	BDE206	BDE207	BDE208	BDE209	BB153	DBDPE	HBB	PBEB
Maori	Male	19-24	All	5		pg/g	(23.4)	175	24.2	(22.5)	169	732	223	299	(118)	(120)	384	1160	585	3780	742	NQ	(25.5)	(5.4)
Maori	Male	25-34	All	13		pg/g	(17.1)	254	23.5	(16.8)	116	1030	179	270	(39.3)	(72)	451	1010	403	5070	298	NQ	(9.5)	(2.37)
Maori	Male	35-49	Northland/Auckland	8		pg/g	(20)	144	(7.65)	(19.7)	(63)	734	147	163	(63.5)	(150)	309	827	362	4090	387	NQ	*31.5*	(5.4)
Maori	Male	35-49	Waikato/Bay of Plenty	8		pg/g	(16.2)	299	25.4	(16)	163	1180	249	215	(45.2)	(102)	326	1070	378	3390	455	NQ	(12.2)	(2.78)
Maori	Male	35-49	Lower North Island	10		pg/g	(20.2)	272	35	(19.9)	133	937	172	208	(36.1)	(81)	323	950	359	5080	872	NQ	*22.5*	(3.78)
Maori	Male	35-49	South Island	6		pg/g	(22)	142	(9.95)	(21.1)	146	641	174	274	(47.5)	(96)	337	911	443	4210	403	NQ	(20.2)	(4.08)
Maori	Male	50-64	Northland/Auckland	16		pg/g	(22.5)	329	18.7	(22.1)	140	931	166	219	(44.8)	(82.5)	NQ	NQ	NQ	NQ	561	NQ	*29.7*	(5.3)
Maori	Male	50-64	Waikato/Bay of Plenty	13		pg/g	(28.3)	239	25.2	(27.9)	130	716	136	(46.8)	(37.5)	(81.5)	287	963	344	*2570*	1310	(3045)	(13.7)	(5.7)
Maori	Male	50-64	Lower North Island	11		pg/g	(11.3)	123	17	(11.1)	106	675	131	145	(19.3)	(40.9)	272	1040	271	4020	2170	(1095)	(9.1)	(4.09)
Maori	Male	50-64	South Island	11		pg/g	(21.4)	339	(8.15)	(21.1)	368	1240	297	465	(60)	(122)	NQ	NQ	NQ	NQ	402	NQ	*42*	(3.26)
Maori	Female	19-24	All	20		pg/g	(21.4)	315	(8.15)	(21.1)	154	677	147	(38.4)	(30.8)	(62.5)	391	919	403	6780	129	NQ	(13.9)	(5.2)
Maori	Female	25-34	Northland/Auckland	12		pg/g	(4.84)	163	23.3	(5.05)	124	644	165	149	(10.1)	(22.4)	455	817	386	3620	163	NQ	52.7	*3.17*
Maori	Female	25-34	Waikato/Bay of Plenty	11		pg/g	(12.9)	174	18.9	(13.4)	147	741	208	169	(14.7)	(34.1)	469	962	408	4630	213	NQ	*26.1*	*1.56*
Maori	Female	25-34	Lower North Island	14		pg/g	(16.7)	159	19.2	(16.4)	143	685	133	161	(25.4)	(53.5)	285	850	306	4010	630	NQ	(13)	(3.62)
Maori	Female	25-34	South Island	8		pg/g	*26.5*	204	24.1	(12)	122	636	195	197	(13.9)	(33.5)	646	1090	526	6920	218	NQ	*25.4*	*2.62*
Maori	Female	35-49	Northland/Auckland	12		pg/g	(23.5)	495	(8.95)	(23.2)	154	749	154	253	(54.5)	(122)	391	1020	384	3830	323	NQ	(17.7)	(5.3)
Maori	Female	35-49	Waikato/Bay of Plenty	12		pg/g	(31.1)	*78.4*	(11.9)	(30.6)	(50)	465	105	(63.5)	(50.5)	(115)	254	730	356	*2230*	408	NQ	(15.3)	(5.85)
Maori	Female	35-49	Lower North Island	9		pg/g	(23)	265	(8.75)	(22.6)	114	687	135	126	(33.6)	(70.5)	*181*	718	265	*2540*	987	NQ	(18.4)	(5.85)
Maori	Female	35-49	South Island	20		pg/g	(19.6)	179	(7.5)	(19.3)	113	532	124	129	(38)	(76)	(157)	759	383	4770	347	NQ	*30.9*	(3.96)
Maori	Female	50-64	Northland/Auckland	18		pg/g	(9.35)	149	*8.71*	(9.2)	102	400	86.9	115	(32.8)	(75)	NQ	NQ	NQ	NQ	887	NQ	*31.1*	(2.53)
Maori	Female	50-64	Waikato/Bay of Plenty	14		pg/g	(17)	152	(6.5)	(16.8)	(43.1)	463	103	(54.5)	(43.7)	(92)	*178*	699	291	*2480*	663	(1880)	(15.4)	(4.35)
Maori	Female	50-64	Lower North Island	13		pg/g	(13.7)	140	20.2	(13.5)	(26.4)	508	94.7	(33.3)	(26.7)	(57.5)	*181*	588	225	*2340*	357	(2085)	(13.2)	(2.86)
Maori	Female	50-64	South Island	16		pg/g	(15.8)	140	18.1	(15.5)	97.8	670	133	145	(26)	(52)	(157)	1010	289	4660	881	NQ	*37.5*	(3.47)
Non-Maori	Male	19-24	All	25		pg/g	(16.6)	121	19.1	(16.4)	134	753	175	278	(32.1)	(61.5)	429	1110	437	3230	316	NQ	(12.6)	(5.35)
Non-Maori	Male	25-34	All	26		pg/g	(29.5)	152	(11.3)	(29)	(72)	732	149	(90.5)	(72.5)	(156)	251	900	286	3310	292	NQ	(32.3)	(5.5)
Non-Maori	Male	35-49	Northland/Auckland	11		pg/g	60	1180	42.8	(11.9)	348	1430	237	484	(31.1)	(60)	494	1430	742	6110	368	NQ	(24)	(7.55)
Non-Maori	Male	35-49	Waikato/Bay of Plenty	18		pg/g	*22.6*	213	25.3	(16.1)	203	951	243	286	(47)	(51)	517	1430	731	6170	784	NQ	*18*	(3.82)
Non-Maori	Male	35-49	Lower North Island	15		pg/g	*27.5*	458	22.8	(8.3)	171	832	192	192	(20.5)	(41.1)	271	826	343	3050	469	NQ	(10.1)	(1.87)
Non-Maori	Male	35-49	South Island	10		pg/g	111	1780	37.4	(17.6)	253	1560	199	247	(25.1)	(46.9)	NQ	NQ	NQ	NQ	545	NQ	*36.6*	(4.63)
Non-Maori	Male	50-64	Northland/Auckland	17		pg/g	(8)	348	19.5	(8.4)	92.1	1120	189	173	(11.6)	(24.9)	*171*	665	*215*	*2820*	704	NQ	*20.3*	(1.04)
Non-Maori	Male	50-64	Waikato/Bay of Plenty	19		pg/g	(20.4)	224	(7.8)	(20.1)	90.1	638	154	219	(31.8)	(71)	226	771	305	3000	463	(2900)	(9.55)	(3.43)
Non-Maori	Male	50-64	Lower North Island	20		pg/g	(22.3)	383	31.9	(22)	146	1270	261	175	(26.3)	(56.5)	269	1190	394	3280	1180	(2235)	(10.1)	(3.34)
Non-Maori	Male	50-64	South Island	16		pg/g	(19.6)	133	(7.45)	(19.3)	102	731	151	141	(41.9)	(86.5)	NQ	NQ	NQ	NQ	906	NQ	*39*	(3.54)
Non-Maori	Female	19-24	Northland/Auckland	8		pg/g	(12.6)	143	27.5	(12.1)	266	805	283	235	(45.4)	(56)	621	1780	946	6510	114	NQ	(21.6)	(10.1)
Non-Maori	Female	19-24	Waikato/Bay of Plenty	15		pg/g	(17.8)	161	19.6	(17.5)	131	582	146	176	(21.1)	(41.3)	403	974	402	2960	151	NQ	(11.7)	(3.68)
Non-Maori	Female	19-24	Lower North Island	14		pg/g	(17.1)	238	21.5	(16.9)	120	724	177	131	(35.3)	(68.5)	377	1010	392	3650	225	NQ	(13.1)	(4.5)
Non-Maori	Female	19-24	South Island	10		pg/g	(16.7)	104	(7.55)	(16.1)	189	553	191	243	(45)	(87.5)	409	1040	583	3750	180	NQ	*26*	(4.57)
Non-Maori	Female	25-34	Northland/Auckland	12		pg/g	*23.9*	220	21.7	(8.5)	123	690	176	174	(13.7)	(27)	336	765	286	*2140*	159	NQ	*16.3*	(0.89)
Non-Maori	Female	25-34	Waikato/Bay of Plenty	14		pg/g	44.6	351	19.5	(18.3)	125	747	150	179	(35.1)	(68)	285	1020	379	3370	204	NQ	(21.4)	(4.02)
Non-Maori	Female	25-34	Lower North Island	17		pg/g	(21.5)	263	(8.2)	(21.2)	147	742	197	236	(29)	(57)	378	1070	412	3330	127	NQ	(16)	(4.99)
Non-Maori	Female	25-34	South Island	16		pg/g	(16.8)	199	21.4	(16.5)	159	815	187	178	(27.4)	(57)	546	1470	480	4970	180	NQ	(17.5)	(3.96)
Non-Maori	Female	35-49	Northland/Auckland	14		pg/g	(20.7)	163	18	(20.4)	(42.6)	531	158	127	(43.1)	(104)	275	738	256	*2710*	459	NQ	(13.5)	(4.83)
Non-Maori	Female	35-49	Waikato/Bay of Plenty	22		pg/g	(20.9)	129	(7.95)	(20.5)	(37.9)	504	114	146	(38.4)	(86.5)	383	855	391	4720	876	NQ	*25.8*	(3.58)
Non-Maori	Female	35-49	Lower North Island	18		pg/g	(18.4)	115	(7)	(18.1)	(41)	406	85	113	(41.4)	(102)	268	497	*169*	*2340*	638	NQ	(12.9)	(5.05)
Non-Maori	Female	35-49	South Island	18		pg/g	(11.8)	114	(4.48)	(11.6)	69.2	532	86	102	(29.6)	(65)	NQ	NQ	NQ	NQ	424	NQ	(10.9)	(3)
Non-Maori	Female	50-64	Northland/Auckland	23		pg/g	(15.2)	114	(5.8)	(15)	75.1	476	112	97.6	(22.1)	(46.9)	209	638	226	*2270*	503	(1225)	*20.3*	(3.35)
Non-Maori	Female	50-64	Northland/Auckland	23	Pool duplicate	pg/g	(15.8)	96.9	(6.05)	(15.6)	73.1	405	92.4	130	(21.7)	(44.5)	193	647	248	*2240*	538	(1525)	*21.9*	(3.75)
Non-Maori	Female	50-64	Waikato/Bay of Plenty	11		pg/g	(16.3)	129	(6.2)	(16.1)	(25.3)	479	84.5	(32)	(25.6)	(60.5)	*106*	634	234	*2100*	638	(2640)	(14.7)	(4.39)
Non-Maori	Female	50-64	Waikato/Bay of Plenty	11	Pool replicate	pg/g	(11.5)	131	*11.2*	(11.4)	(28.3)	439	102	106	(28.6)	(58)	NQ	NQ	NQ	NQ	509	NQ	(12.5)	(2.8)
Non-Maori	Female	50-64	Lower North Island	20		pg/g	(19.4)	175	(7.4)	(19.1)	(30.5)	502	98.9	(38.5)	(30.8)	(65)	*184*	738	244	*2370*	488	(2150)	*28.6*	(3.05)
Non-Maori	Female	50-64	South Island	20		pg/g	(9.95)	155	*10.9*	(9.8)	75.1	527	94.9	108	(33.4)	(69)	NQ	NQ	NQ	NQ	353	NQ	*30.3*	(2.83)
Method blank						pg/g	(9.85)	*19.9*	(4.45)	(9.45)	(27.1)	(20.5)	(22)	(32.7)	(32.9)	(67)	*107*	*155*	*129*	*938*	(11)	NQ	(13.3)	(6.25)
Bovine blank						pg/g	*21*	239	(4.22)	(8.95)	*44.8*	*47.4*	(17.5)	(26.1)	(26.3)	(47.6)	*98.4*	*126*	*81.8*	*1280*	(4.99)	NQ	*23.1*	(2.99)
Lab blank						pg/g	(13.7)	44.7	(5.25)	(13.5)	(16.8)	(13.5)	(12.6)	(21.3)	(17)	(35.7)	62.6	65.4	41.9	597	(8.9)	(795)	(10.1)	(4.57)
Lab blank						pg/g	(12.9)	(6.1)	(4.93)	(12.7)	(23)	(18.5)	(17.2)	(29.1)	(23.3)	(47.9)	(117)	223	(78)	(820)	(8.9)	NQ	(8.3)	(3.1)
Lab blank						pg/g	(12)	16.8	(5.4)	(11.5)	(29.6)	(22.3)	(24)	(35.7)	(35.9)	(67.5)	66	112	92.4	607	(13.3)	NQ	(17.6)	(4.39)
Lab blank						pg/g	NQ	NQ	NQ	(7.2)	NQ	NQ	NQ	NQ	(9.25)	(17.5)	(37.3)	NQ	62.7	926	17.3	NQ	19.6	1.58
Lab blank						pg/g	(16.4)	103	(6.25)	(16.1)	(22.7)	(18.2)	(16.9)	(28.6)	(23)	(50)	119	164	104	2340	(15.8)	NQ	(16.7)	(5.35)
Lab blank						pg/g	(11.3)	(5.35)	(4.31)	(11.1)	(17.6)	(14.2)	(13.2)	(22.2)	(17.8)	(34.9)	(15.8)	62.3	52.3	840	(9.4)	NQ	(10.4)	(4.11)
Lab blank						pg/g	(10.4)	14.7	(4.71)	(10)	(25.8)	(19.5)	(20.9)	(31.1)	(31.3)	(59)	57.5	97.4	80.5	529	(11.5)	NQ	(15.3)	(3.83)
Lab blank						pg/g	NQ	NQ	NQ	(7.6)	NQ	NQ	NQ	NQ	(9.75)	(18.5)	(39.3)	NQ	66	976	18.2	NQ	20.7	1.66

Values in brackets are <LOD, reported as 0.5LOD

NQ - not quantified

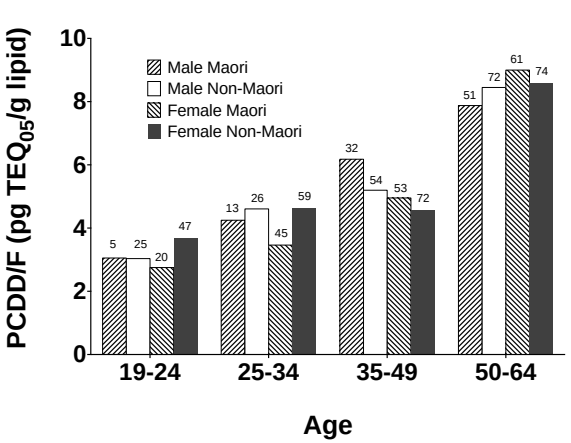
Results shaded and in italics are < 3 x average lab blank

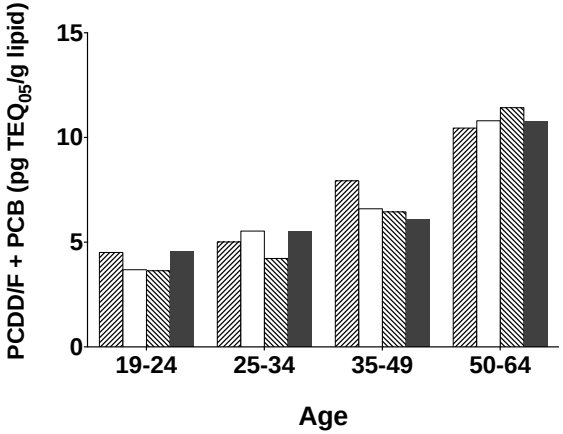
Ethnicity	Gender	Age	Region	N	Comments	Units	PFHxS	PFOS	PFOA	PFNA	PFBS	PFDS	PFHxA	PFHpA	PFDA	PFUnA	PFDoA	PFTrDA	PFTeDA	PFOSA	NEtFOSAA	NMeFOSAA
Maori	Male	19-24	Northland/Auckland	1		ng/mL	(0.25)	2.84	2	*0.6*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Male	19-24	Waikato/Bay of Plenty	2		ng/mL	(0.25)	2.22	1.91	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Male	19-24	Lower North Island	2		ng/mL	0.76	7.19	1.76	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Male	25-34	Northland/Auckland	3		ng/mL	1.15	2.73	3.21	1.06	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Male	25-34	Waikato/Bay of Plenty	6		ng/mL	1.02	4.07	2.78	0.76	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Male	25-34	Lower North Island	2		ng/mL	1.18	3.7	2.5	*0.58*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Male	25-34	South Island	2		ng/mL	0.83	3.4	1.63	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Male	35-49	Northland/Auckland	8		ng/mL	1.2	3.92	3.16	*0.66*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Male	35-49	Waikato/Bay of Plenty	8		ng/mL	*0.59*	4.63	3.59	0.77	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Male	35-49	Lower North Island	10		ng/mL	0.95	3.47	2.32	*0.57*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Male	35-49	South Island	6		ng/mL	1.41	3.66	2.76	*0.73*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Male	50-64	Northland/Auckland	16		ng/mL	1.3	5.38	2.98	0.84	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	*0.59*
Maori	Male	50-64	Waikato/Bay of Plenty	13		ng/mL	0.81	5.86	3.24	1.34	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Male	50-64	Lower North Island	11		ng/mL	0.97	4.05	3.46	0.82	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Male	50-64	South Island	11		ng/mL	1.69	5.42	3.62	0.94	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	19-24	Northland/Auckland	5		ng/mL	*0.66*	2.32	1.93	*0.63*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	19-24	Waikato/Bay of Plenty	5		ng/mL	*0.51*	2.72	1.96	*0.67*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	19-24	Lower North Island	6		ng/mL	(0.25)	3.02	2.15	*0.7*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	19-24	South Island	4		ng/mL	*0.61*	1.73	1.74	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	25-34	Northland/Auckland	12		ng/mL	*0.57*	2.44	1.85	*0.52*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	25-34	Waikato/Bay of Plenty	11		ng/mL	0.83	2.58	2.13	*0.62*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	25-34	Lower North Island	14		ng/mL	*0.52*	1.96	1.75	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	25-34	South Island	8		ng/mL	*0.58*	2.64	1.98	*0.62*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	35-49	Northland/Auckland	12		ng/mL	*0.63*	2.66	2.04	*0.71*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	35-49	Waikato/Bay of Plenty	12		ng/mL	(0.25)	2.61	1.62	*0.51*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	35-49	Lower North Island	9		ng/mL	*0.55*	3.14	2.21	*0.61*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	35-49	South Island	20		ng/mL	1.07	2.56	1.95	*0.57*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	35-49	South Island	20	Pool duplicate	ng/mL	1.17	2.64	1.9	*0.57*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	50-64	Northland/Auckland	18		ng/mL	0.87	4.25	3.17	0.99	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	50-64	Waikato/Bay of Plenty	14		ng/mL	1.39	6.28	2.61	0.96	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	50-64	Lower North Island	13		ng/mL	*0.62*	3.44	2.17	*0.74*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	50-64	Lower North Island	13	Pool replicate	ng/mL	*0.69*	3.22	2.68	*0.71*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Maori	Female	50-64	South Island	16		ng/mL	0.94	3.55	2.29	*0.64*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	19-24	Northland/Auckland	5		ng/mL	3.05	3.25	2.96	*0.66*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	19-24	Waikato/Bay of Plenty	7		ng/mL	(0.25)	2.65	2.04	*0.5*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	19-24	Lower North Island	9		ng/mL	*0.74*	3.37	2.54	*0.6*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	19-24	South Island	4		ng/mL	2.22	3.94	2.61	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	25-34	Northland/Auckland	3		ng/mL	2.22	5.01	2.8	0.84	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	25-34	Waikato/Bay of Plenty	11		ng/mL	1.21	3.39	3.14	0.82	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	25-34	Lower North Island	4		ng/mL	1.2	3.86	2.5	0.81	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	25-34	South Island	8		ng/mL	1.34	3.75	3.21	0.87	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	35-49	Northland/Auckland	11		ng/mL	2.23	5.51	4.2	0.82	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	35-49	Waikato/Bay of Plenty	18		ng/mL	1.23	4.1	3.25	*0.71*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	35-49	Lower North Island	15		ng/mL	1.82	3.59	2.55	*0.54*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	35-49	South Island	10		ng/mL	2.18	3.78	2.21	*0.66*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	50-64	Northland/Auckland	17		ng/mL	1.75	4.02	2.83	0.77	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	50-64	Waikato/Bay of Plenty	19		ng/mL	1.07	3.79	2.73	0.78	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	50-64	Lower North Island	20		ng/mL	1.9	5.2	3.01	0.85	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Male	50-64	South Island	16		ng/mL	1.96	4.34	3.08	0.78	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	19-24	Northland/Auckland	8		ng/mL	*0.53*	1.92	1.96	*0.64*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	19-24	Waikato/Bay of Plenty	15		ng/mL	*0.63*	5.33	2.11	*0.73*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	19-24	Lower North Island	14		ng/mL	(0.25)	1.89	1.96	*0.62*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	19-24	South Island	10		ng/mL	0.8	2.22	2.05	*0.63*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	25-34	Northland/Auckland	12		ng/mL	(0.25)	2.42	1.79	*0.63*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	25-34	Waikato/Bay of Plenty	14		ng/mL	(0.25)	2.22	1.87	*0.6*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	25-34	Lower North Island	17		ng/mL	(0.25)	2.08	1.56	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	25-34	South Island	16		ng/mL	(0.25)	1.96	1.67	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	35-49	Northland/Auckland	14		ng/mL	*0.56*	2.53	1.53	*0.56*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	35-49	Waikato/Bay of Plenty	22		ng/mL	*0.58*	2.95	1.75	*0.6*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	35-49	Lower North Island	18		ng/mL	*0.64*	2.26	1.82	*0.55*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	35-49	South Island	18		ng/mL	1.23	2.39	1.71	*0.57*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	50-64	Northland/Auckland	23		ng/mL	0.8	3.92	2.57	0.79	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	50-64	Waikato/Bay of Plenty	11		ng/mL	3.47	6.72	3.65	1.07	(0.25)	(0.25)	(0.25)	(0.25)	*0.51*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	50-64	Lower North Island	20		ng/mL	*0.67*	3.41	2.96	0.96	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	50-64	Lower North Island	20	Pool duplicate	ng/mL	*0.68*	3.39	2.59	0.92	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Non-Maori	Female	50-64	South Island	20		ng/mL	1.36	3.48	2.53	*0.7*	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Bovine blank						ng/mL	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Method blank						ng/mL	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Lab blank						ng/mL	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Lab blank						ng/mL	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Lab blank						ng/mL	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Lab blank						ng/mL	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Lab blank						ng/mL	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Lab blank						ng/mL	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Lab blank						ng/mL	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Lab blank						ng/mL	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)

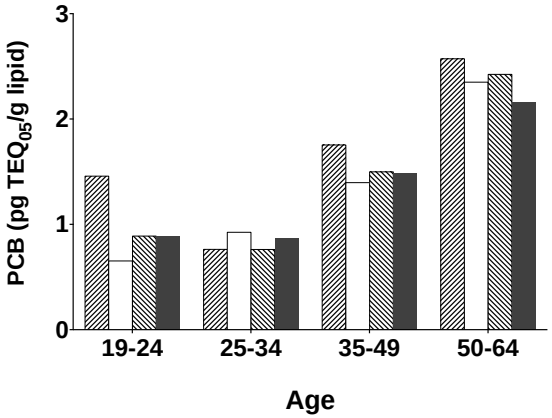
Values in brackets are <LOD, reported as 0.5LOD

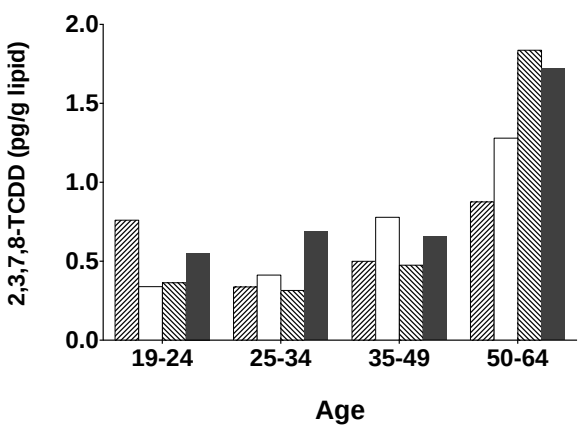
Results shaded and in italics are < 3 x average lab blank

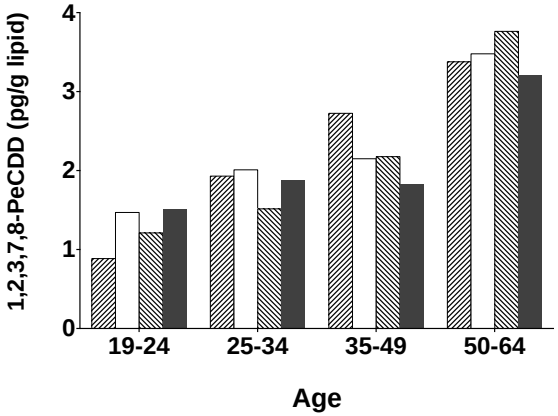
Appendix C5 - Result graphs (regions combined)

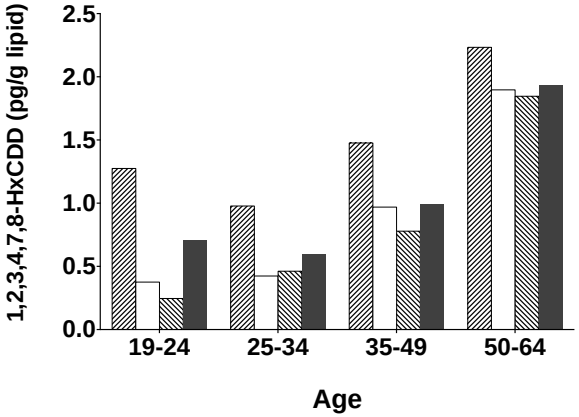




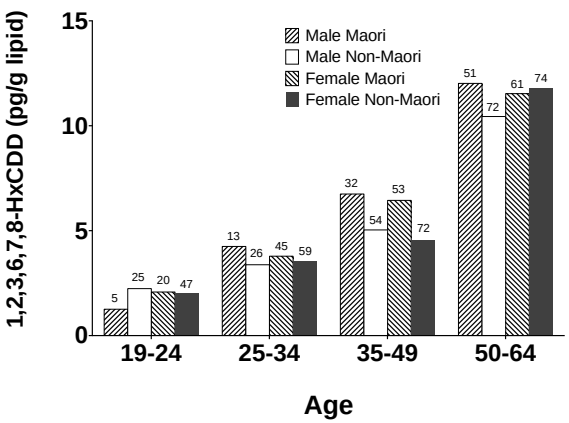


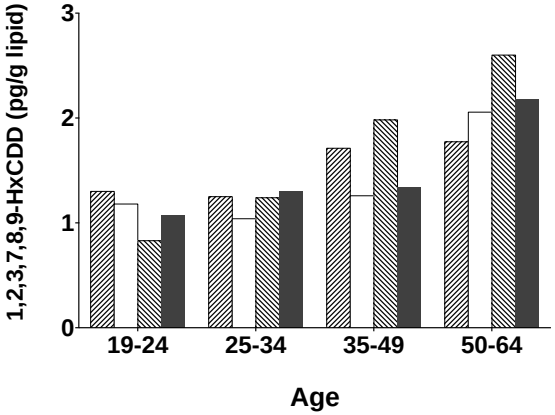


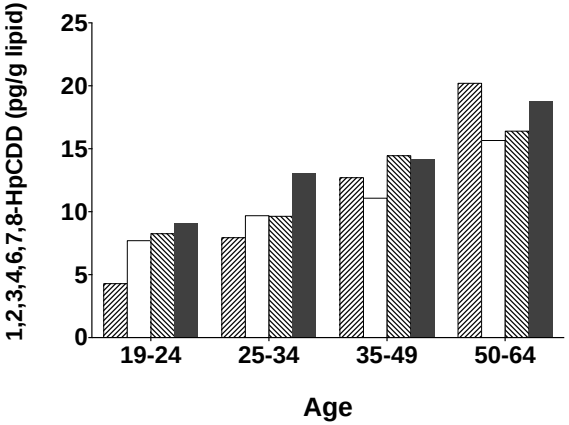


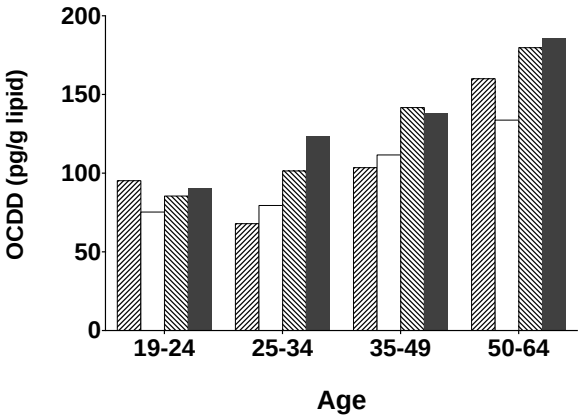


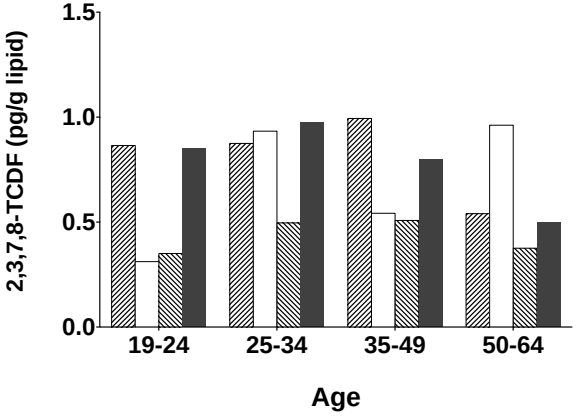
Appendix C5 - Result graphs (regions combined)

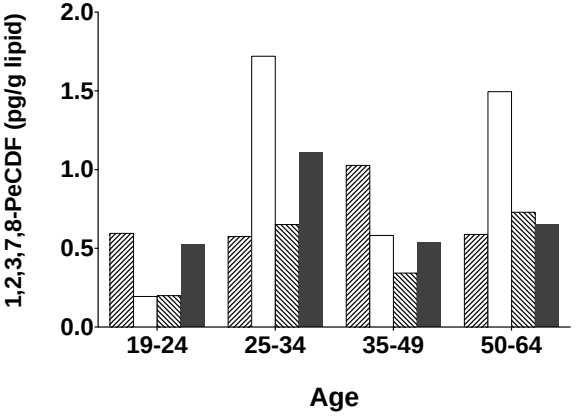




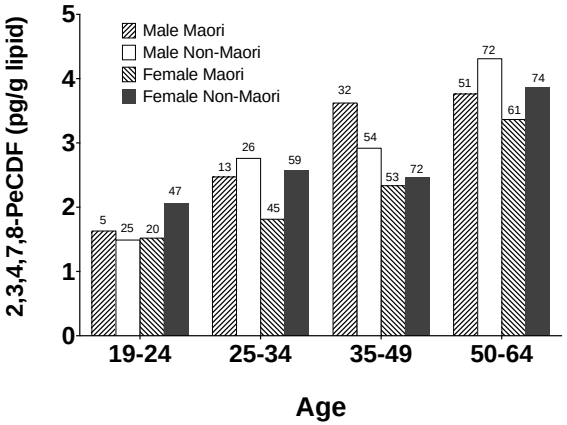


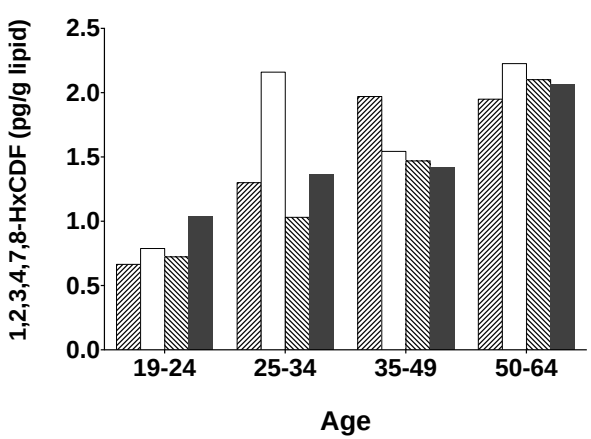


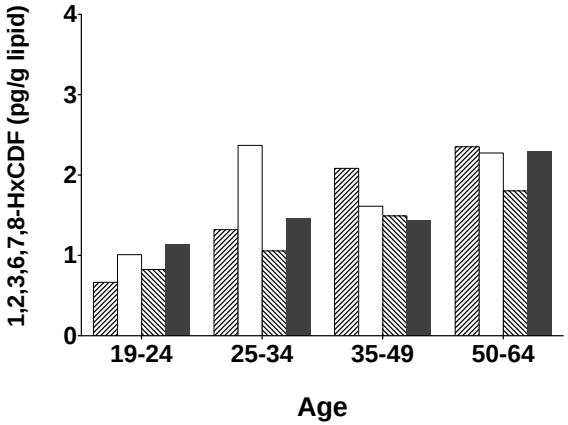


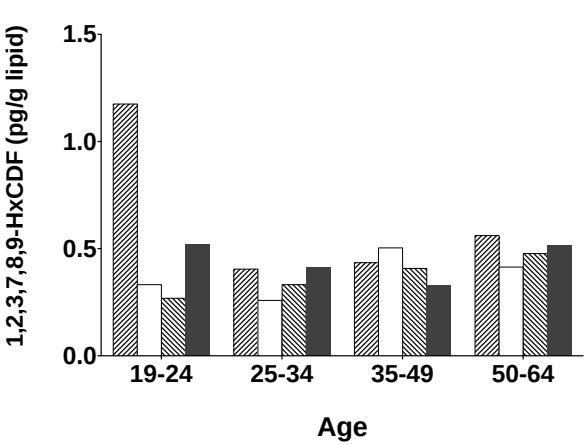


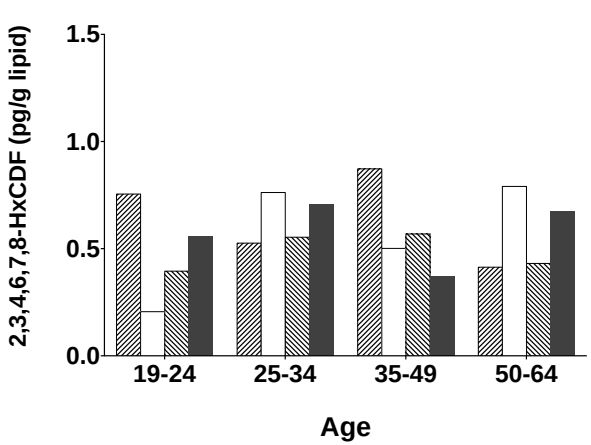
Appendix C5 - Result graphs (regions combined)

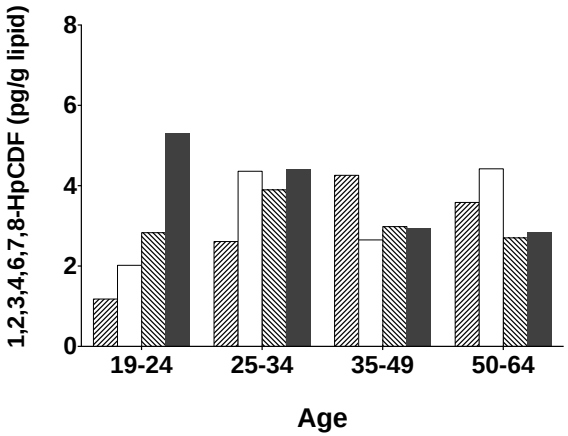




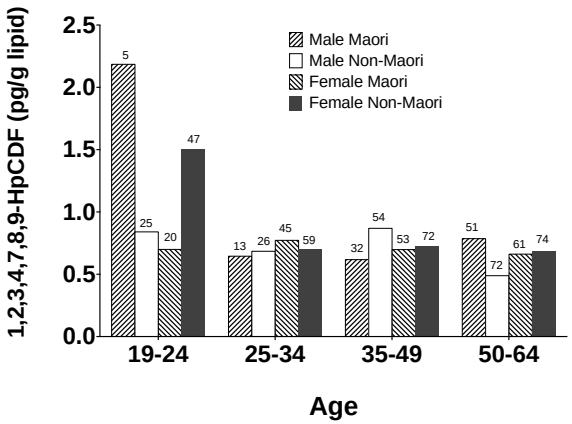


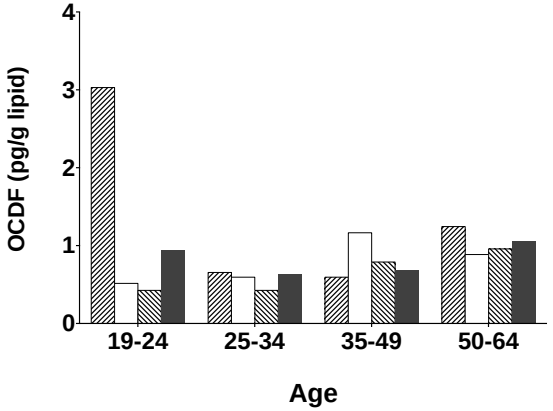


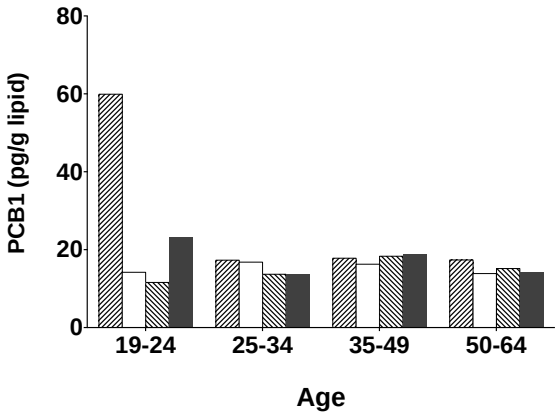


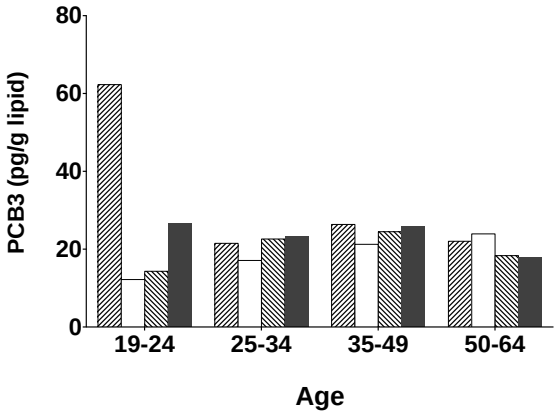


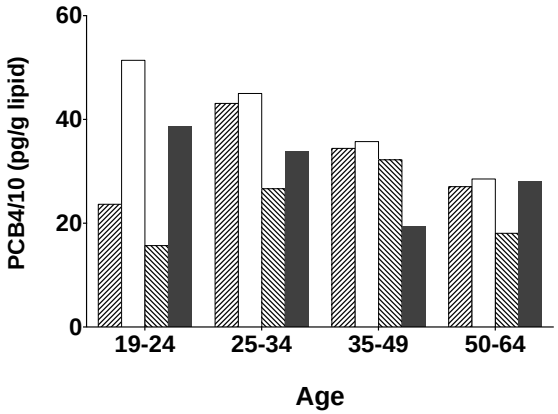
Appendix C5 - Result graphs (regions combined)

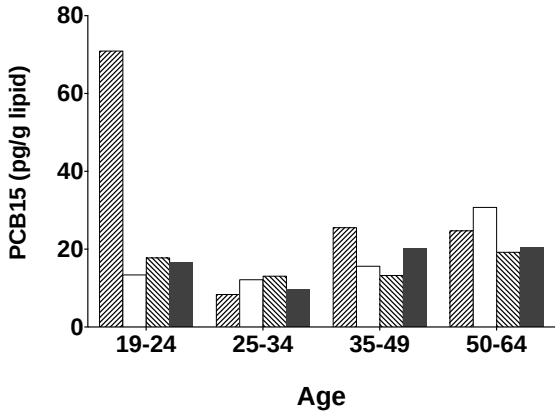




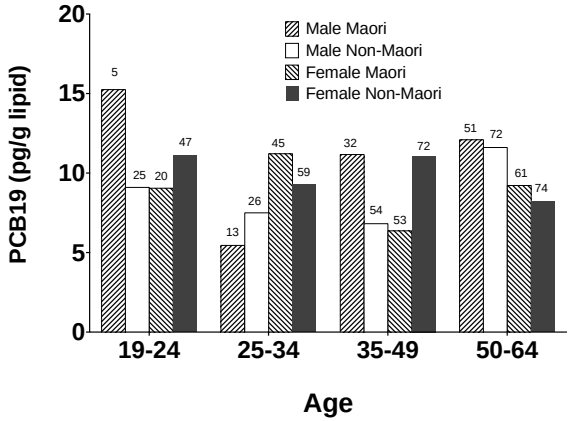


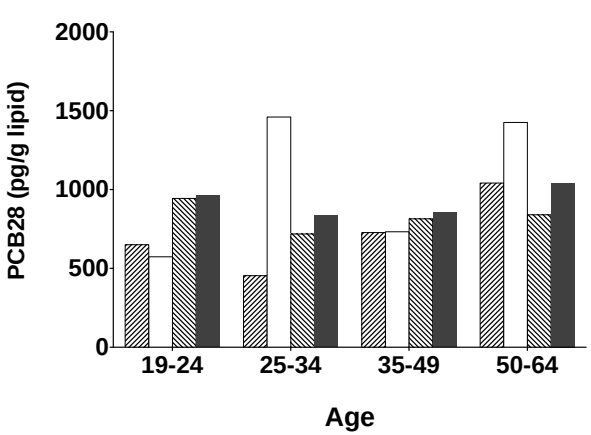


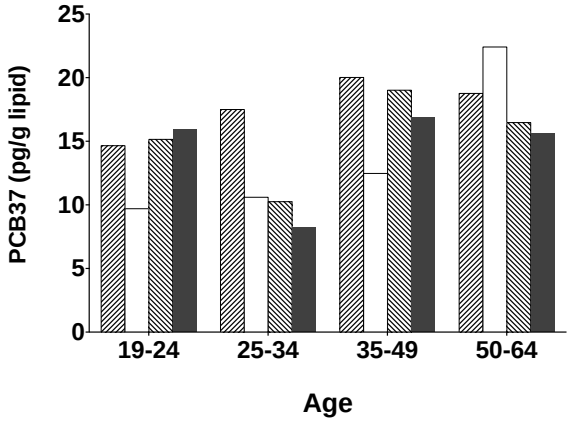


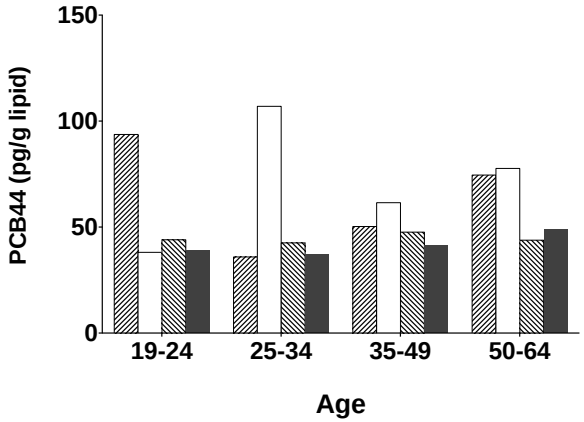


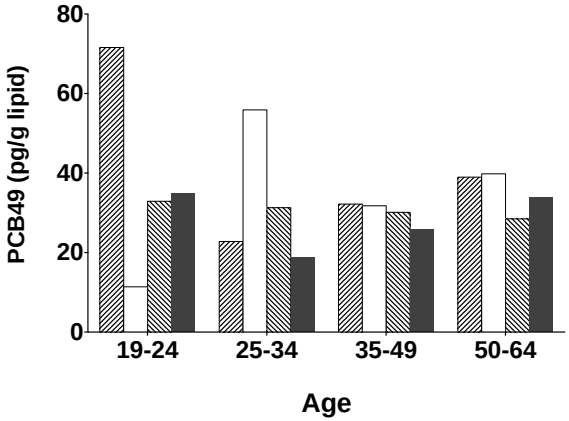
Appendix C5 - Result graphs (regions combined)

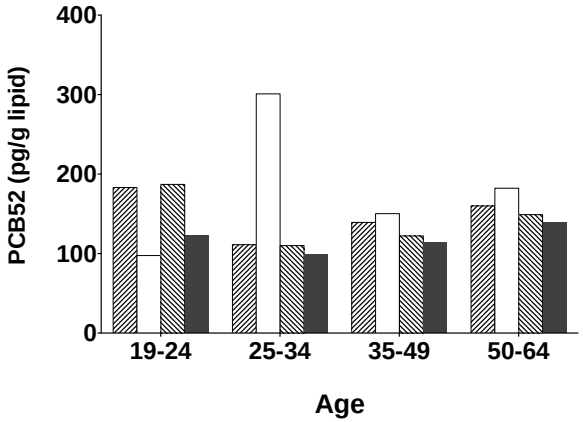




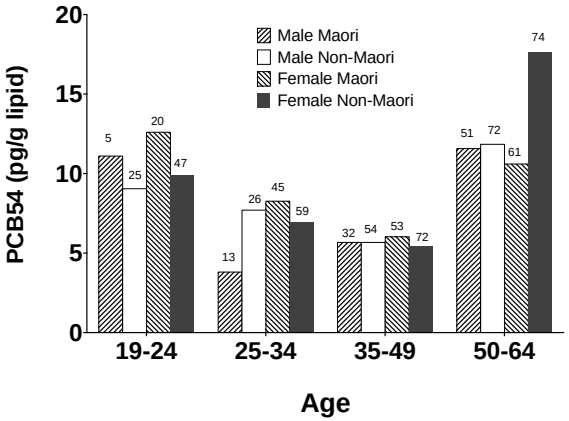


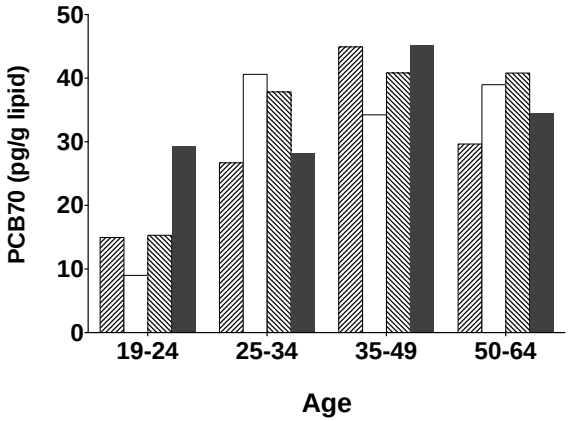


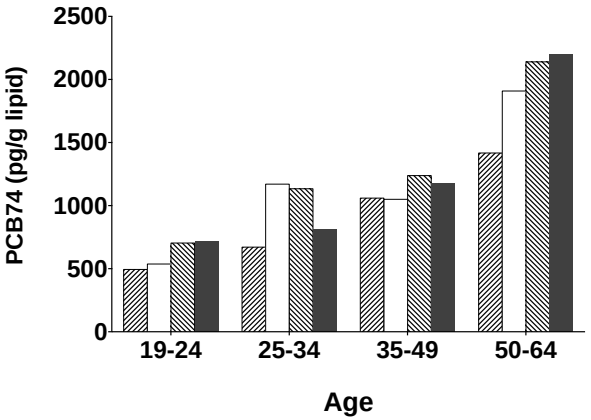


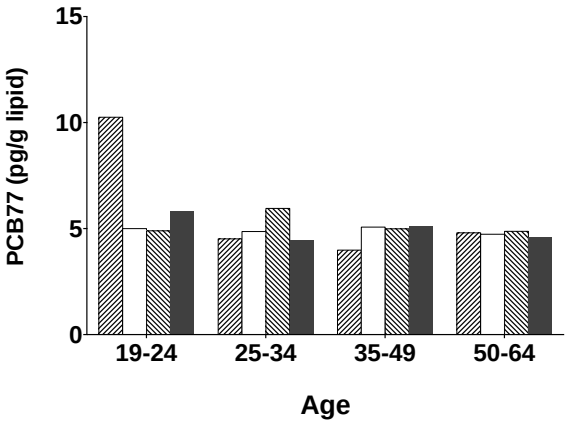


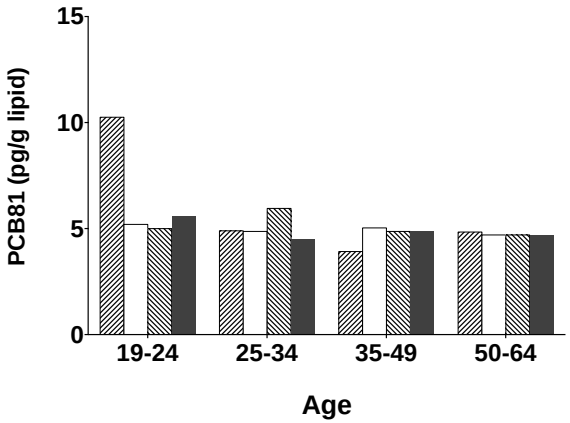
Appendix C5 - Result graphs (regions combined)

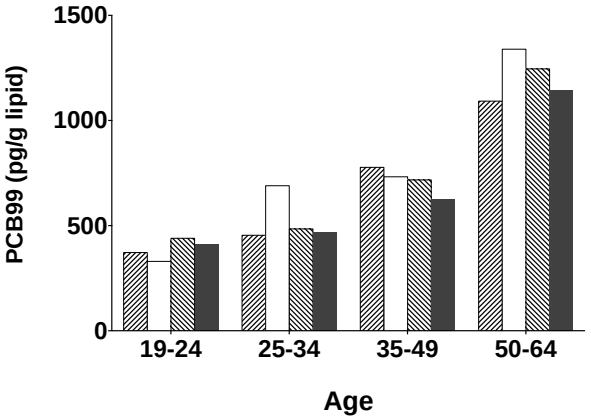




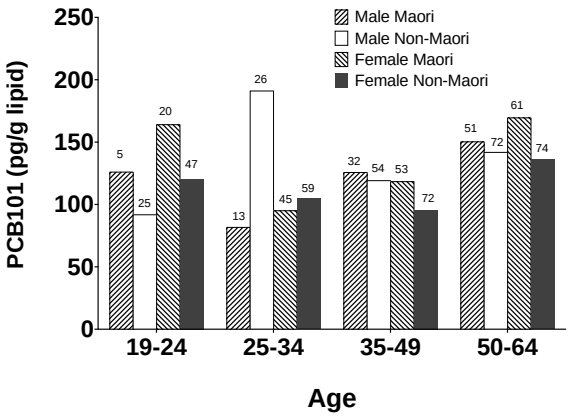


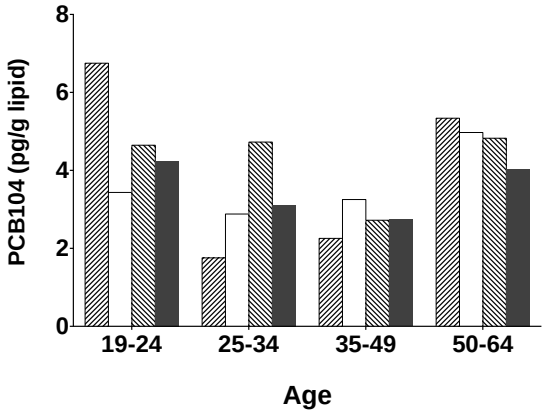


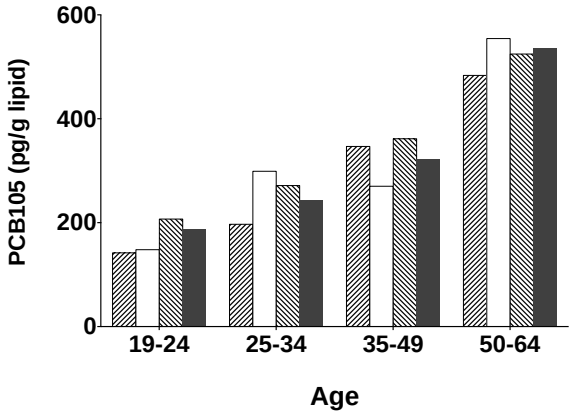


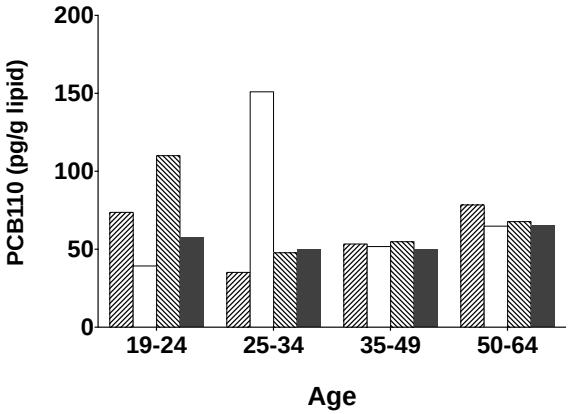


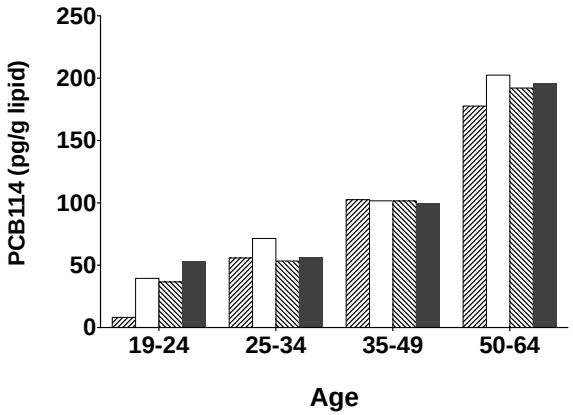
Appendix C5 - Result graphs (regions combined)

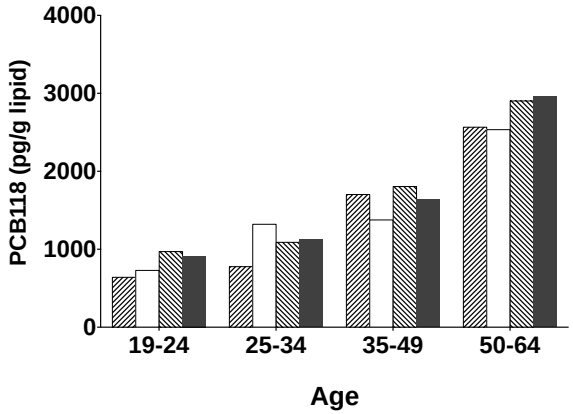




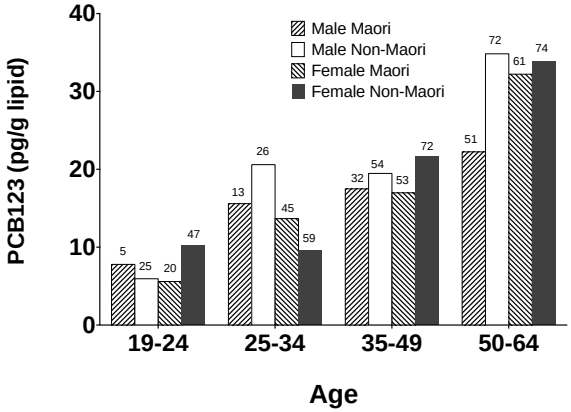


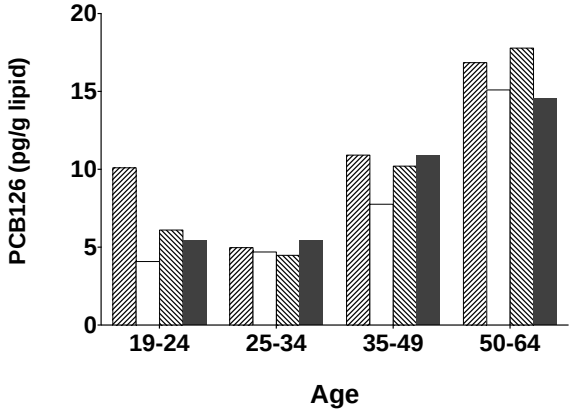


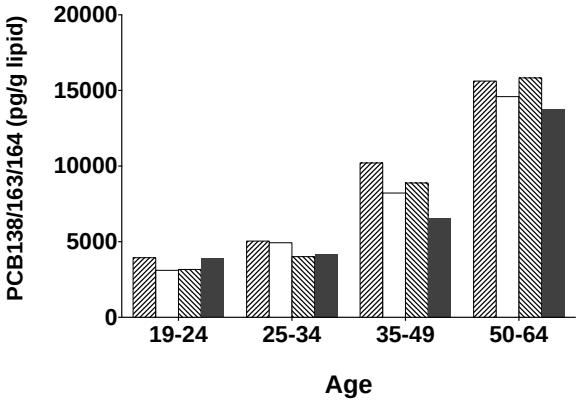


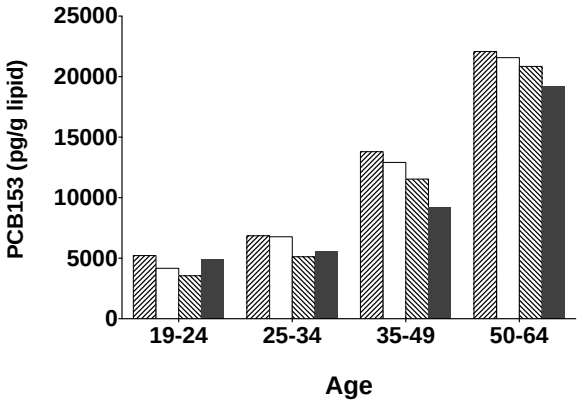


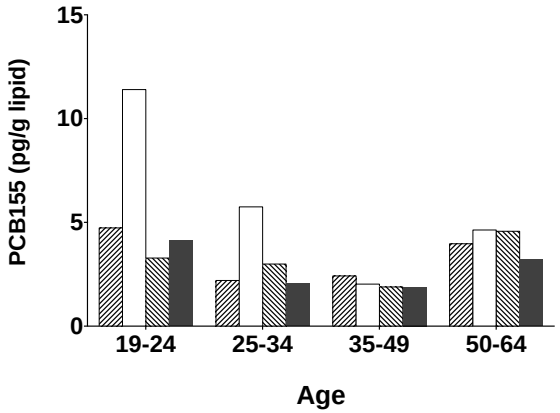
Appendix C5 - Result graphs (regions combined)

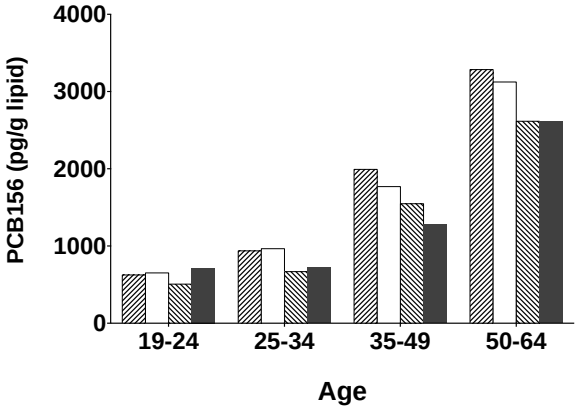




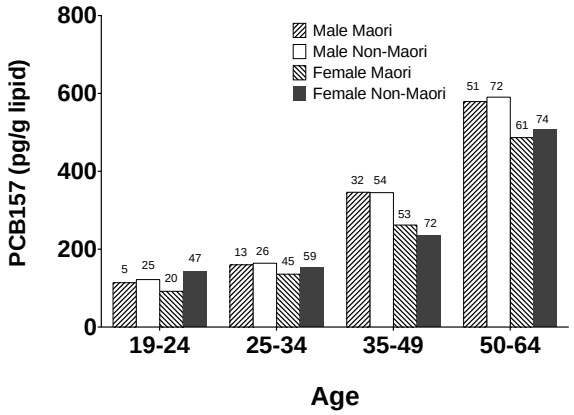


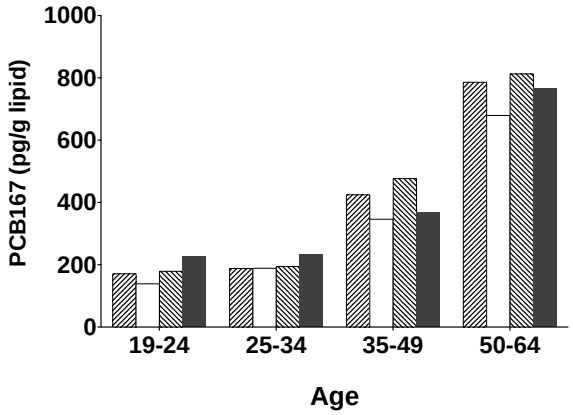


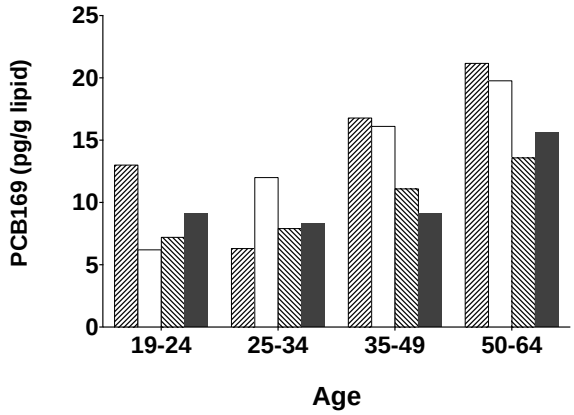


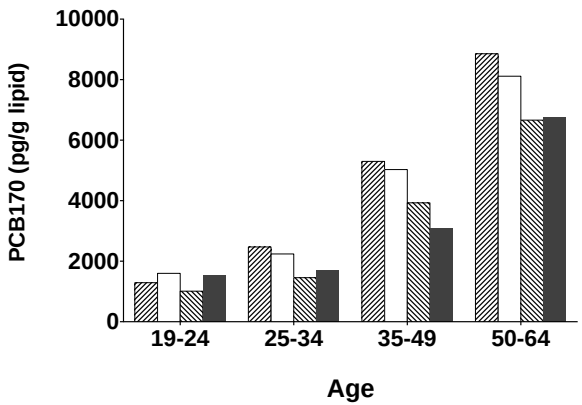


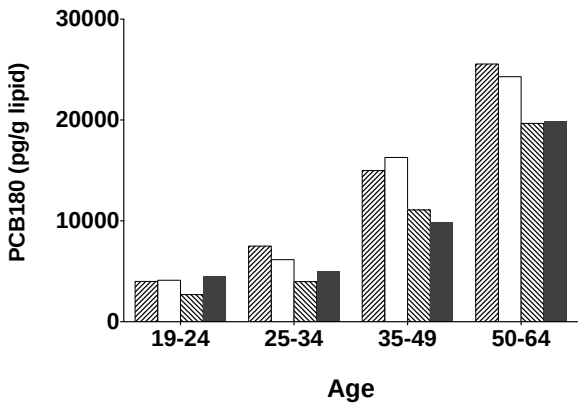
Appendix C5 - Result graphs (regions combined)

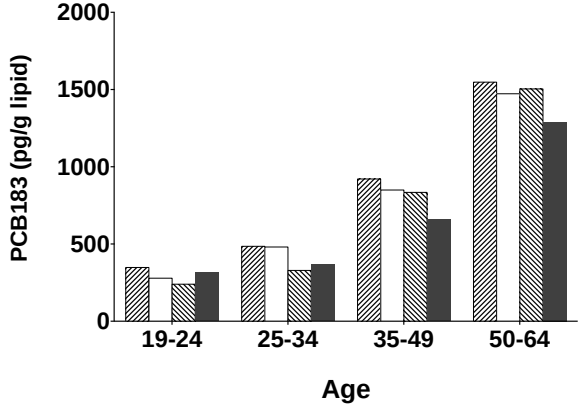




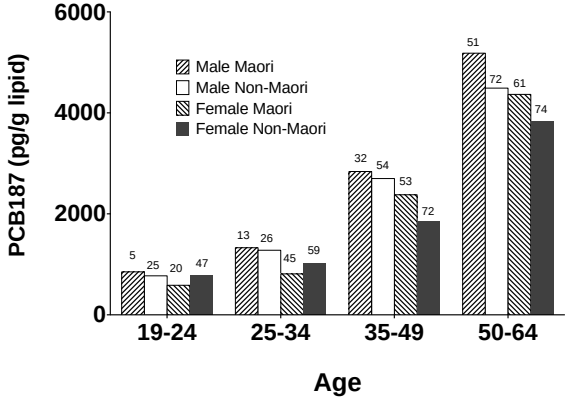


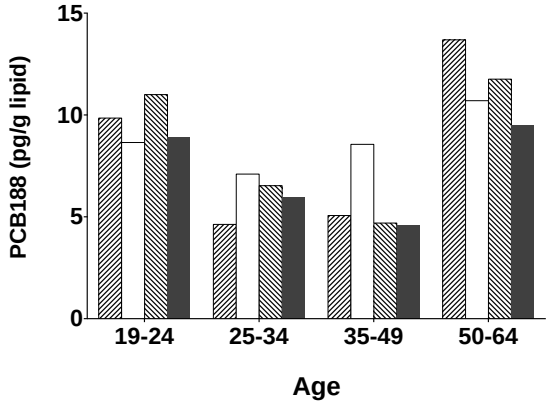


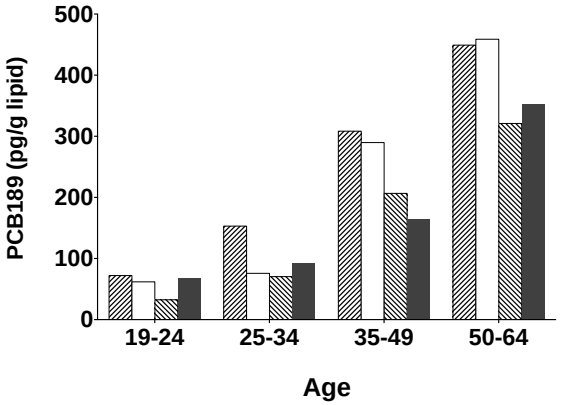


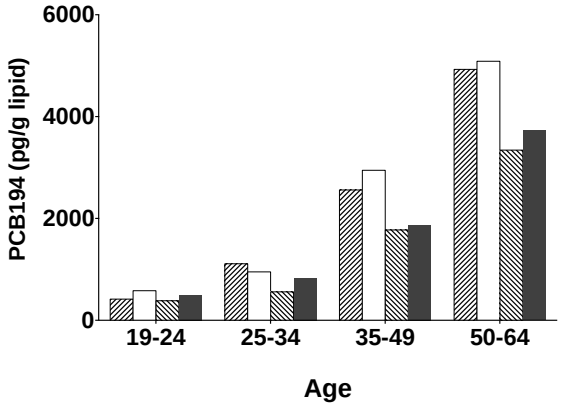


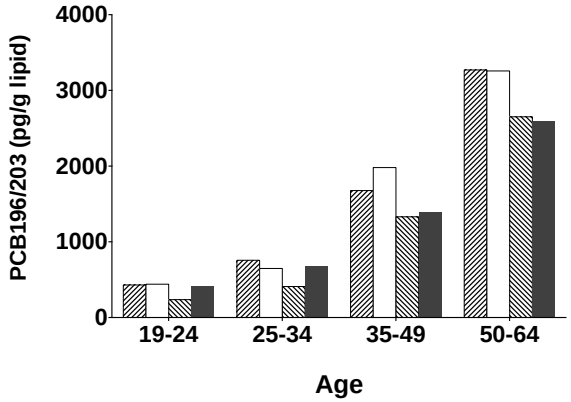
Appendix C5 - Result graphs (regions combined)

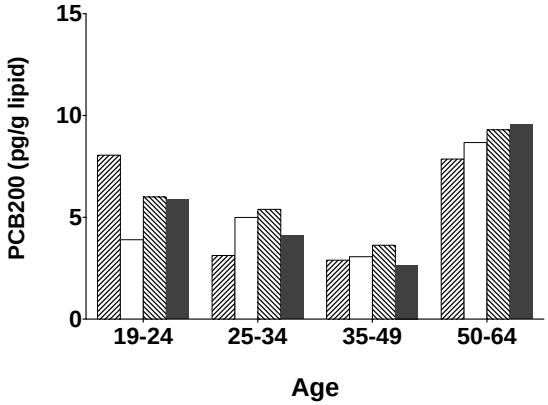




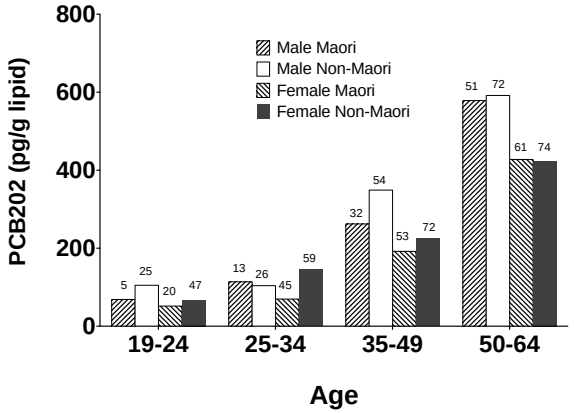


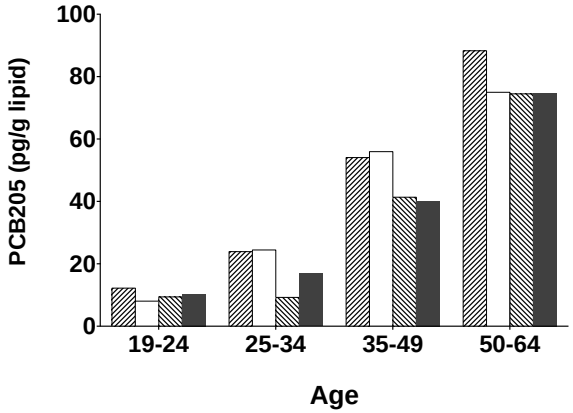


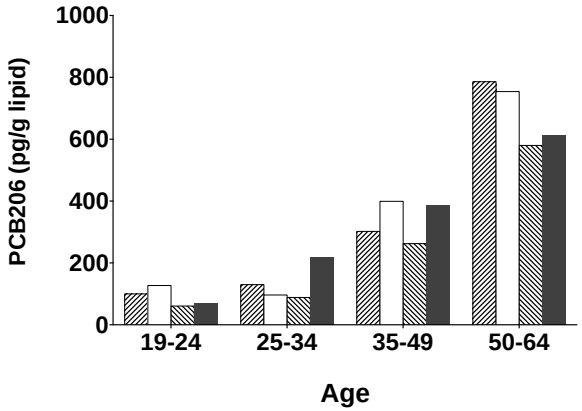


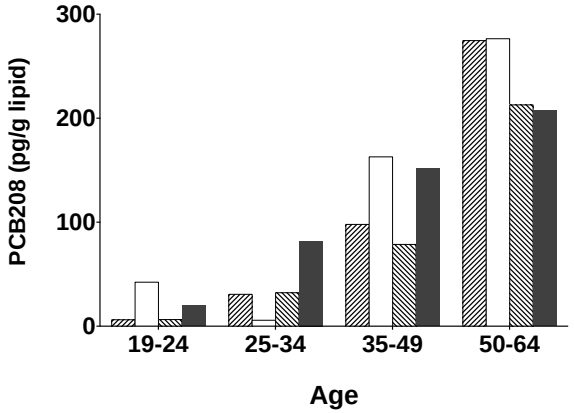


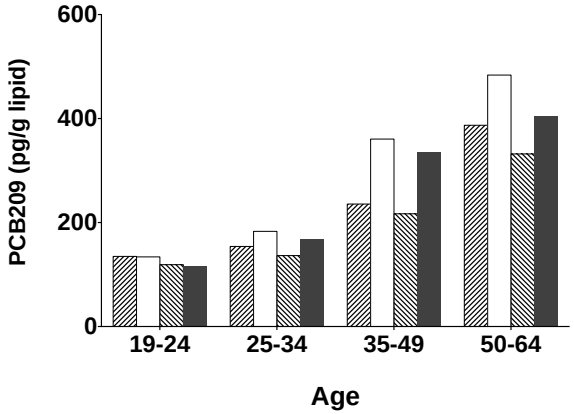
Appendix C5 - Result graphs (regions combined)



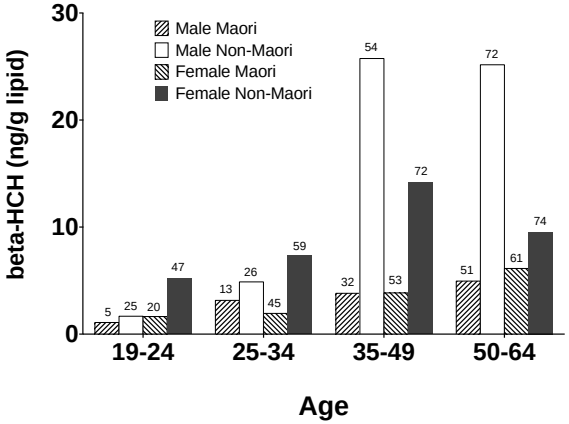


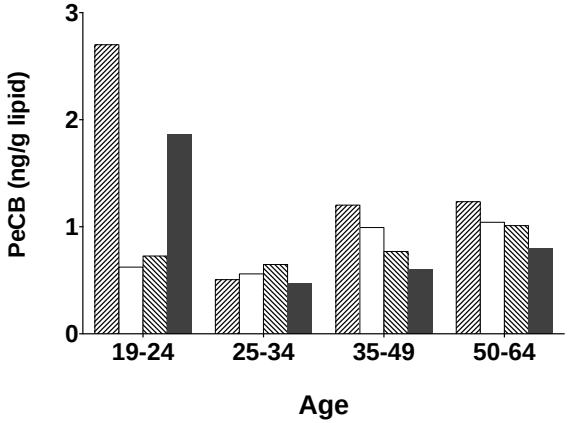


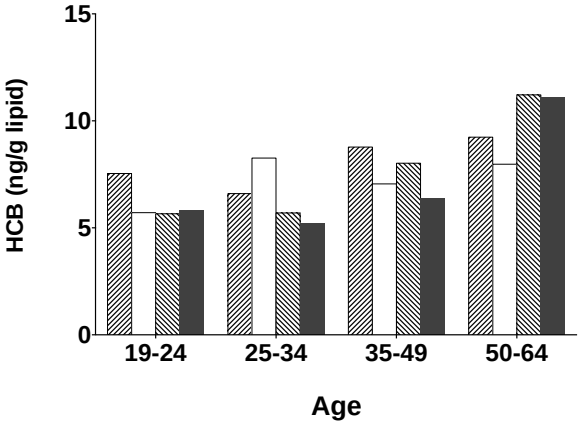


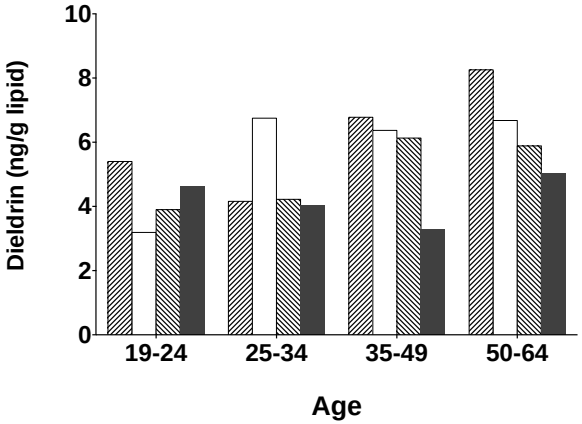


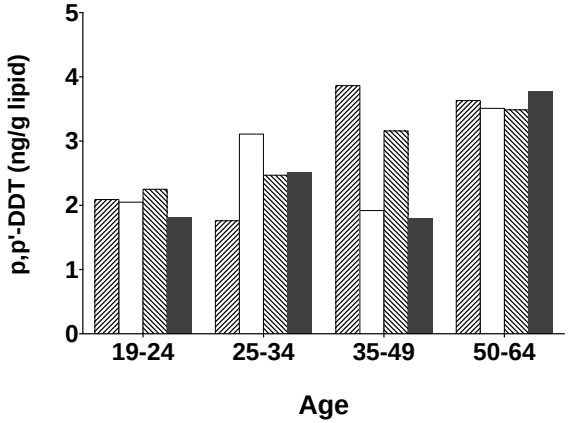
Appendix C5 - Result graphs (regions combined)

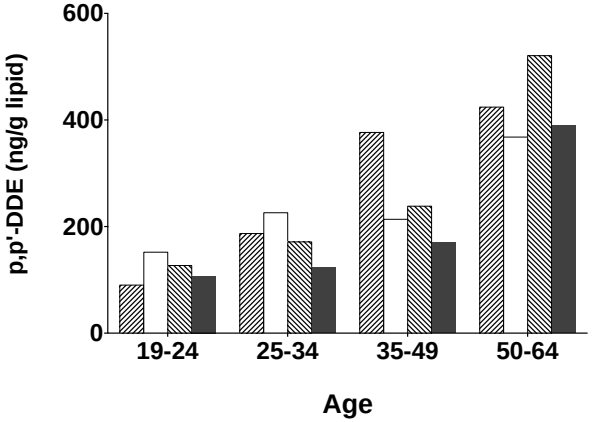




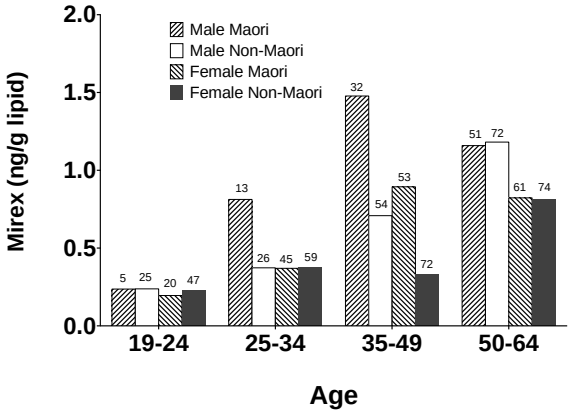




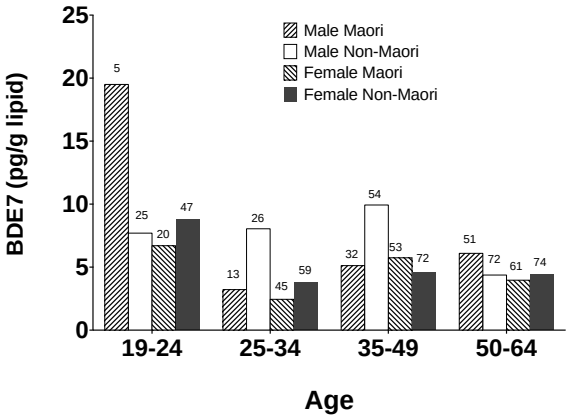


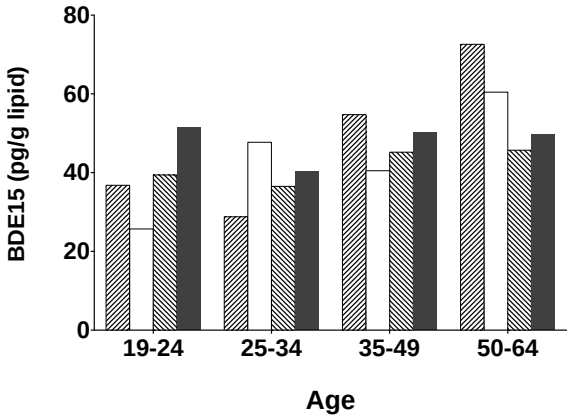


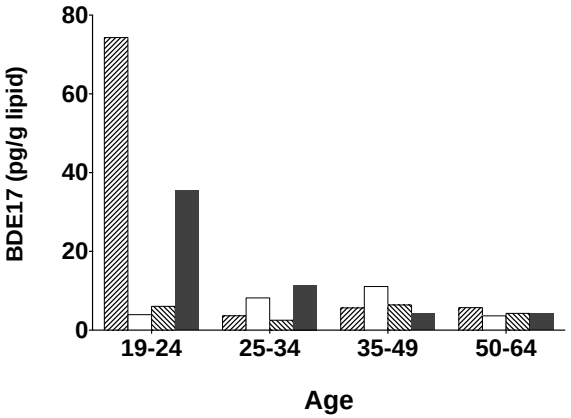
Appendix C5 - Result graphs (regions combined)

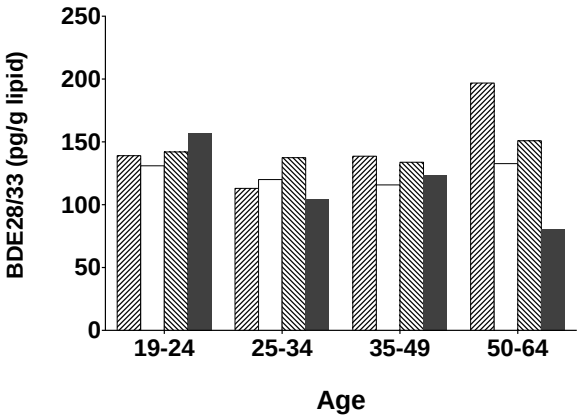


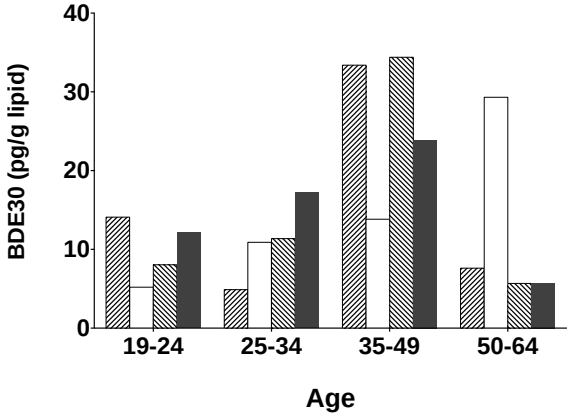
Appendix C5 - Result graphs (regions combined)

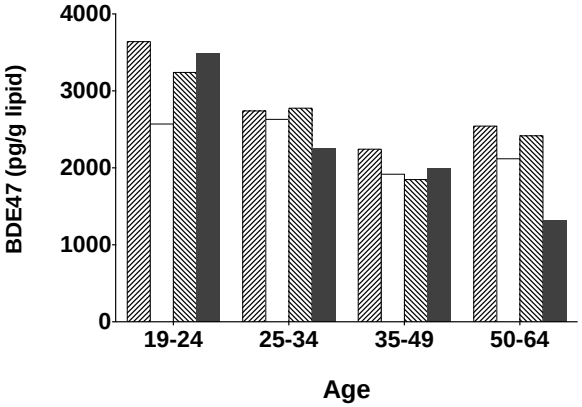




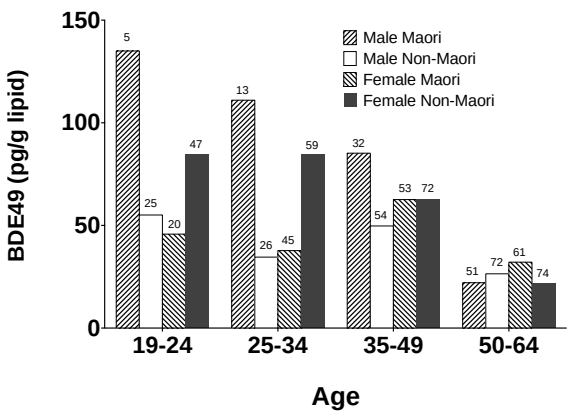


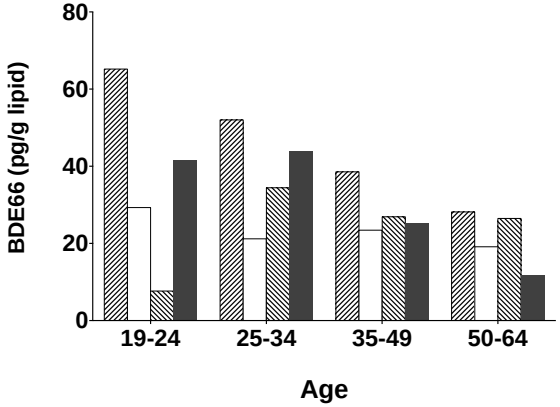


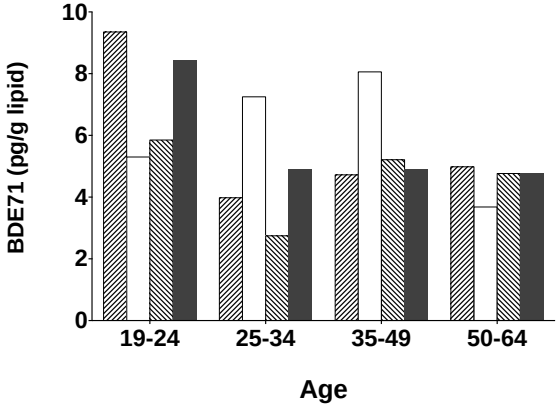


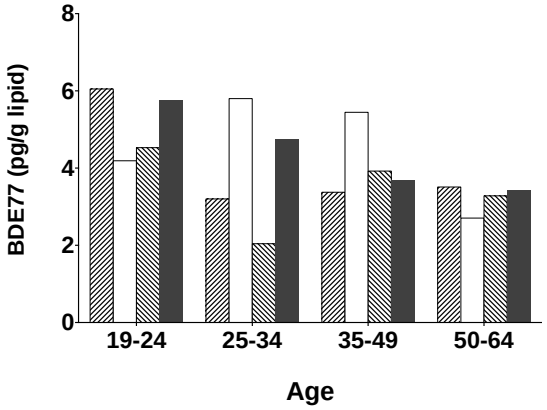


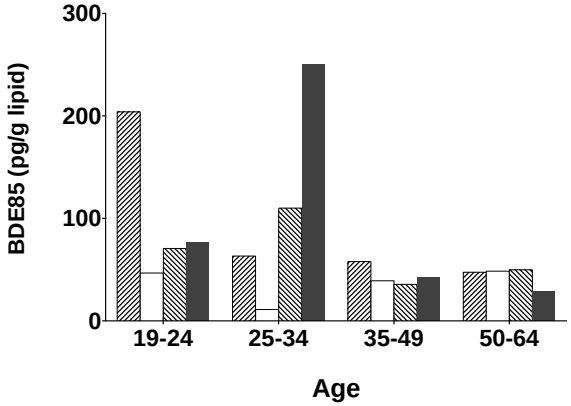
Appendix C5 - Result graphs (regions combined)

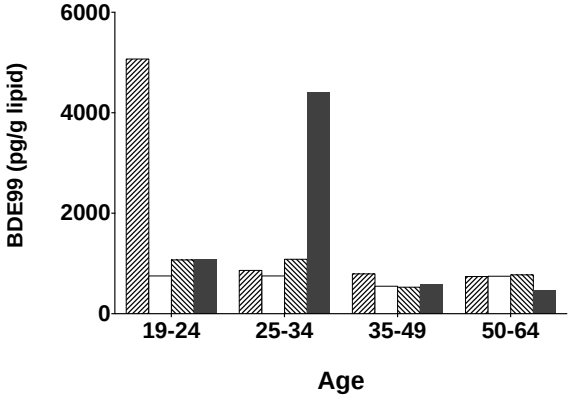




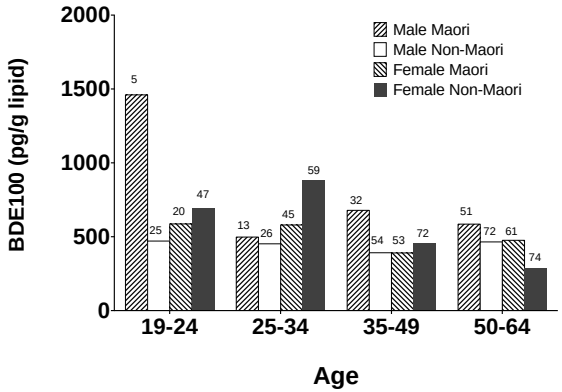


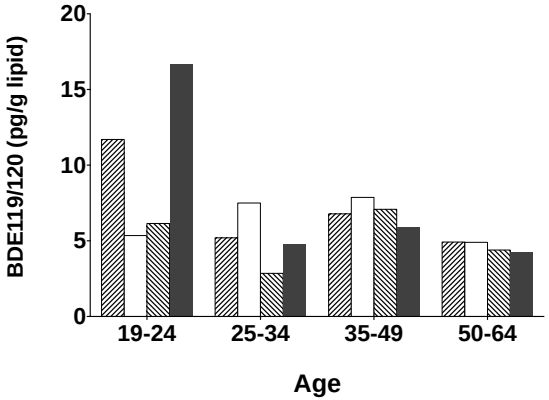


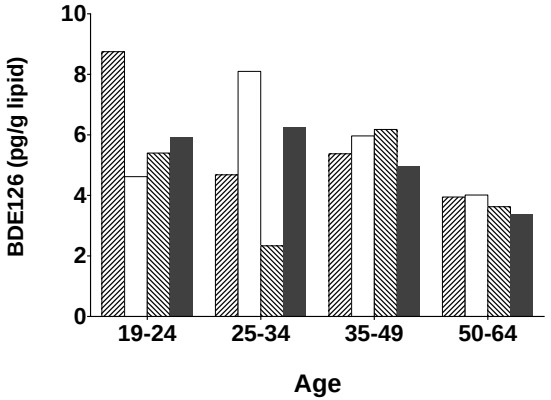


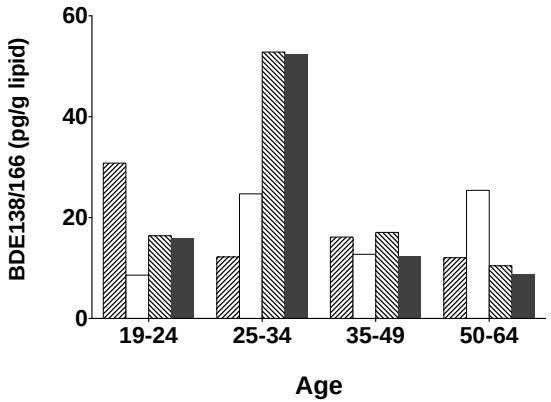


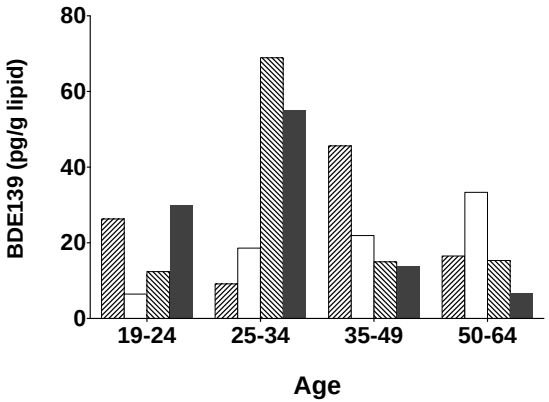
Appendix C5 - Result graphs (regions combined)

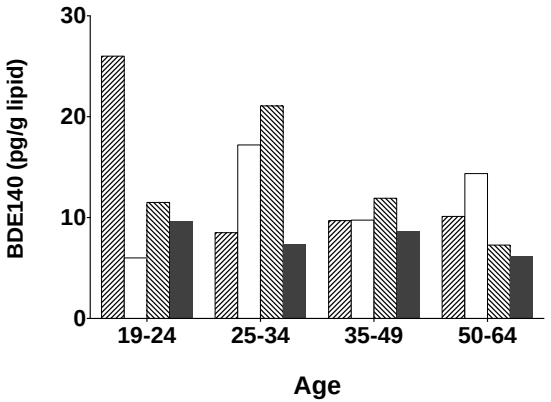




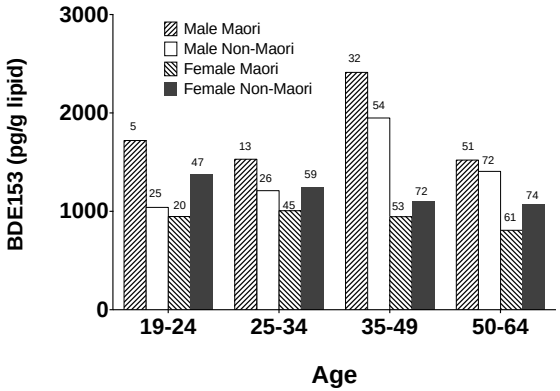


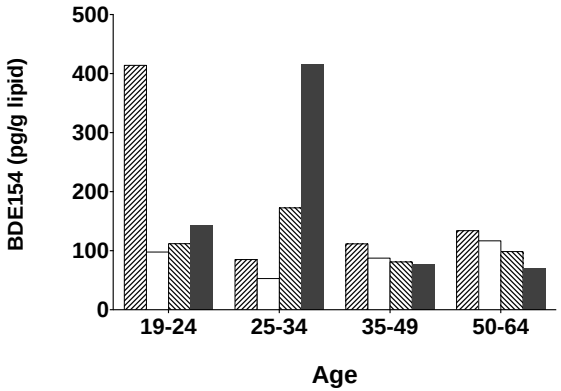


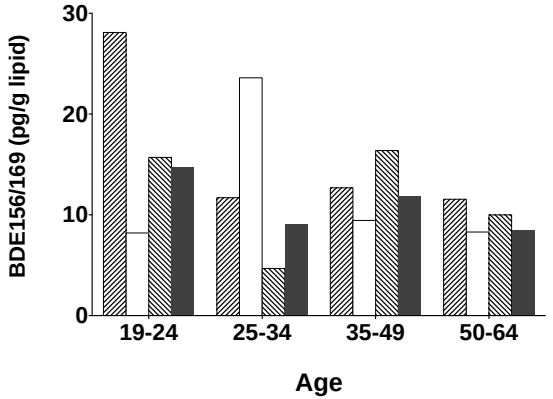


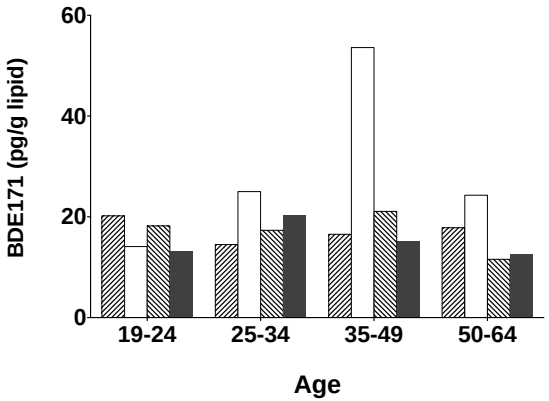


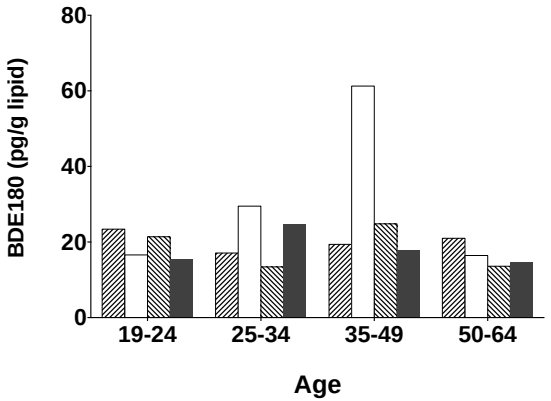
Appendix C5 - Result graphs (regions combined)

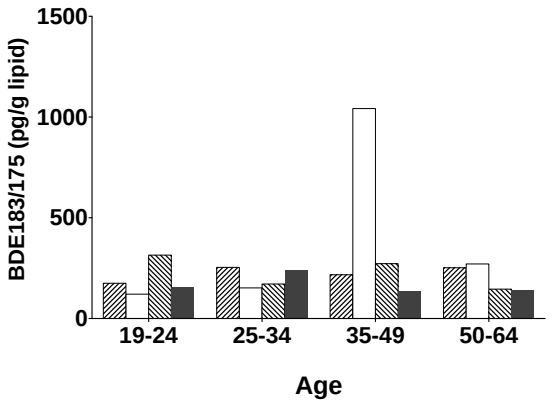




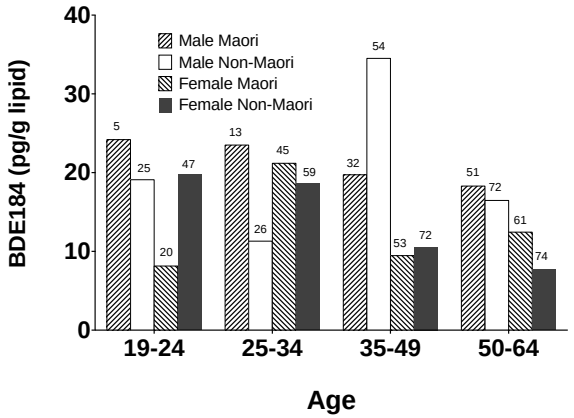


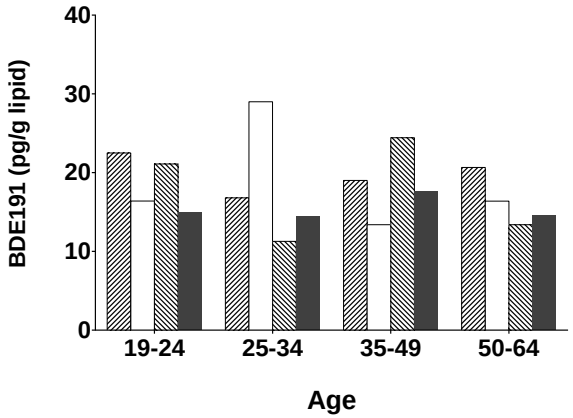


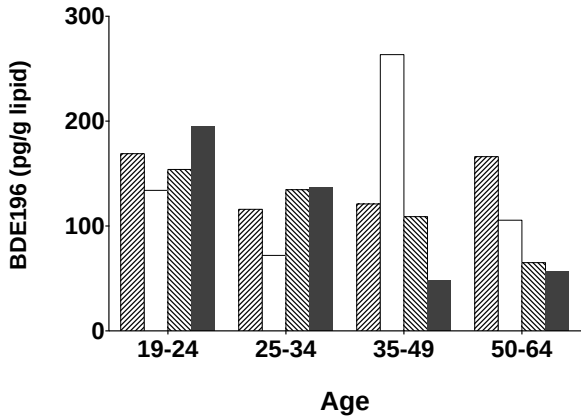


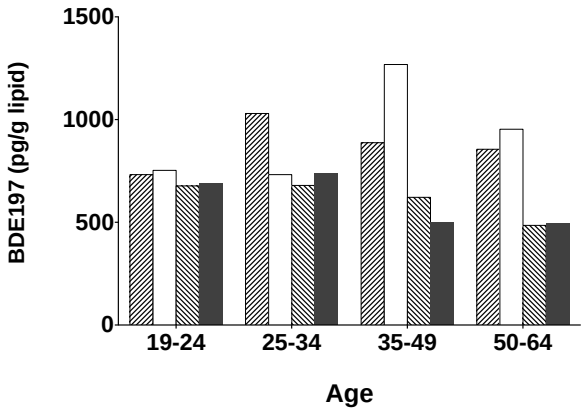


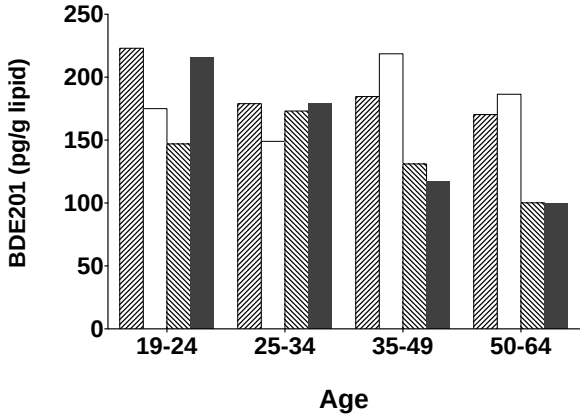
Appendix C5 - Result graphs (regions combined)

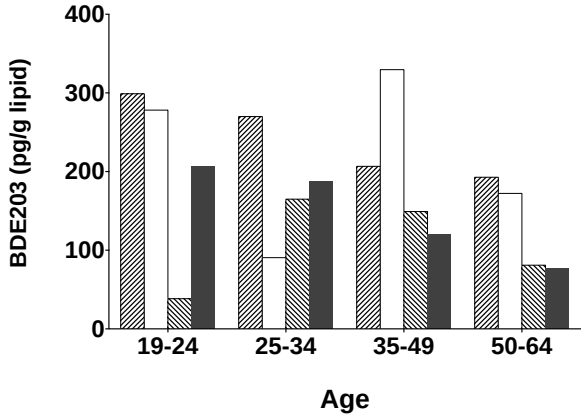




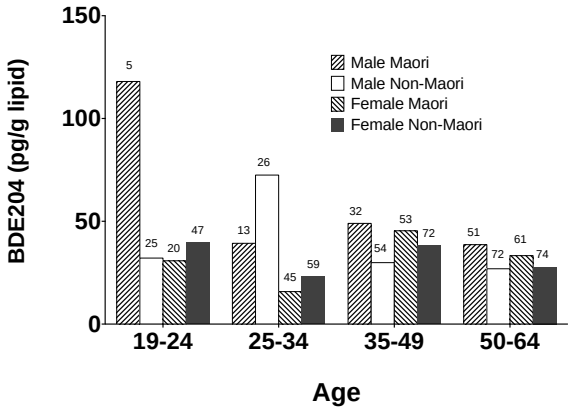


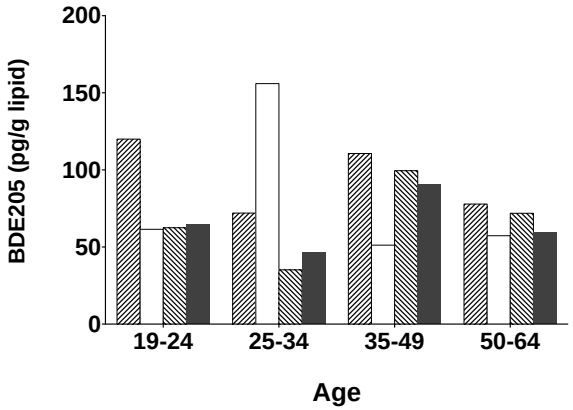


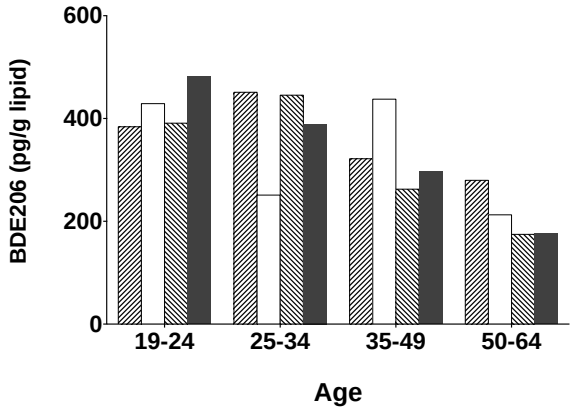


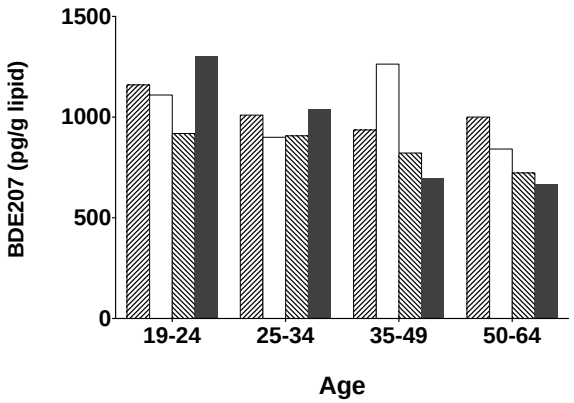


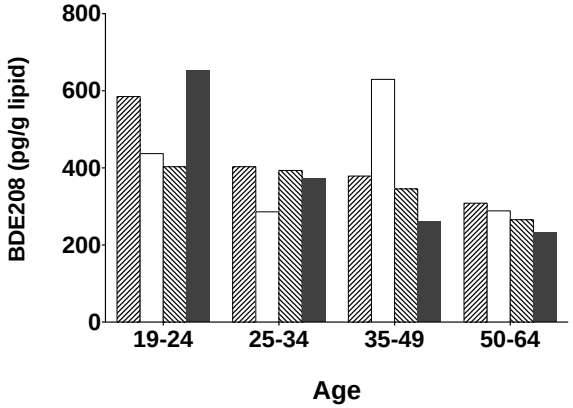
Appendix C5 - Result graphs (regions combined)

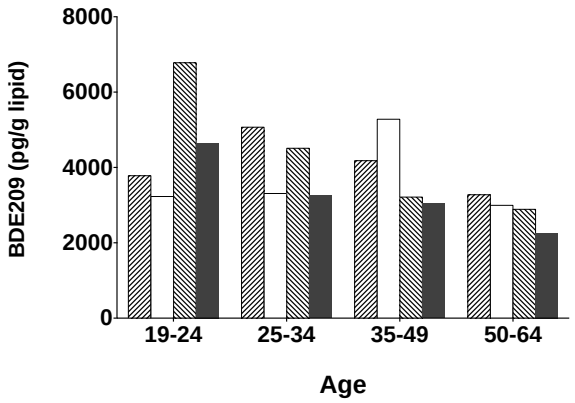




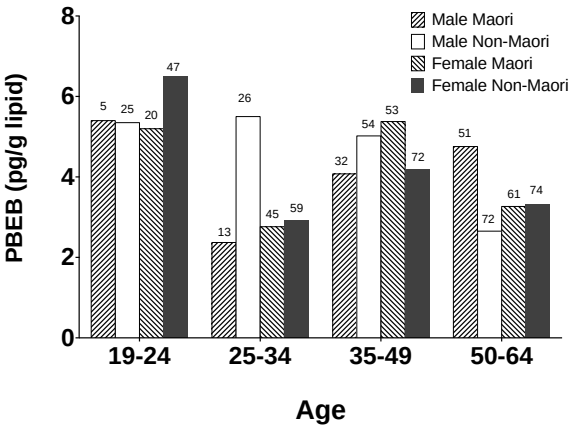


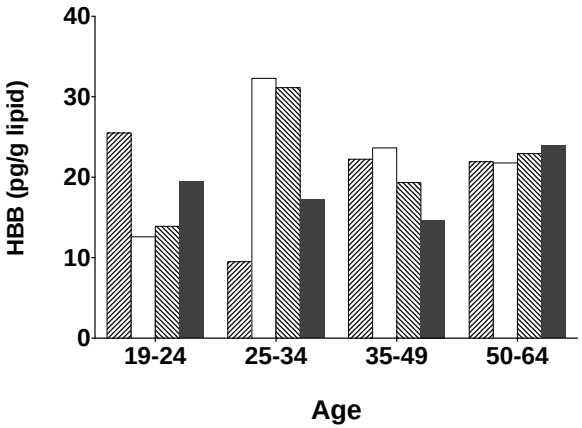


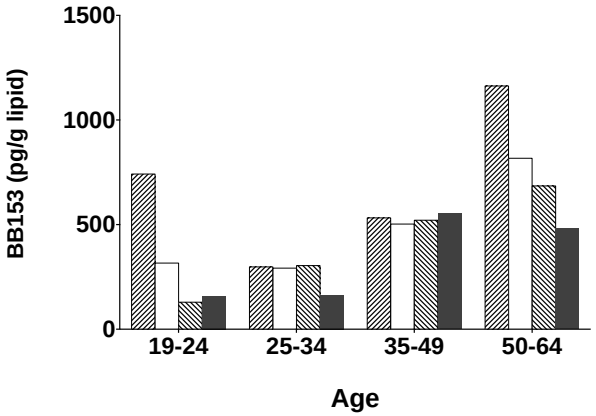




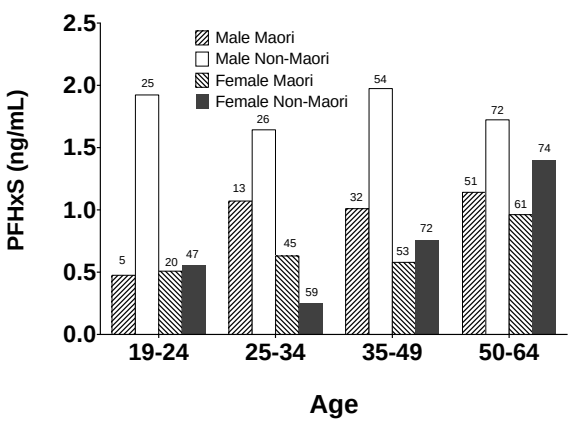
Appendix C5 - Result graphs (regions combined)

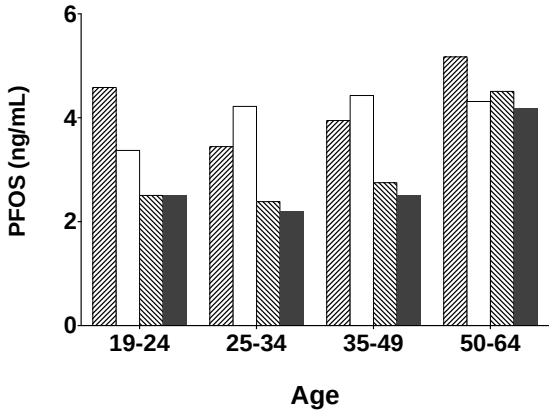


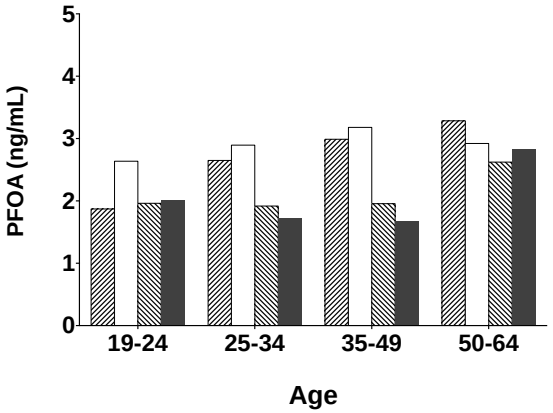


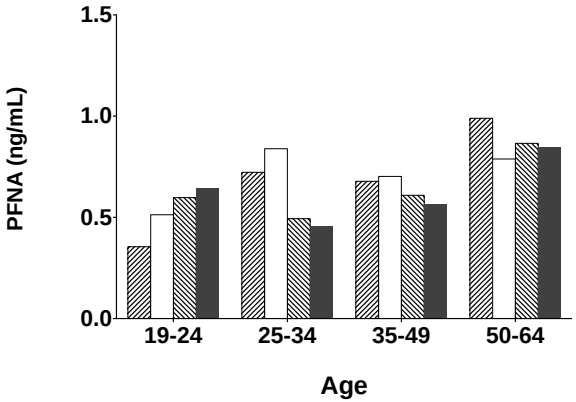


Appendix C5 - Result graphs (regions combined)



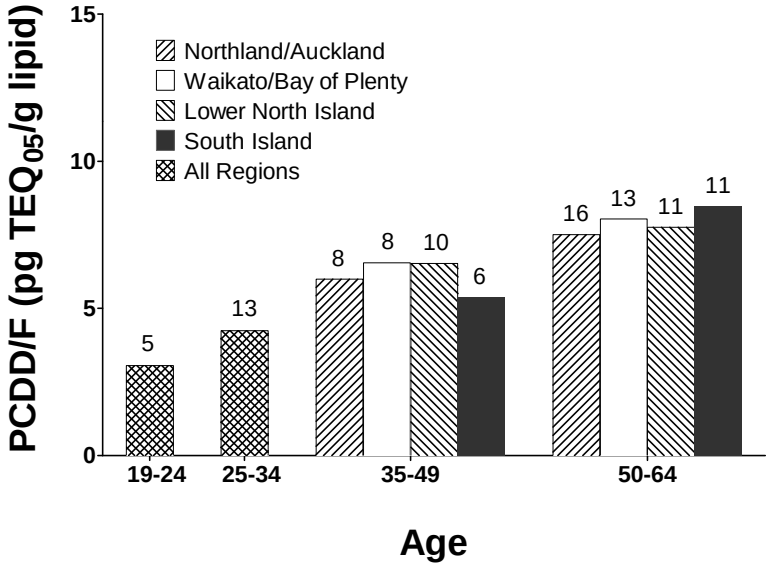




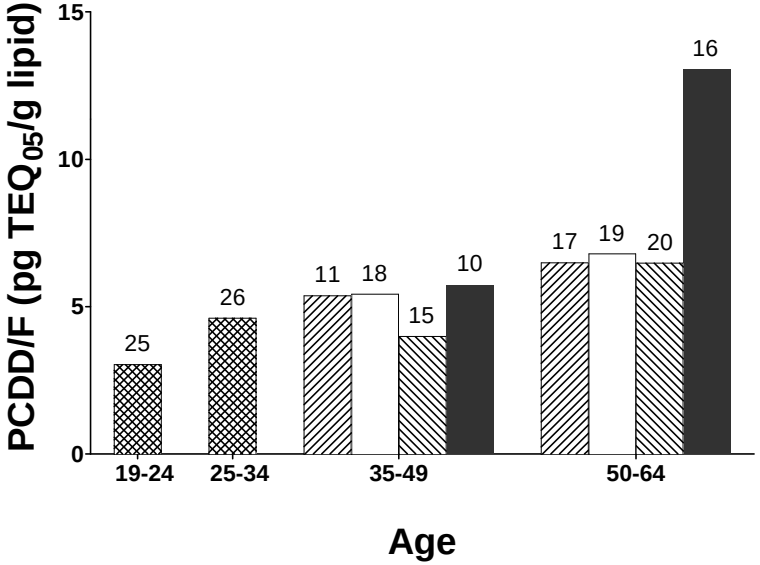


Appendix C6 - Region-specific results graphs (PCDD/F)

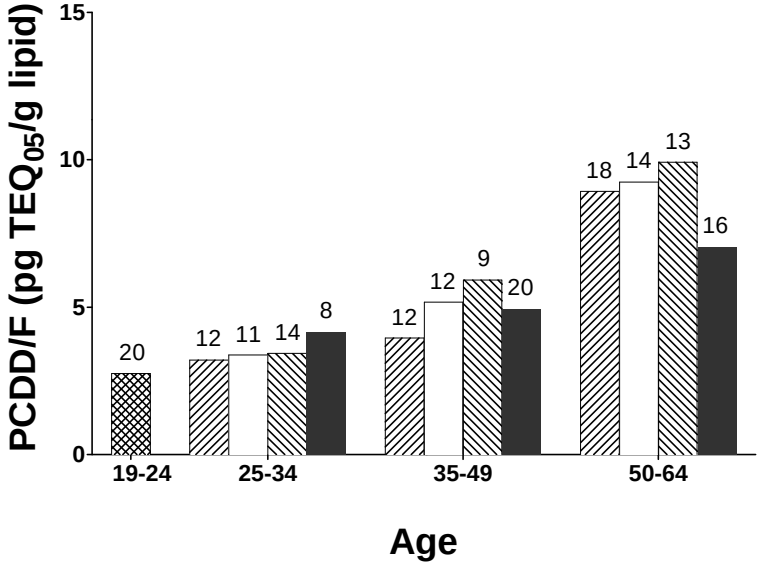
Maori Male



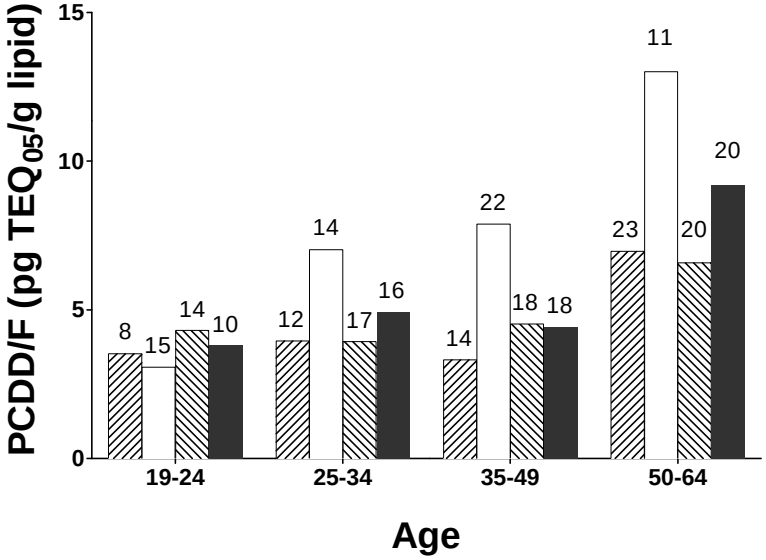
Non-Maori Male



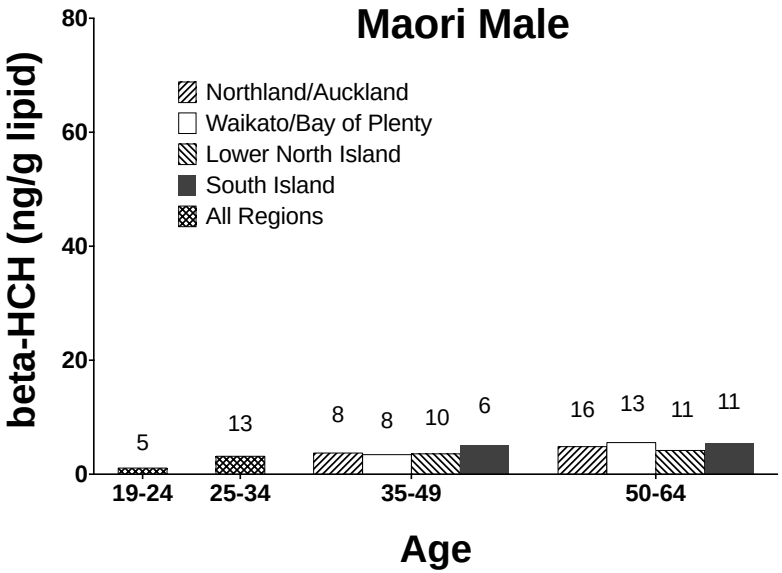
Maori Female

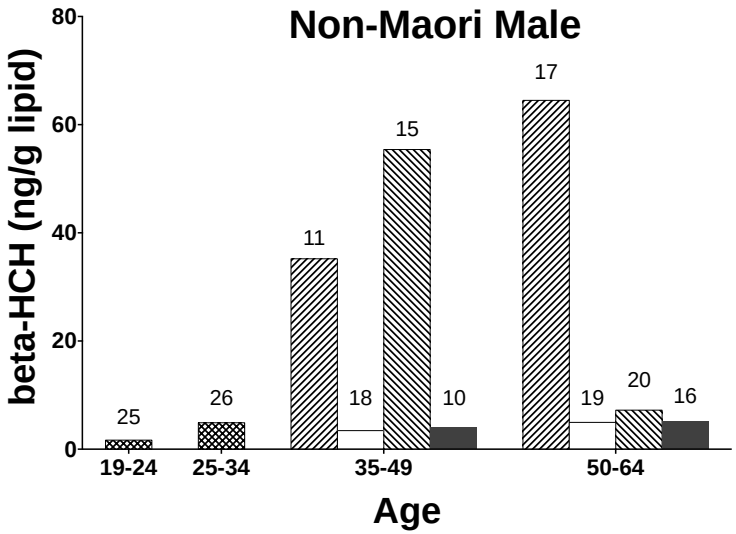


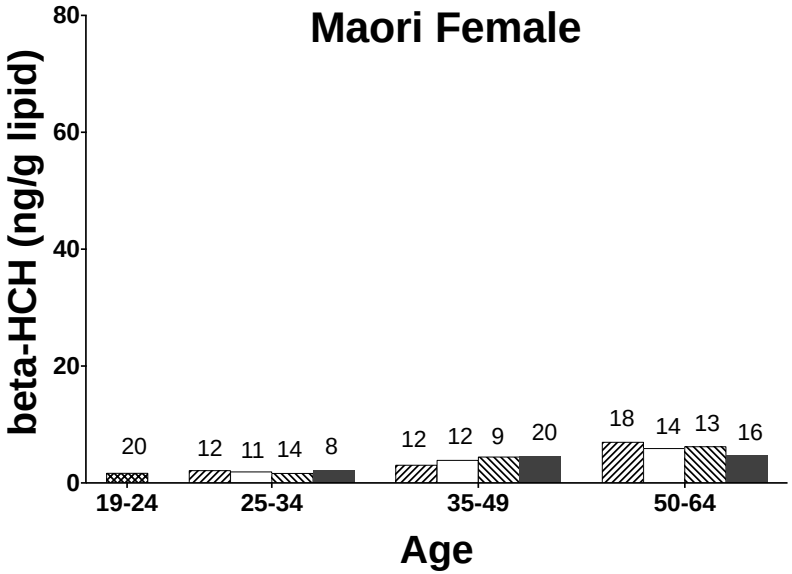
Non-Maori Female

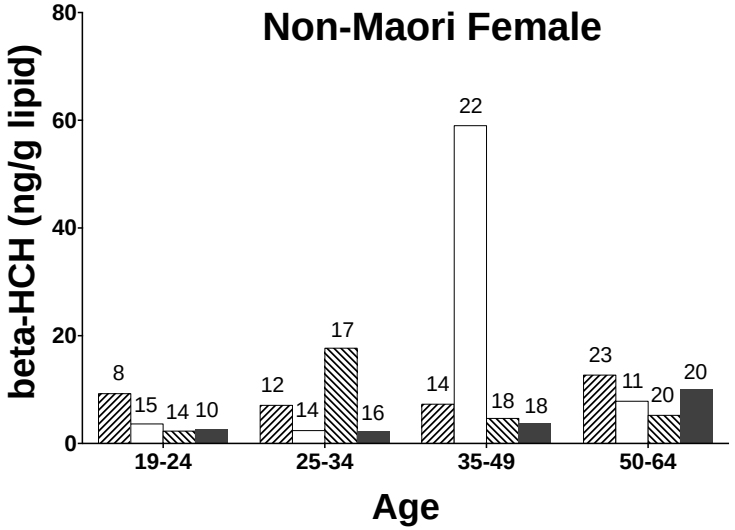


Appendix C6 - Region-specific results graphs (*beta*-HCH)

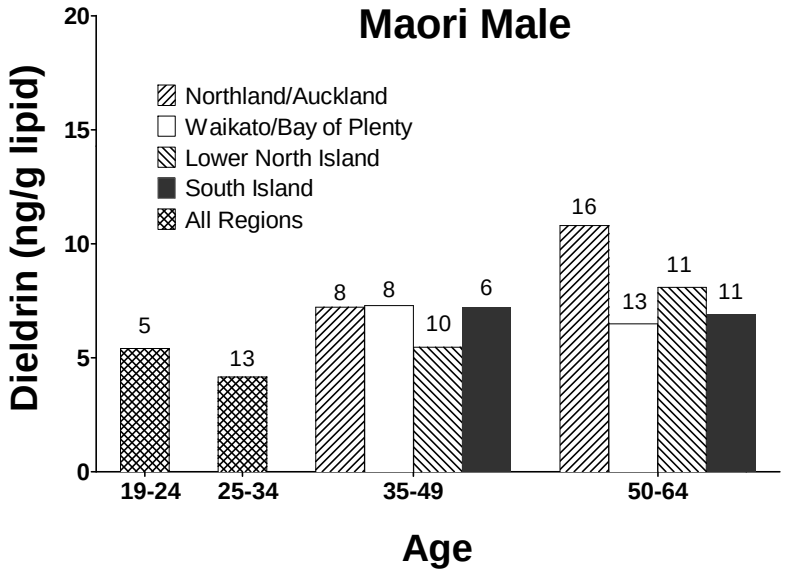


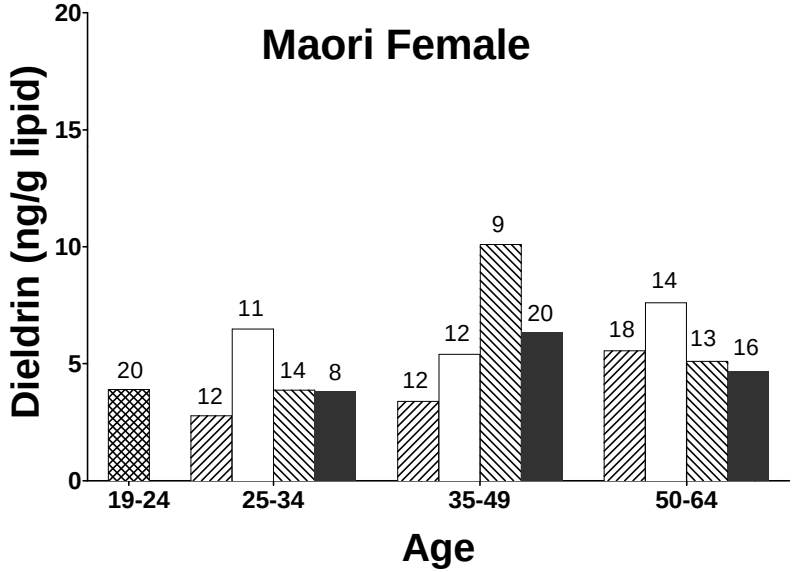


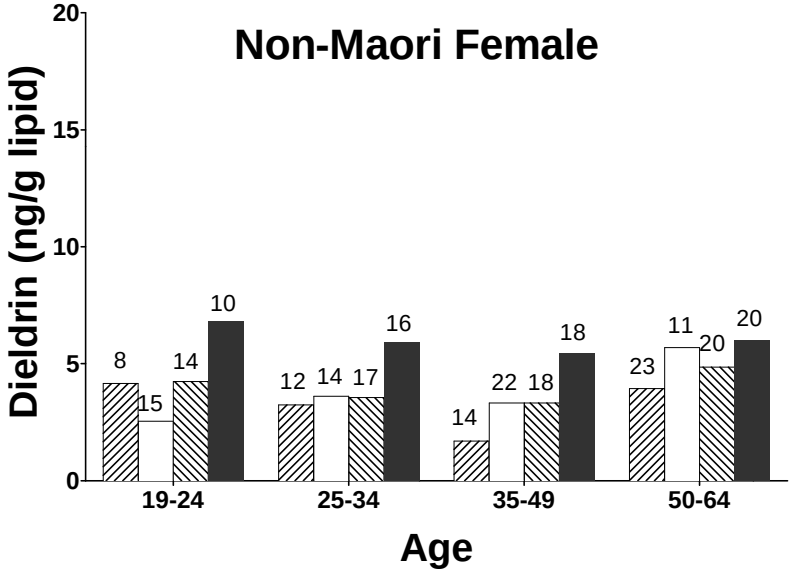




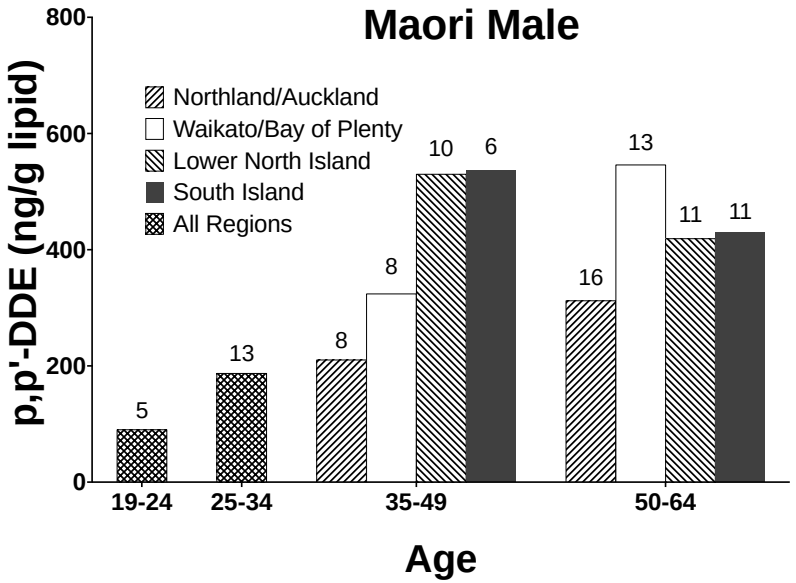
Appendix C6 - Region-specific results graphs (dieldrin)

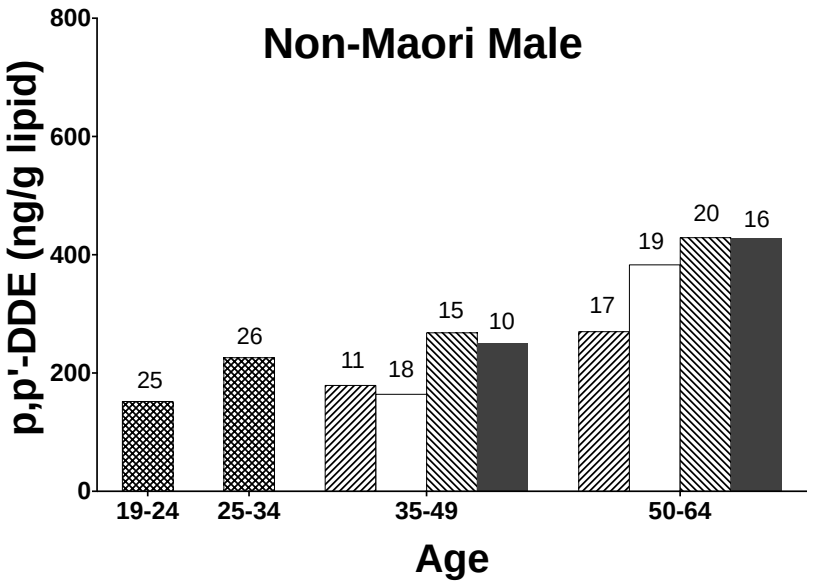


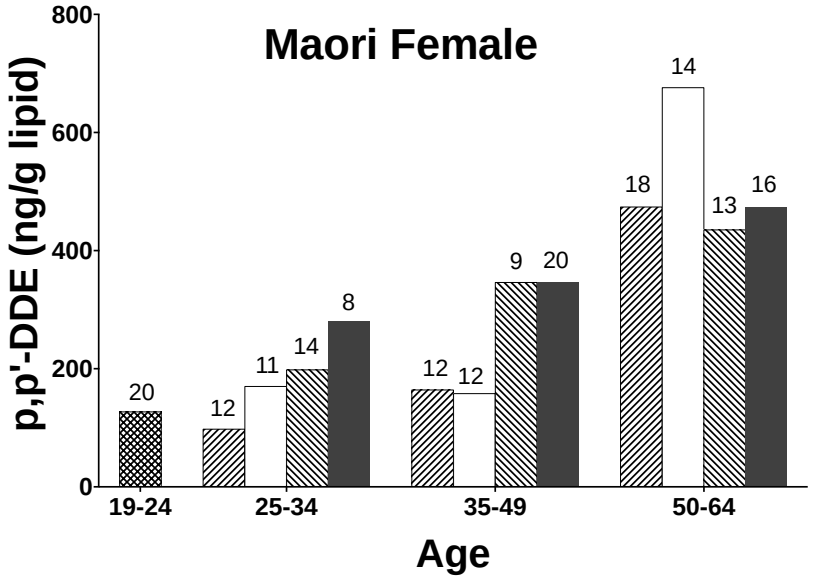


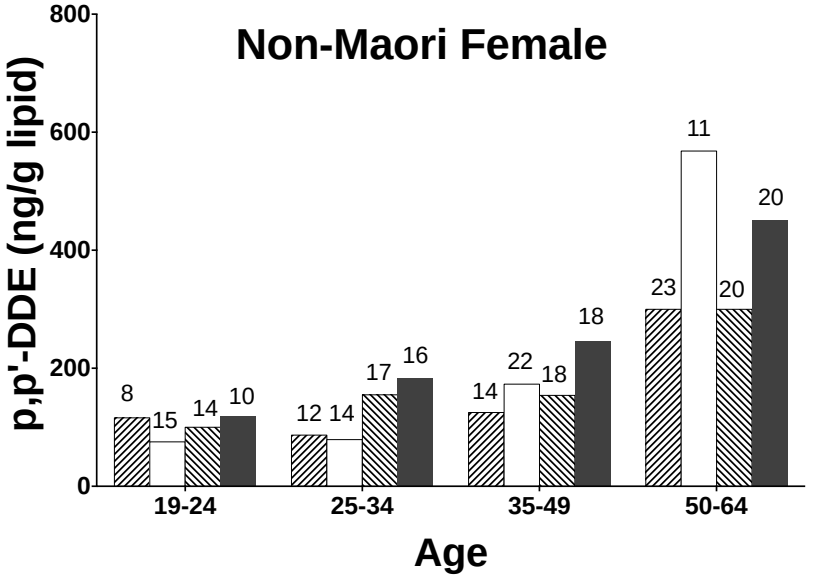


Appendix C6 - Region-specific results graphs (*p,p'*-DDE)

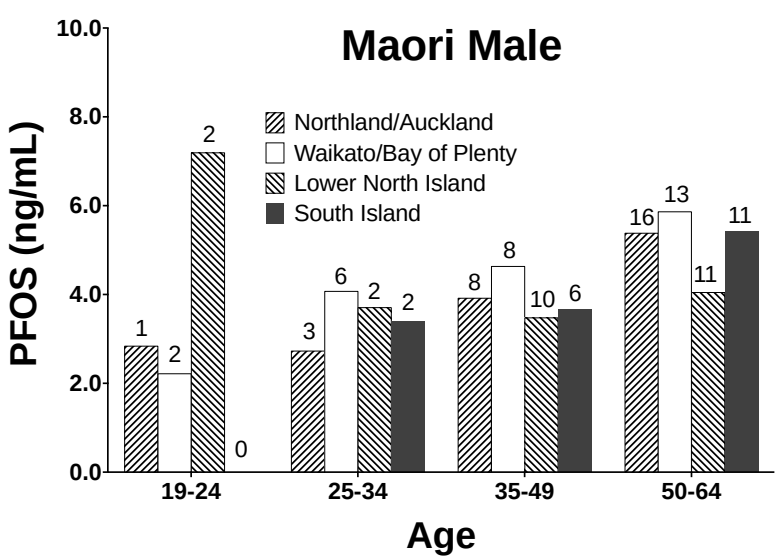


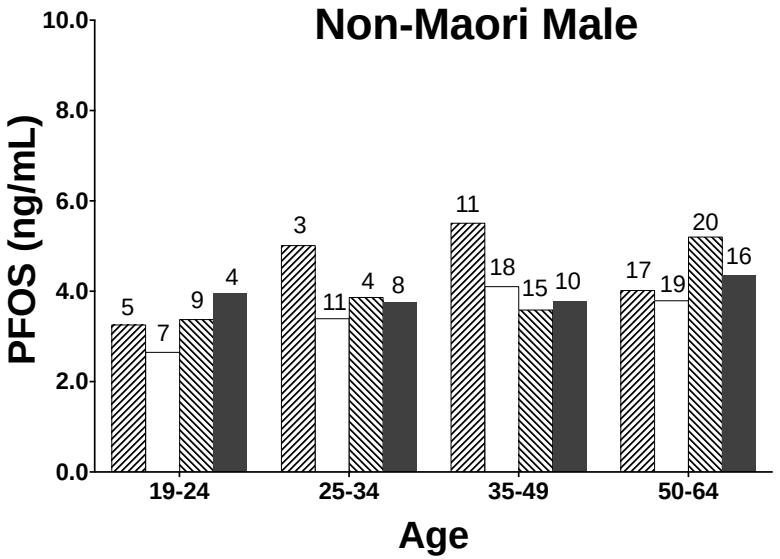


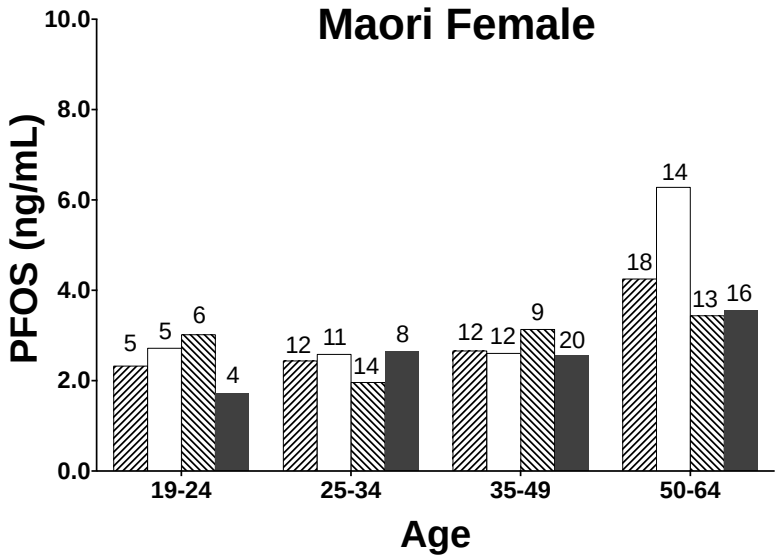


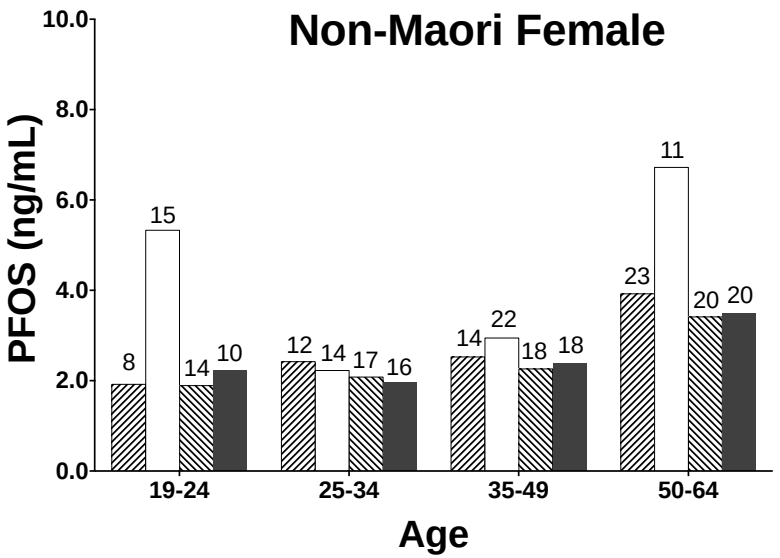


Appendix C6 - Region-specific results graphs (PFOS)

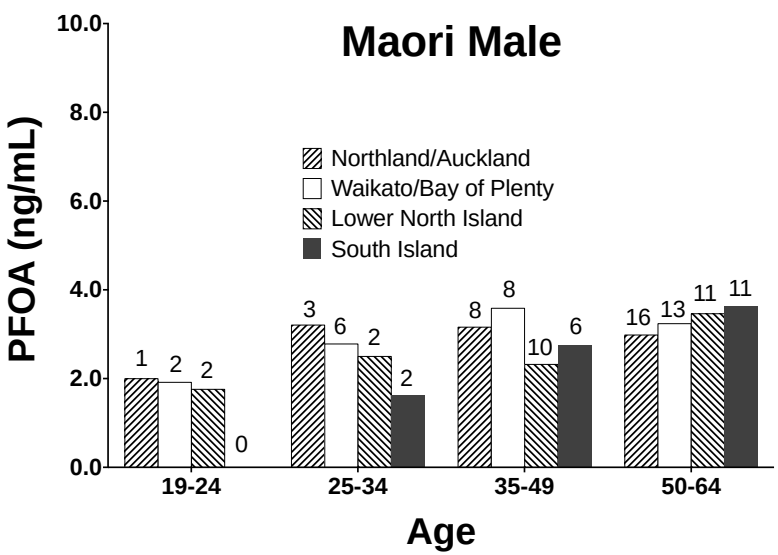


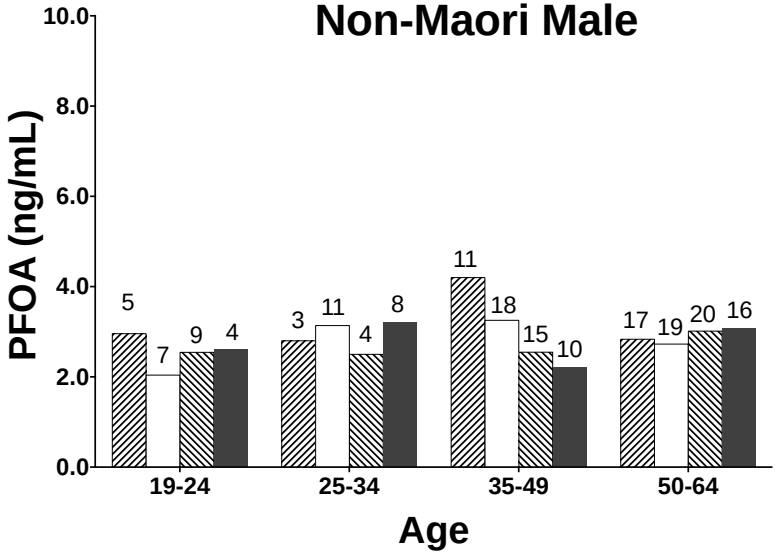


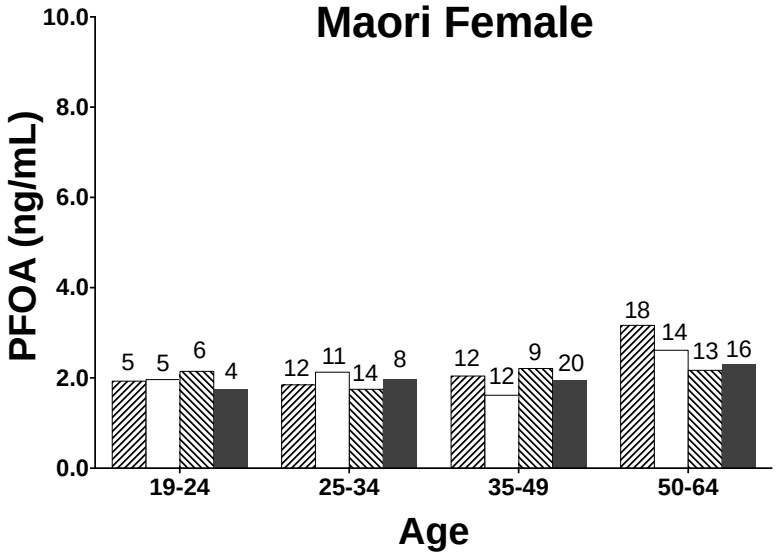


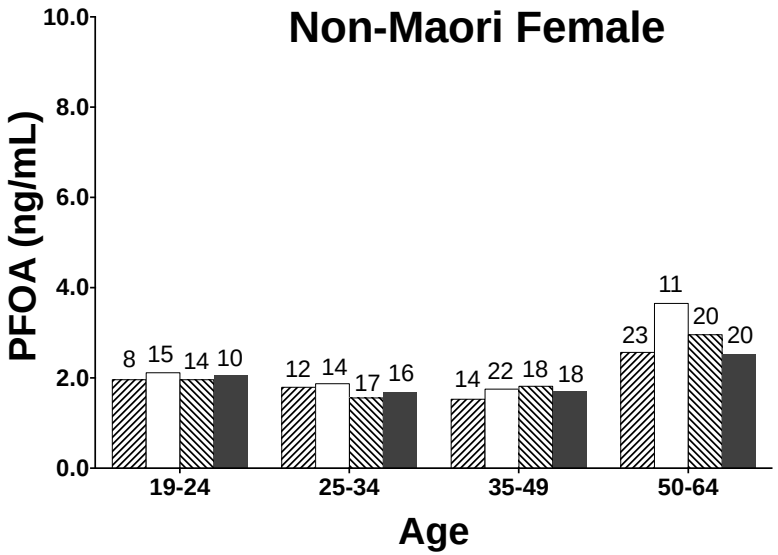


Appendix C6 - Region-specific results graphs (PFOA)









Appendix C6 - Region-specific results graphs (PFNA)