Concentrations of selected organochlorines in the serum of the non-occupationally exposed New Zealand population

Organochlorines Programme

Ministry for the Environment

May 2001

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Executive summary

This study has measured the concentrations of polychlorinated dibenzo-p-dioxins (PCDDs) polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs) and organochlorine pesticides in serum from a cross-sectional survey of the adult New Zealand population. As well as determining baseline levels of these contaminants, the study set out to determine the relationships of concentrations to age, geographic region, ethnicity and sex.

Samples were obtained from people aged 15 years and older, Maori and non-Maori, males and females. People who reported occupational exposure to the chemicals were excluded from the study. Collection of serum was carried out from December 1996 through to November 1997 in conjunction with the National Nutrition Survey of the Ministry of Health. In total 2,925 people participated in this serum study, each providing a single vacutainer of blood from which the serum was separated. Because, from any one person, an insufficient volume of serum was collected for analysis of the full suite of organochlorine contaminants being studied, individual samples were pooled on the basis of age (15–24, 25–34, 35–49, 50–64 and 65+ years), geographic region (Northland/Auckland, Waikato/Bay of Plenty, Lower North Island, South Island), ethnicity (Maori and non-Maori) and sex (male and female). Pooled serum samples were prepared for 60 strata, using 1,834 of the individual samples collected.

For the PCDDs and PCDFs, almost all congeners were detected in almost every stratum, with concentrations increasing across the age groups. Mean PCDD and PCDF toxic equivalents (TEQ) increased from 6.69 ng TEQ kg^{-1} lipid for the 15–24 age group to 20.7 ng TEQ kg^{-1} lipid for the 65+ age group. The mean concentration for the New Zealand population aged 15 years and older was 12.8 ng TEQ kg^{-1} lipid. TEQ data used the 1997 World Health Organization toxic equivalent factors.

In contrast to the PCDDs and PCDFs, a large number of PCB congeners were reported as being below the limits of detection (LOD), and, as a consequence, there are marked differences in the results for sums of congeners and for PCB TEQs, depending on whether concentrations below the LOD are assumed to be present at either half the LOD, or assuming that LOD values are equivalent to a concentration of zero (i.e. LOD = 0). Because of this, PCB concentrations calculated assuming LOD = 0 are the most informative. On this basis, PCB concentrations were found to range from 1.50 ng TEQ kg^{-1} lipid for the 15–24 age group to 6.50 ng TEQ kg^{-1} lipid for the 65+ age group. The mean PCB concentration across the entire study population was 3.33 ng TEQ kg^{-1} lipid. PCB TEQs were estimated to contribute approximately 15–30% to the total sum of PCDD/PCDF TEQ plus PCB TEQ when LODs were set to zero.

When PCB levels were reported as the sum of the 42 congeners analysed, concentrations increased from 20.8 µg kg^{-1} lipid for the 15–24 age group to 139 µg kg^{-1} lipid for the 65+ age group (assuming LOD = 0). The mean PCB concentration for the New Zealand population aged 15 years and older was 79.0 µg kg^{-1} lipid.

The most frequently detected pesticides in the study population were:

- pp'-DDE, which was detected in all strata: mean concentrations, by age, increased from 646 µg kg^{-1} lipid (15–24 age group) to 1780 µg kg^{-1} lipid (65+ age group); the mean concentration across all age groups was 1080 µg kg^{-1} lipid
- dieldrin, which was detected in 57 out of 60 strata: mean concentrations, by age, increased from 10.8 µg kg^{-1} lipid (15–24 age group) to 22.4 µg kg^{-1} lipid (65+ age group); the mean concentration across all age groups was 14.2 µg kg^{-1} lipid
- β-HCH, which was detected in 40 out of 60 strata: concentrations were in the range < 7–73.1 µg kg^{-1} lipid, with a mean concentration across all age groups of 19.7 µg kg^{-1} lipid; a general trend of increasing concentration with age was also found for this pesticide.

Of the remaining pesticides analysed, pp'-DDT was detected in 18 strata at a maximum concentration of 49.2 µg kg^{-1} lipid, γ-HCH was detected in one stratum at a concentration of 91.1 µg kg^{-1} lipid, HCB was detected in four strata at a maximum concentration of 53.6 µg kg^{-1} lipid and *trans*-nonachlor was detected in three strata at a maximum concentration of 8.4 µg kg^{-1} lipid.

Some regional differences in organochlorine concentrations were observed. PCDD, PCDF and PCB concentrations appeared to be marginally higher in the two upper North Island regions (Northland/Auckland and Waikato/Bay of Plenty) relative to the two more southern regions (Lower North Island and South Island). These differences may reflect the higher population density and level of industrialisation in the north of the country. Concentrations of pp'-DDE, on the other hand, increased markedly in a north–south direction. This may reflect historical use patterns of the pesticide pp'-DDT, and the atmospheric transportation of pp'-DDE from warmer to colder climates by a continual volatilisation/condensation process.

When assessed by ethnicity and sex, the data do not show any *consistent* differences in exposure to the organochlorines investigated between Maori and non-Maori, or between males and females across all age groups. However, some variation in organochlorine concentrations between males and females for the oldest age group was observed, although no reason for this is obvious. In addition, PCB concentrations when expressed as the sum of congeners tended to be marginally higher in males than in females for all age groups.

The report provides an assessment of the organochlorine concentrations measured in this study with concentrations reported in the published literature for comparable non-occupationally exposed populations from other countries. This comparison shows that concentrations of PCDDs, PCDFs and PCBs in the serum of New Zealanders tended to be at the lower end of the range of concentrations measured in people in other developed countries, as did concentrations of the pesticide β-HCH. In contrast, serum concentrations of pp'-DDE tended to be similar to levels measured in overseas populations.

When reported on a lipid weight basis, the concentrations of organochlorines measured in the serum of New Zealand women were in good agreement with data from a recently published study of organochlorines in the breast milk of New Zealand women. This result demonstrates the applicability of serum as the most relevant human matrix to assess population exposures for males and females across a range of ages.

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1 Introduction

In 1995, the Ministry for the Environment commenced a national Organochlorines Programme to characterise the extent of contamination of the New Zealand environment by selected organochlorine contaminants, and to establish risk-based environmental acceptance criteria for these substances. The contaminants that are the focus of the Organochlorines Programme are the:

- polychlorinated dibenzo-p-dioxins (PCDDs) and the polychlorinated dibenzofurans (PCDFs). These are often referred to generically as 'dioxins', but throughout this report, the PCDD and PCDF nomenclature is used (sometimes abbreviated as PCDD/F in tabulated data)
- polychlorinated biphenyls (PCBs)
- organochlorine pesticides and their degradation products, including DDT, DDE, dieldrin, lindane (γ-HCH) and β-HCH
- chlorophenols, in particular pentachlorophenol (PCP).

The development of risk-based acceptance criteria for organochlorines requires information on the background concentrations of these contaminants in the environment, in humans, and on exposure pathways. To support the development of acceptance criteria, the Organochlorines Programme has undertaken a series of detailed scientific investigations on population and environmental exposures to organochlorines, including surveys to determine the concentrations of organochlorine residues in food produce, human serum, and environmental media.

This report presents the findings of the study to determine the background concentrations of PCDDs, PCDFs, PCBs and organochlorine pesticides (including their degradation products) in the serum of New Zealanders. Separate reports have been published on organochlorine concentrations, including PCDDs, PCDFs, PCBs and organochlorine pesticides in the environment (Buckland *et al*., 1998a,b; 1999; Scobie *et al*., 1998), and on PCDD, PCDF and PCB concentrations in New Zealand retail foods (Buckland *et al*., 1998c).

The objectives of the serum study described in this report were to:

1. obtain estimates of baseline concentrations of PCDDs, PCDFs, PCBs and organochlorine pesticides in serum sampled from the non-occupationally exposed New Zealand population
2. determine the relationships of organochlorine contaminant concentrations to age, ethnicity, sex and geographic region
3. obtain data that can be used, under the Resource Management Act, to develop national environmental standards for the protection of human health and the environment from organochlorine contaminants.

The serum study was undertaken to determine the background concentrations of the target organochlorine substances in New Zealanders. This study was not intended to identify or characterise highly exposed or at-risk populations (such as occupational groups), or to assess exposures related to known PCDD and PCDF emission point sources. The exposure data from this study have been used in a health risk appraisal of the New Zealand population to PCDDs, PCDFs and dioxin-like PCBs, which has been published as a separate report (Smith and Lopipero, 2001).

The Organochlorines Programme

The Organochlorines Programme was initiated in response to a recognition of the need to minimise industrial emissions of PCDDs and PCDFs to air and water, clean-up sites contaminated with organochlorine residues and manage the safe disposal of waste stocks of organochlorine chemicals such as the PCBs and persistent pesticides. The Organochlorines Programme is consistent with current international concerns on persistent organic pollutants (UNEP, 1997).

The Organochlorines Programme as a whole comprises the study of environmental and human levels of organochlorine substances; the development of an inventory of ongoing PCDD and PCDF emissions; and the estimation of the risk posed by these substances. The integration of these and other components of the Organochlorines Programme is shown in Figure 1.1. The outcomes from the overall programme will be:

- National environmental standards for PCDDs and PCDFs and where necessary environmental guidelines or standards for PCBs, organochlorine pesticides and chlorophenols;
- Identified clean-up technologies that can safely and effectively destroy organochlorine wastes;
- An integrated management strategy for PCDDs, PCDFs and other organochlorine contaminants and wastes in New Zealand;
- Identification of issues for the phase-out of organochlorines;
- Informed public input to Government decisions on the management of organochlorines in the New Zealand environment.

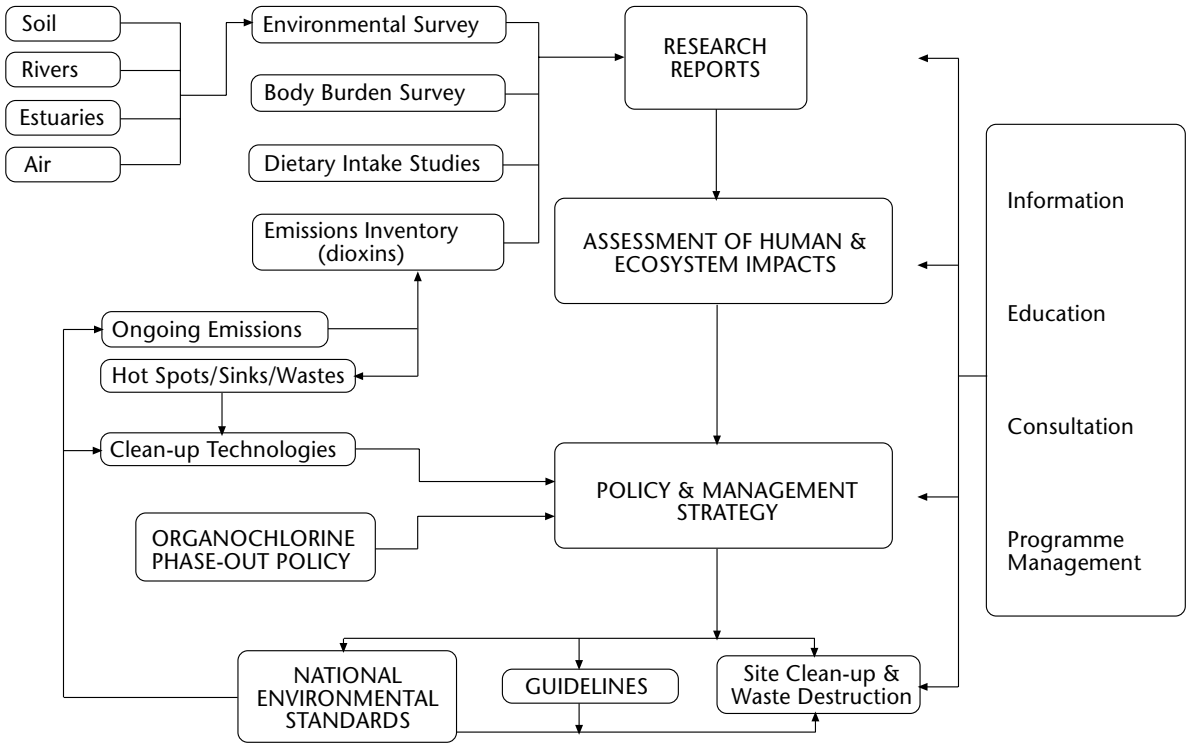

Figure 1.1 Overview of the New Zealand Organochlorines Programme

2 Background information on PCDDs, PCDFs and PCBs

2.1 Chemical structure and toxicity

2.1.1 PCDDs and PCDFs

The PCDDs and PCDFs are chemically classified as halogenated hydrocarbons. They are tricyclic aromatic compounds, comprising two benzene rings joined via either one or two oxygen atoms at adjacent carbons on each of the benzene rings, as shown in Figure 2.1.

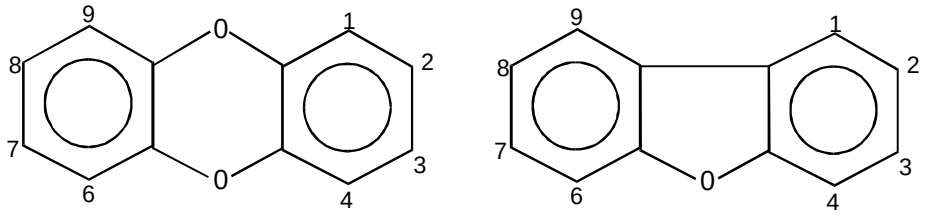

Figure 2.1 Structures of dibenzo-p-dioxin and dibenzofuran

Both groups of chemicals may have up to eight chlorine atoms attached at carbon atoms 1 to 4 and 6 to 9. Each individual compound resulting from this is referred to as a congener. Each specific congener is distinguished by the number and position of chlorine atoms around the aromatic nuclei. In total, there are 75 possible PCDD congeners and 135 possible PCDF congeners. Groups of congeners with the same number of chlorine atoms are known as homologues. The number of congeners in each homologue group is shown in Table 2.1. The most widely studied of the PCDDs and PCDFs is 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). This congener is often generically referred to as 'dioxin', and is the reference compound for this class of chemicals.

Table 2.1 Homologues and congeners of PCDDs and PCDFs

Abbreviation	Homologue name	No. of possible congeners	No. of possible 2,3,7,8-chlorinated congeners
MCDD	Monochlorodibenzo-p-dioxin	2	0
DiCDD	Dichlorodibenzo-p-dioxin	10	0
TrCDD	Trichlorodibenzo-p-dioxin	14	0
TCDD	Tetrachlorodibenzo-p-dioxin	22	1
PeCDD	Pentachlorodibenzo-p-dioxin	14	1
HxCDD	Hexachlorodibenzo-p-dioxin	10	3
HpCDD	Heptachlorodibenzo-p-dioxin	2	1
OCDD	Octachlorodibenzo-p-dioxin	1	1
MCDF	Monochlorodibenzofuran	4	0
DiCDF	Dichlorodibenzofuran	16	0
TrCDF	Trichlorodibenzofuran	28	0
TCDF	Tetrachlorodibenzofuran	38	1
PeCDF	Pentachlorodibenzofuran	28	2
HxCDF	Hexachlorodibenzofuran	16	4
HpCDF	Heptachlorodibenzofuran	4	2
OCDF	Octachlorodibenzofuran	1	1

Congeners containing one, two or three chlorine atoms are thought to be of no toxicological significance. However, 17 congeners with chlorine atoms substituted in the 2, 3, 7 and 8- positions are thought to pose a risk to human and environmental health. Toxic responses include dermal toxicity, immunotoxicity, carcinogenicity and adverse effects on reproduction, development and endocrine functions. Increasing substitution from four to eight chlorine atoms generally results in a marked decrease in potency.

2.1.2 Polychlorinated biphenyls

PCBs were commercial products prepared industrially by the chlorination of biphenyl. The commercial preparations were graded and marketed according to their chlorine content. For example, Aroclor 1232 contains 32% by weight of chlorine and Aroclor 1260 contains 60% by weight of chlorine.

The PCBs are structurally and chemically similar to the PCDDs and PCDFs, and comprise up to 209 congeners, from the monochloro congener through to the fully chlorinated decachloro congener. The basic aromatic biphenyl nucleus is shown in Figure 2.2, and the distribution of PCB congeners arising from attachment of chlorine atoms to this nucleus is given in Table 2.2.

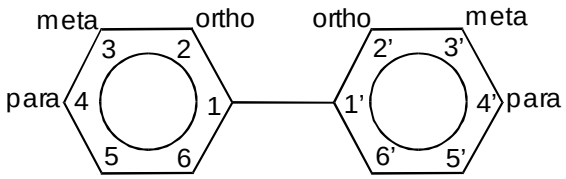

Figure 2.2 Structure of biphenyl

Table 2.2 Distribution of PCB congeners

No. of Cl substituents	Cl_1	Cl_2	Cl_3	Cl_4	Cl_5	Cl_6	Cl_7	Cl_8	Cl_9	Cl_{10}
No. of congeners	3	12	24	42	46	42	24	12	3	1

Like the PCDDs and PCDFs, the biological and toxic effects of the PCBs are highly dependent both on the degree of chlorination and on the position of the chlorine atoms around the aromatic nuclei (i.e. whether they are *ortho*-, *meta*- or *para*- to the phenyl-phenyl bridge at carbon-1). Certain PCBs (the so called non-*ortho* and mono-*ortho* congeners) are conformationally similar to the PCDDs and PCDFs, and appear to elicit dioxin-specific biochemical and toxic responses through a similar mechanistic action. In this regard, they are often referred to as 'dioxin-like' PCBs.

2.2 Toxic equivalency factors and toxic equivalents

In environmental media, PCDDs, PCDFs and PCBs occur as complex mixtures of congeners, which therefore complicates any environmental or human health risk evaluation. However, because it is widely accepted that the toxicological action of PCDDs, PCDFs and dioxin-like PCBs is via a common mechanism of action (in the initial stages, at least), these compounds have been assigned individual toxic equivalency factors (TEF) values, as agreed by international convention (see, for example, Kutz *et al*., 1990; Van den Berg *et al.*, 1998). This mechanism of action is believed to involve the binding of a congener to a cellular protein known as the 'Ah receptor'. The importance

of the TEF approach is that it allows the combined toxicity of a complex mixture of congeners to be represented in terms of a single numerical value, or 'toxic equivalents' (TEQ). The TEQ contribution of each congener is calculated by multiplying its concentration by the TEF for that congener. This approach facilitates risk assessment and regulatory control of exposure to these mixtures.

The TEQ method is based on toxicological and *in vitro* biological data, and knowledge of structural similarities among this group of chemicals. In essence, TEFs are estimates of the relative toxicities of individual PCDD, PCDF and dioxin-like PCB congeners compared to the toxicity of 2,3,7,8-TCDD, which, as the reference compound for this group of chemicals, is assigned a TEF of one. All 2,3,7,8-PCDDs and PCDFs, along with the dioxin-like PCBs, have been assigned TEF values, which are generally less than one, reflecting their lower toxic potency. Periodically, these TEFs are revised based on new toxicological data. The latest internationally accepted TEFs for the PCDDs, PCDFs and dioxin-like PCBs, as agreed at a 1997 World Health Organization (WHO) consultation (Van den Berg *et al*., 1998), are shown in Table 2.3. Earlier TEF schemes for the PCDDs and PCDFs (Ahlborg, 1989; Kutz *et al*., 1990) and the PCBs (Ahlborg *et al*., 1994) have been widely used to assess the combined toxicity of these compounds.[1]

Table 2.3 Toxic equivalency factors for PCDDs, PCDFs and dioxin-like PCBs for humans and mammals

PCDD/PCDF congener	TEF value	PCB congener[2]	TEF value
2,3,7,8-TCDD	1	Non-*ortho* PCBs	
1,2,3,7,8-PeCDD	1	PCB #81	0.0001
1,2,3,4,7,8-HxCDD	0.1	PCB #77	0.0001
1,2,3,6,7,8-HxCDD	0.1	PCB #126	0.1
1,2,3,7,8,9-HxCDD	0.1	PCB #169	0.01
1,2,3,4,6,7,8-HpCDD	0.01		
OCDD	0.0001	Mono-*ortho* PCBs	
		PCB #105	0.0001
2,3,7,8-TCDF	0.1	PCB #114	0.0005
1,2,3,7,8-PeCDF	0.05	PCB #118	0.0001
2,3,4,7,8-PeCDF	0.5	PCB #123	0.0001
1,2,3,4,7,8-HxCDF	0.1	PCB #156	0.0005
1,2,3,6,7,8-HxCDF	0.1	PCB #157	0.0005
2,3,4,6,7,8-HxCDF	0.1	PCB #167	0.00001
1,2,3,7,8,9-HxCDF	0.1	PCB #189	0.0001
1,2,3,4,6,7,8-HpCDF	0.01		
1,2,3,4,7,8,9-HpCDF	0.01		
OCDF	0.0001		

Source: Van den Berg *et al*., 1998.

[1] PCDD, PCDF and PCB data presented in this report have been calculated using the 1997 WHO TEFs (Van den Berg *et al*., 1998). However, concentrations of individual PCDD, PCDF and PCB congeners are reported in Appendices D and E, allowing the reader to calculate TEQ concentrations using alternative TEF schemes.

[2] PCB numbering by Ballschmiter and Zell (1980).

The use of TEFs assumes that the toxicity of the various congeners acts in an additive fashion. The toxic potency of a mixture of PCDDs, PCDFs and dioxin-like PCBs (i.e. the TEQ) is the sum of the products of the concentration of each congener present in the mixture and that congener's TEF, as given by the following equation:

$$TEQ = \sum([PCDD_x] \times TEF_x) + \sum([PCDF_y] \times TEF_y) + \sum([PCB_z] \times TEF_z)$$

Thus, TEQs represent 2,3,7,8-TCDD toxic equivalents for mixtures of PCDDs, PCDFs and dioxin-like PCBs.

PCBs also exhibit 'non-dioxin-like' toxicity in which the toxic effects are not mediated through the Ah-receptor (Safe and Hutzinger, 1987; Safe, 1994). These effects include cancer promotion, endocrine disruption and neurobehavioural toxicity. Importantly, the TEF concept developed for the PCDDs and PCDFs and the dioxin-like PCBs cannot be applied to 'non-dioxin-like' effects that are not Ah-receptor mediated.

2.3 Sources

2.3.1 PCDDs and PCDFs

PCDDs and PCDFs are unintentional products of chemical reactions or incomplete combustion in thermal processes involving organic matter and chlorine. Internationally, the manufacture and use of chlorinated aromatic chemicals have been major sources of PCDDs and PCDFs in the environment. Most notable examples include the wood preservative and biocide PCP, the herbicide 2,4,5-trichlorophenoxy acetic acid (2,4,5-T) and the PCBs. Of these, only 2,4,5-T was manufactured in New Zealand. Other processes, such as the manufacture of chlorine-bleached pulp, have also led to environmental contamination by PCDDs and PCDFs.

Combustion processes are recognised as another important source of PCDDs and PCDFs. Most thermal reactions that involve the burning of organic material in the presence of a chlorine source result in the formation of these substances. PCDDs and PCDFs have been detected in emissions from the incineration of various types of wastes, particularly municipal, medical and hazardous wastes; from fossil fuel plants, domestic coal and wood fires; and from automobile engines (especially when using leaded fuels), and accidental fires. Metallurgical production, including the production of iron and steel as well as non-ferrous metals, and metal processing and refining, especially the secondary processing of scrap metals, can also lead to the formation and release of PCDDs and PCDFs. An extensive review of PCDD and PCDF sources has been published by Fiedler *et al.* (1990), and more recently by the United States Environmental Protection Agency (US EPA, 1998). A compilation of source inventories for a number of industrialised countries, primarily in the northern hemisphere, has also been published (UNEP, 1999).

Although natural combustion sources (like forest fires) have probably always been a source of PCDDs and PCDFs, the background levels associated with the pre-industrial processes (before the 1930s/1940s) have been found to be negligible when compared to those resulting from more recent industrial activities (Kjeller *et al.,* 1991; Beurskens *et al.,* 1993; Jones and Alcock, 1996).

Tighter government regulations, improved industrial processes and the use of modern pollution control equipment have resulted in a lowering of PCDD and PCDF emissions from known

industrial sources in many countries. However, it is unlikely that a complete elimination of these contaminants will be possible because of uncontrolled releases, such as forest fires and other accidental fires.

2.3.2 Polychlorinated biphenyls

The PCBs were industrial chemicals prepared by a number of major chemical companies, which were used worldwide. Commercial PCB products found wide use in industry as heat transfer fluids, hydraulic fluids, solvent extenders, flame retardants and dielectric fluids (Waid, 1986). The unusual industrial versatility of PCBs is directly related to their chemical and physical properties, which include resistance to acids and bases, compatibility with organic materials, resistance to oxidation and reduction, excellent electrical insulating properties, thermal stability, and non-flammability.

The widespread use of PCBs, coupled with industrial accidents and improper disposal practices, has resulted in significant environmental contamination by these chemicals in many countries, particularly within the more industrialised northern hemisphere.

3 Organochlorines in New Zealand

3.1 PCDDs and PCDFs

A comprehensive inventory of PCDD and PCDF emissions to air, land and water, and an assessment of PCDD and PCDF reservoir sources has been published as one component of the Organochlorines Programme (Buckland *et al*., 2000). This inventory has estimated that, for the reference year of 1998, the total quantity of PCDDs and PCDFs released to the environment was in the range 41–109 g I-TEQ (Table 3.1).

Table 3.1 PCDD and PCDF emissions to air, land and water

Receiving environment	Annual release estimate,[1] g I-TEQ yr^{-1}
Air	14–51
Land	26–54
Water	0.56–3.9
Total emissions	41–109

1. Calculated as international-TEQ (I-TEQ) using the TEFs of Kutz *et al*. (1990).

The major industrial emission estimates to air were from landfill fires (estimated at 10–15 g I-TEQ yr^{-1}), the burning of wood and coal as fuels in industrial appliances (0.88–6.4 g I-TEQ yr^{-1}), the burning of clinical, pathological and quarantine waste (0.38–3.5 g I-TEQ yr^{-1}) and ferrous and non-ferrous metal production (0.23–3.3 g I-TEQ yr^{-1}). Comparatively lower amounts of PCDDs and PCDFs were emitted from cement and lime manufacture (0.10–0.81 g I-TEQ yr^{-1}), crematoria (0.0080–0.45 g I-TEQ yr^{-1}) and coal-fired power generation (0.059–0.11 g I-TEQ yr^{-1}). Emissions from a number of other industrial processes were also assessed in the New Zealand inventory, including hazardous waste incineration and wastewater solids incineration. They were found to be negligible sources of PCDDs and PCDFs.

Non-industrial emission estimates to air included domestic wood burning and coal burning for space-heating (0.71–8.7 g I-TEQ yr^{-1} and 0.36–0.59 g I-TEQ yr^{-1} respectively), the domestic burning of waste in backyard fires (0.54–6.4 g I-TEQ yr^{-1}), and the inadvertent and uncontrolled burning of buildings and vehicles (0.37–2.8 g I-TEQ yr^{-1}). The use of unleaded petrol and diesel for land transport was estimated to emit 0.11–1.2 g I-TEQ yr^{-1}.

Solid waste streams from the burning of coal, wood and waste were identified as significant contributors to the release of PCDDs and PCDFs to land, primarily to landfill. The deposition of industrial and domestic refuse at landfills was estimated to account for about 20 g I-TEQ of PCDDs and PCDFs released to land each year.

Since the late 1980s, advances in environmental and chemical management practices are believed to have resulted in a reduction in the release of PCDDs and PCDFs to the New Zealand environment. Reasons for this include the following:

- many smaller, poorly designed and/or operated, hospital waste incinerators have closed

- leaded petrol (which emits more PCDDs and PCDFs than unleaded petrol) has been phased out of use in New Zealand's land transport fleet
- the use of PCP in the timber industry ceased in 1988, and it was deregistered[3] in 1991
- 2,4,5-T manufacture ceased in 1987, and, once existing stocks were exhausted, its widespread use ceased
- upgrades at New Zealand's two bleached kraft pulp mills have seen both mills convert to elemental chlorine-free technology
- through regulations under the Toxic Substances Act (1979), the import of PCBs was prohibited from January 1987 and their use has been prohibited since January 1994.

Nevertheless, past industrial practices have created PCDD and PCDF reservoirs. Generally these are localised sites of contamination in which the levels of PCDDs and PCDFs are elevated compared to typical background levels in the wider general environment. Such reservoirs create the potential for the redistribution and circulation of the contaminants into the wider environment. The inventory has estimated that the quantity of PCDDs and PCDFs contained within reservoir sources in New Zealand is 1450–1700 g I-TEQ, primarily arising from historical 2,4,5-T use (620–860 g I-TEQ) and the past use of PCP (310 g I-TEQ), as well as from PCDDs and PCDFs associated with refuse deposited to landfills (500 g I-TEQ).

The major sources that continue to release PCDDs and PCDFs to the New Zealand environment, and sources that no longer occur in New Zealand, are summarised in Table 3.2.

Table 3.2 Current and historical sources of PCDDs and PCDFs in New Zealand

Current sources include:
⩓ uncontrolled landfill fires
⩓ waste incineration, primarily clinical, pathological and quarantine waste incineration, crematoria and the domestic burning of waste in backyard fires
⩓ metallurgical industries, especially the secondary processing of scrap metals
⩓ industrial and domestic coal and wood combustion
⩓ cement and lime manufacture
⩓ exhaust emissions from vehicles running on diesel and unleaded petrol
⩓ uncontrolled and accidental fires, including building and vehicle fires, as well as forest scrub and grass fires
⩓ sewage wastes
⩓ waste and refuse deposited to landfill
⩓ ongoing releases from reservoirs, including sludge ponds and contaminated sites.
Sources that no longer occur include:
⩓ use of PCP
⩓ manufacture and use of the herbicide 2,4,5-T
⩓ use of PCBs
⩓ manufacture of bleached kraft pulp using elemental chlorine
⩓ use of leaded fuels in New Zealand's land transport fleet.

[3] Importation, manufacture or sale prohibited, though existing stocks can be used.

3.2 Polychlorinated biphenyls

Internationally, large-scale production of PCBs commenced in the 1930s for use in a variety of industrial applications. PCBs were never manufactured in New Zealand, but have been imported and used extensively in the electricity industry as insulating fluids or resins in transformers and capacitors. PCBs were also used in smaller quantities as heat transfer fluids, plasticisers, printing inks, flame retardants, paint additives, sealing liquids and immersion oils.

In March 1986 the New Zealand Customs Department placed a prohibition on importing PCBs, and later that year regulations to control the importation of PCBs were promulgated as an amendment to the Toxic Substances Regulations 1983. In 1988 a further amendment to the Toxic Substances Regulations 1983 prohibited the use and storage of PCBs with effect from 1 January 1994. Following two extensions, this regulation came into effect on 1 August 1995. A summary of the legislative status of PCBs in New Zealand is provided in Buckland *et al.* (1998a).

Information relating to the quantity of PCBs imported into New Zealand is extremely limited, although some estimates have been made (OECD, 1987; Ministry for the Environment, 1988). Whilst the current holdings of PCBs are uncertain, more accurate assessments have been made of the quantity of PCBs that has been shipped overseas for destruction. These estimates put the quantity of PCBs (including PCB contaminated material) exported from New Zealand since 1987 at approximately 1300–1600 tonnes (Ministry of Health, 1998).

3.3 Organochlorine pesticides

From the mid 1940s until the 1970s persistent organochlorine pesticides (including DDT, dieldrin and lindane) were used heavily in New Zealand. Although few records were kept of the volumes imported into the country, the most substantial quantities are likely to have been imported during the 1950s and 1960s. The main areas of use were agriculture, horticulture, timber treatment and public health (Table 3.3). Smaller amounts were also used for amenity purposes and in households.

The use of pesticides in New Zealand was not subject to compulsory regulatory control until the Agricultural Chemicals Act 1959 established the Agricultural Chemicals Board. The use of persistent organochlorine pesticides was then progressively restricted by a succession of legislative measures, so that, by the mid 1970s their use had effectively ceased in agriculture and horticulture. All persistent organochlorine pesticides except PCP were formally deregistered by the Pesticides Board in 1989, and PCP was deregistered in 1991.

A chronology of persistent organochlorine pesticides in New Zealand and a summary of relevant legislation have been published by Buckland *et al.* (1998a).

Table 3.3 Summary of the historical usage of persistent organochlorine pesticides in New Zealand

Pesticide	Application
DDT	Used as a pasture insecticide to control grass grub (*Costelytra zealandia*) and porina (*Wiseana* sp.) caterpillars. Frequently mixed with fertiliser or lime and applied particularly to agriculture pastures, as well as lawns, market gardens and parks.
Lindane (γ-HCH)	Used as an insecticide in agriculture for the control of lice on cattle, ectoparasites (lice, keds and blowflies) in sheep and grass grub in pasture. Also used for insect control on vegetables and in orchards. Household use: flyspray, flea control, and carpet moth. Commercial hexachlorocyclohexane (HCH) was not *officially* used in New Zealand, although many dip sites show evidence of the use of crude HCH.
Aldrin and dieldrin	Introduced in 1954 for use as stock remedies in sheep sprays or dips for controlling sheep ectoparasites. Aldrin was used to control horticultural pests such as wireworm, soldier fly and blackvine weevil, and in limited quantities to control household spiders. Dieldrin was used for controlling carrot rust fly, crickets and armyworm and was also used for timber preservation (mostly in plywood glues) and to mothproof carpets.
Chlordane	Broad spectrum agricultural insecticide, also used in the timber industry as a treatment against termites and borer, and as an insecticide in glues used for the manufacture of plywood, finger jointed and laminated timber.
Hexachlorobenzene (HCB)	Used experimentally between 1970 and 1972 as a seed-dressing fungicide for cereal grain.
Heptachlor, endrin and toxaphene	Only small amounts of these pesticides were ever used in New Zealand. (Endrin and toxaphene were not included in the New Zealand survey).
PCP	In the order of 5,500 tonnes of PCP is estimated to have been used in the New Zealand timber industry over a 35 to 40-year period as an antisapstain (fungicidal) treatment for freshly cut timber (mainly *Pinus radiata*). Its use in the timber industry ceased in 1988. PCP was also used to a relatively minor extent by the pulp and paper industry and the tanning industry, in mushroom culture in home gardens and on roofs to control moss and algae.

3.4 Global transportation of organochlorines

The use or emission of organochlorines in other countries, and their global transportation, represent an additional and ongoing source of these contaminants to the New Zealand environment. Considerable research has taken place in the northern hemisphere on the transboundary transport and global redistribution of contaminants. Studies have also investigated the transport in air and water of contaminants from the northern to the southern hemispheres. These phenomena are particularly relevant to the transportation of organochlorines and their deposition in New Zealand. However, the significance of these inputs compared to 'local' sources of organochlorines, and the relative contributions these two inputs make to human population exposures, is difficult to assess and quantify.

4 Project Design

This investigation is a cross-sectional survey of the levels of organochlorine contaminants in serum from a representative sample of the non-occupationally exposed New Zealand population aged 15 years and older. Collection of serum samples was carried out from December 1996 though to November 1997 in conjunction with the National Nutrition Survey (NNS) of the Ministry of Health (Quigley and Watts, 1997). Information on the project design, including sample collection, processing and transportation, sample numbers and serum pooling criteria are given below, with further details provided in Appendix A.

4.1 Sample collection, processing and transportation

From each participant, a volume of blood was collected into vacutainers by a trained phlebotomist. The blood was couriered to the University of Otago, Dunedin, where it was centrifuged and the separated serum stored in vials at -70 ^{o}C pending transportation to the USA for chemical analysis.

Only samples from individuals who had not been occupationally exposed to organochlorines were analysed for the current study. These samples were transported to the Centers for Disease Control and Prevention (CDC), Atlanta, Georgia, where they were pooled and analysed for PCDDs, PCDFs, PCBs and organochlorine pesticides. Full details of the sample collection, processing and transportation are provided in Appendix A, Section A2.

4.2 Sample numbers

Of the 3,376 subjects who provided a blood sample for the NNS, 2,925 people responded to questions on occupational exposure to organochlorines and supplied a vacutainer of blood for organochlorine analysis. Of these, 2,788 provided at least 2 mL of serum, and of these, 2,497 samples (1,487 females and 1,010 males) were judged eligible for inclusion in the current study on the basis of there being no evidence of occupational exposure.

Because, from any one person, an insufficient volume of serum was collected for analysis for the full suite of organochlorine contaminants being studied, it was necessary to pool individual serum samples, and undertake analysis of the pooled samples. To maximise the volume of serum available for analysis, and because it was necessary to use equal volumes of individual serum samples for those pooled within a stratum (see Section 4.3), only 1,834 samples (1,034 females and 800 males) of the total 2,497 eligible samples were actually included in pooled samples. The number of eligible subjects, plus the total available serum volume for each stratum, is provided in Appendix A, Section A5, Table A2.

4.3 Serum pooling criteria

From each participant, up to 10 mL of whole blood (equivalent to approximately 5–6 mL of serum) was collected and processed to provide serum for organochlorine analysis. The optimal volume of serum required to achieve the necessary limits of detection for PCDD, PCDF and non-*ortho* PCB analysis was approximately 50 mL. Therefore, to achieve adequate volumes for analysis, individual serum samples were pooled according to certain stratification, selection and pooling criteria described below.

4.3.1 Stratification criteria

The serum was pooled according to specified stratification criteria based on age, ethnicity, sex and geographic region. This stratification provided a total of 80 strata for the study. However, of these, only pooled serum from 60 strata were analysed for organochlorine contaminants, due to some strata having either insufficient sample numbers or an insufficient pooled sample volume (see Section 4.3.2, and Appendix A, Section A5.2 and Table A2). The stratification criteria applied were as follows:

Age stratification

- 15–24 years
- 25–34 years
- 35–49 years
- 50–64 years
- 65+ years

Ethnicity stratification

- Maori
- Non-Maori

Sex stratification

- Male
- Female

Geographic stratification

- Northland/Auckland
- Waikato/Bay of Plenty
- Lower North Island
- South Island

4.3.2 Serum selection criteria

In addition to the exclusion of serum samples from potentially occupationally exposed individuals, the following criteria were applied when selecting serum samples for pooling.

1. A minimum of five eligible subjects were required for pooling in any stratum to reduce the possible impact of outliers. When five eligible subjects were not available in a particular stratum, then no pooled serum sample was prepared and no organochlorine concentration data were obtained for that stratum.
2. A minimum pooled serum volume of 25 mL for each stratum was required for inclusion in this study, although a volume of 50 mL was preferred in order to optimise limits of detection for the PCDDs, PCDFs and non-*ortho* PCBs.

These restrictions led to 20 strata being excluded from the study, leaving a total of 60 strata for which pooled serum samples were prepared and organochlorine contaminant concentration data were obtained.

4.3.3 Serum pooling criteria

For the 60 strata that were to have pooled samples prepared for analysis, serum was pooled according to the following protocols.

1. Strata where there were fewer than 25 individual samples: for each stratum, the largest possible total pooled serum volume was calculated such that each contributing individual sample contributed an equal volume.

2. Strata for which there were more than 25 individual samples (excluding those strata used for variance estimation): 2 mL of serum from each individual sample was pooled and a 50 mL volume from this total pool was taken for analysis.

3. Strata used to produce data for variance estimation (see Appendix A, Section A6): each pooled sample consisted of 25 randomly selected serum samples from that stratum. Each individual sample contributed 2 mL of serum, providing a volume of 50 mL for each pool.

4.4 Chemical analysis

The pooled serum samples were analysed at the CDC, Atlanta, USA, for the following organochlorine contaminants.

PCDDs and PCDFs. All seventeen 2,3,7,8-chlorinated congeners were determined. Data are reported for individual congener concentrations, for the sum of the seventeen 2,3,7,8-PCDDs and PCDFs and as total TEQ levels. TEQs were calculated using the WHO TEFs (Van den Berg *et al*., 1998) (Table 2.3).

PCBs. Four non-*ortho* PCB congeners[4] (**#81**, **#77**, **#126**, **#169**) and 38 *ortho* PCB congeners (PCB #18, #28, #52, #49, #44, #74, #66, #101, #99, #87, #110, **#118**, **#105**, #151, #149, #146, #153, #138, #158, #128, **#167**, **#156**, **#157**, #178, #187, #183, #177, #172, #180, #170, **#189**, #201, #196, #203, #195, #194, #206, #209) were determined. Data are reported for individual congener concentrations, for the sum of the 42 congeners and as PCB TEQ levels. PCB TEQs were calculated using the WHO TEFs (Van den Berg *et al*., 1998) (Table 2.3). Congeners that have been assigned TEFs are bolded.

Pesticides. Hexachlorocyclohexanes (β- and γ-HCH), hexachlorobenzene (HCB), aldrin, dieldrin, endrin, op$^{'}$-DDT, pp$^{'}$-DDT and mirex were determined, along with the pesticide degradation products, heptachlor epoxide, *trans*-nonachlor, oxychlordane and pp$^{'}$-DDE.

PCDDs, PCDFs and non-*ortho* PCBs were extracted from serum by C_{18} solid phase extraction (SPE) and purified using a multi-column clean-up of acid/neutral/basic silica, followed by acidic alumina then carbon. *Ortho*-PCBs and organochlorine pesticides were extracted by C_{18} SPE and purified by Florisil.

Target analytes were quantified by ^{13}C isotope dilution using capillary gas chromatography high resolution mass spectrometry operating in the selected ion monitoring mode. Concentration data are reported (Appendices D, E and F) on a lipid weight basis, corrected for recovery of ^{13}C surrogate standards.

[4] PCB numbering by Ballschmiter and Zell (1980).

The lipid content of each sample was determined using a ‘summation’ method, allowing the lipid weight concentrations to be adjusted to a serum volume basis. Lipid data are reported in Appendix C.

Full details of the analytical procedures for PCDD, PCDF, PCB and organochlorine pesticide analysis, and lipid content determination, are reported in Appendix B.

5 Levels of organochlorines in the serum of New Zealanders

5.1 Overall summary of data

Stratum-specific results for organochlorines in serum from the non-occupationally exposed New Zealand population aged 15 years and older are reported for:

- PCDDs and PCDFs in Appendix D
- PCBs in Appendix E
- organochlorine pesticides, including their degradation products, in Appendix F.

For the PCDDs, PCDFs and PCBs, all TEQ data reported in this study were calculated using the TEFs proposed by the WHO in 1997 (Table 2.3; Van den Berg *et al*., 1998). Results for all analyte groups are reported on a lipid weight basis.

A summary of PCDD, PCDF and PCB TEQs in the serum of adult New Zealanders aged 15 years and older is provided in Table 5.1. This summary presents minimum, maximum, weighted median and weighted mean TEQ levels obtained from all 60 serum pools analysed.[5]

Table 5.1 Summary data for PCDD, PCDF and PCB TEQs in the serum of adult New Zealanders

	Concentration, ng TEQ kg^{-1} lipid weight basis			
PCDD/PCDF/PCB	**Minimum**	**Maximum**	**Weighted median**	**Weighted mean (n = 60)**
PCDD/F TEQ (inc ½ LODs)	5.05	26.7	12.4	12.8
PCDD/F TEQ (exc LODs)	4.98	26.7	12.4	12.7
PCB TEQ (inc ½ LODs)	4.47	11.9	6.42	6.86
PCB TEQ (exc LODs)	1.21	10.2	2.46	3.33
Sum of PCDD/F TEQ + PCB TEQ (inc ½ LODs)[1]	9.71	38.5	18.7	19.7
Sum of PCDD/F TEQ + PCB TEQ (exc LODs)[1]	6.19	36.9	14.8	16.1

1. Data derived from the individual strata analysed, not from summing the PCDD/PCDF/PCB data listed above.
inc ½ LODs = Half the limits of detection were included in the TEQ calculation.
exc LODs = Limits of detection were excluded from the TEQ calculation, by setting LOD = 0.

An issue that arises for the PCDDs, PCDFs and PCBs when calculating TEQ levels, and when summing the concentrations of congeners, is what assumptions to make for those congeners that fall below their limit of detection (LOD). The two methods used in this study are to assume, firstly, that the congeners are actually present at a level of half the LOD, and, secondly, to assume that the congeners are not present, in which case they are given a zero concentration. The greater the

[5] Throughout Sections 5 and 6 of this report, median and mean concentrations are reported as weighted concentrations, even if not explicitly stated as such. Weighted median and mean concentrations were calculated to take into account the number of individuals in each pool (Appendix A, Table A3). The calculation of weighted medians and means is described in Appendix B, Section B1.9.

number of non-detectable congeners, the greater the difference in the TEQ level and the sum of congeners calculated when using the two methods.

For the PCDDs and PCDFs, almost all congeners were detected in almost every stratum. Consequently, there is little difference in the TEQ level determined or in the sum of 2,3,7,8-congeners, regardless of whether half LOD values are included or excluded from the calculations. When half the LODs were included, the mean PCDD and PCDF concentration was found to increase from 6.69 ng TEQ kg^{-1} lipid for the 15–24 age group to 20.7 ng TEQ kg^{-1} lipid for the 65+ age group. The mean concentration across the New Zealand population aged 15 years and older was determined as 12.8 ng TEQ kg^{-1} lipid.

In contrast, a large number of PCB congeners were reported as below limits of detection, and, as a result, there are marked differences in the TEQ levels calculated when either including half LOD values or assuming LOD = 0. Because of the impact of non-detectable values on the TEQ, the values obtained for 'PCB TEQ (exc LODs)' (which treat undetected PCB congeners as having zero concentration) are generally more informative than 'PCB TEQ (inc ½ LODs)' (which assign undetected PCB congeners a concentration of half their LOD value).

Using data based on assuming LOD = 0, PCB concentrations were found to increase from 1.50 ng TEQ kg^{-1} lipid for the 15–24 age group to 6.50 ng TEQ kg^{-1} lipid for the 65+ age group. The mean PCB TEQ level across all ages was determined as 3.33 ng TEQ kg^{-1} lipid. Again, based on LOD = 0, PCB TEQs were estimated to contribute approximately 15–30% to the total sum of PCDD and PCDF TEQ + PCB TEQ determined for any stratum.

When PCBs were quantified as the sum of congeners, concentrations (assuming LOD = 0) were found to increase from 20.8 µg kg^{-1} lipid for the 15–24 age group to 139 µg kg^{-1} lipid for the 65+ age group. The mean concentration for the sum of PCB congeners across all ages was 79.0 µg kg^{-1} lipid.

The most frequently detected pesticides in serum from the New Zealand population were:

- pp'-DDE, which was detected in all strata: concentrations were in the range 413–2780 µg kg^{-1} lipid, with median and mean concentrations of 919 µg kg^{-1} and 1080 µg kg^{-1} lipid respectively
- dieldrin, which was detected in 57 out of 60 strata: concentrations were in the range < 8–28.4 µg kg^{-1} lipid, with median and mean concentrations of 11.5 µg kg^{-1} and 14.2 µg kg^{-1} lipid respectively
- β-HCH, which was detected in 40 out of 60 strata: concentrations were in the range < 7–73.1 µg kg^{-1} lipid, with median and mean concentrations of 10.7 µg kg^{-1} and 19.7 µg kg^{-1} lipid respectively.

Concentrations of pp'-DDE, dieldrin and β-HCH were found to increase with age.

Of the remaining pesticides analysed, pp'-DDT was detected in 18 strata at a maximum concentration of 49.2 µg kg^{-1} lipid. All other pesticides were either not detected, or detected on less than 10% of occasions (i.e. detected in less than six strata). Of these, γ-HCH was detected in one stratum at a concentration of 91.1 µg kg^{-1} lipid, HCB was detected in four strata at a maximum concentration of 53.6 µg kg^{-1} lipid, and *trans*-nonachlor was detected in three strata at a maximum concentration of 8.4 µg kg^{-1} lipid.

An analysis of the concentrations of PCDDs, PCDFs, PCBs and selected organochlorine pesticides stratified by age, geographic region, ethnicity and sex is presented in the following sections.

5.2 PCDDs and PCDFs

Minimum, maximum, weighted median and weighted mean concentrations for individual 2,3,7,8-PCDD and PCDF congeners, sum of 2,3,7,8-PCDD/PCDF congeners and PCDD/PCDF TEQs across all strata are reported in Table 5.2.[6] Stratum-specific data are reported in Appendix D. The discussion of PCDD and PCDF TEQ levels in this section specifically references TEQs including half LOD values. However, as previously noted, the inclusion of half LOD values has minimal effect on the TEQ level calculated for the PCDDs and PCDFs, and consequently the findings are equally valid for TEQ levels calculated assuming LOD = 0.

The congeners detected at the highest concentrations were 1,2,3,4,6,7,8-HpCDD and OCDD. 1,2,3,4,6,7,8-HpCDD was detected in the range < 30–85.9 ng kg^{-1} lipid, and OCDD was detected in the range 143–961 ng kg^{-1} lipid.

2,3,7,8-TCDD was detected in almost all strata, at a maximum concentration of 7.0 ng kg^{-1} lipid and 1,2,3,7,8-PeCDD was detected in all strata at a maximum concentration of 9.3 ng kg^{-1} lipid. The three 2,3,7,8-HxCDD congeners were detected in > 90% of strata, and in a concentration profile dominated by 1,2,3,6,7,8-HxCDD, which is typical of the profile normally observed in human tissue.

2,3,7,8-TCDF was detected in less than 50% of strata, at a maximum concentration of 0.7 ng kg^{-1} lipid. In contrast, 2,3,4,7,8-PeCDF, which was more frequently detected and present at higher concentrations than 1,2,3,7,8-PeCDF, was quantified in all strata to a maximum concentration of 8.3 ng kg^{-1} lipid. Three of the four HxCDF congeners were detected in all or almost all of the strata, whilst 1,2,3,7,8,9-HxCDF was not quantified in any strata. Again, the profile of the 2,3,7,8-HxCDF congeners is typical of that observed in human tissue.

An earlier publication on this study reported quantified levels of OCDF in all strata (Bates *et al*. 1999). This was contrary to other New Zealand data for plasma (Hannah *et al*. 1994) and breast milk (Bates *et al*. 1994; 2001), in which OCDF was very infrequently detected, and then only at very low concentrations. We were subsequently advised by the analytic laboratory that they had detected an OCDF contamination problem. We therefore consider OCDF not to have been detected in any strata in this study, and all measurements for this congener are presented in this report as limits of detection.

[6] In this table and all subsequent tables in this report (including appendices), median and mean concentrations are shown only for those compounds that were detected in at least 66% of all strata, or 66% of strata grouped on the basis of age, geographic region or ethnicity and sex. The rationale for this was that if a contaminant was not frequently quantified, the median or mean value determined might not be truly representative of the data set, yet it could be misinterpreted as representing a 'national median' or 'national average' for New Zealand.

Table 5.2 Concentrations of PCDDs and PCDFs in the serum of New Zealanders

Congener	Number of positives	Concentration, ng kg^{-1} lipid weight basis[1] Minimum	Maximum	Weighted median	Weighted mean (n = 60)[2]
2,3,7,8-TCDD	58	< 1	7.0	2.0	2.3
1,2,3,7,8-PeCDD	60	2.0	9.3	4.9	4.7
1,2,3,4,7,8-HxCDD	56	< 2	5.9	2.7	2.8
1,2,3,6,7,8-HxCDD	58	< 0.7	39.6	20.2	20.8
1,2,3,7,8,9-HxCDD	59	< 2	8.3	3.9	4.2
1,2,3,4,6,7,8-HpCDD	58	< 30	85.9	37.4	38.4
OCDD	60	143	961	366	361
2,3,7,8-TCDF	23	< 0.2	0.7	nc	nc
1,2,3,7,8-PeCDF	12	< 0.2	0.7	nc	nc
2,3,4,7,8-PeCDF	60	1.8	8.3	3.8	4.0
1,2,3,4,7,8-HxCDF	60	0.90	4.3	2.1	2.2
1,2,3,6,7,8-HxCDF	60	1.1	4.6	2.5	2.6
2,3,4,6,7,8-HxCDF	56	< 0.9	1.4	0.8	0.8
1,2,3,7,8,9-HxCDF	0	< 0.2	< 2	nc	nc
1,2,3,4,6,7,8-HpCDF	30	< 5	21.7	nc	nc
1,2,3,4,7,8,9-HpCDF	29	< 0.3	1.2	nc	nc
OCDF	0	< 1	< 200	nc	nc
Sum of 2,3,7,8-PCDD/Fs (inc ½ LODs)[3]		178	1170	465	459
Sum of 2,3,7,8-PCDD/Fs (exc LODs)[3]		174	1070	440	447
PCDD/F TEQ (inc ½ LODs)[3]		5.05	26.7	12.4	12.8
PCDD/F TEQ (exc LODs)[3]		4.98	26.7	12.4	12.7

1. For any individual congener, calculation of the weighted median includes LOD values and calculation of the weighted mean includes half LOD values (see Appendix B, Section B1.9).
2. n = 59 for 1,2,3,7,8-PeCDF and n = 58 for 1,2,3,4,7,8-HxCDD.
3. Sum of 2,3,7,8-PCDD/Fs and TEQ data are taken or calculated from the individual strata analysed, and not from the summarised congener data reported in the table.

nc = Not calculated (median or mean concentration reported only if a congener was detected on more than 66% of occasions across all strata).

inc ½ LODs = Half the limits of detection were included in the sum of 2,3,7,8-PCDD/Fs and the TEQ calculation.
exc LODs = Limits of detection were excluded from the sum of 2,3,7,8-PCDD/Fs and the TEQ, by setting LOD = 0.

The mean PCDD and PCDF concentrations for each of the five age groups assessed in this study are reported in Table 5.3. These data, which summarise results for all 60 strata analysed, show a consistent trend toward higher concentrations of PCDD and PCDF congeners in the older age groups. When expressed on a TEQ basis, PCDD and PCDF levels increased from 6.69 ng TEQ kg^{-1} lipid for the 15–24 age group to 20.7 ng TEQ kg^{-1} lipid for the 65+ age group. The mean PCDD and PCDF TEQ level across all strata is 12.8 ng TEQ kg^{-1} lipid (Table 5.2).

Table 5.3 Weighted mean concentrations of PCDDs and PCDFs in serum, by age

	Concentration, ng kg^{-1} lipid weight basis[1]				
Congener	**15–24 yrs**	**25–34 yrs**	**35–49 yrs**	**50–64 yrs**	**65+ yrs**
2,3,7,8-TCDD	1.0	1.4	2.0	3.1	4.6
1,2,3,7,8-PeCDD	2.6	3.4	4.7	5.8	7.2
1,2,3,4,7,8-HxCDD	1.3	1.9	3.0	3.5	4.4
1,2,3,6,7,8-HxCDD	8.3	15.2	21.7	26.3	33.6
1,2,3,7,8,9-HxCDD	2.6	3.4	4.1	4.9	6.1
1,2,3,4,6,7,8-HpCDD	21.7	32.3	38.6	47.3	53.3
OCDD	227	320	385	411	455
2,3,7,8-TCDF	nc	nc	nc	nc	0.3
1,2,3,7,8-PeCDF	nc	nc	nc	nc	nc
2,3,4,7,8-PeCDF	2.3	2.9	4.0	5.0	6.1
1,2,3,4,7,8-HxCDF	1.3	1.6	2.1	2.7	3.3
1,2,3,6,7,8-HxCDF	1.5	2.0	2.5	3.2	3.7
2,3,4,6,7,8-HxCDF	0.5	0.7	0.8	1.0	0.9
1,2,3,7,8,9-HxCDF	nc	nc	nc	nc	nc
1,2,3,4,6,7,8-HpCDF	nc	nc	5.9	4.8	nc
1,2,3,4,7,8,9-HpCDF	nc	nc	0.3	nc	nc
OCDF	nc	nc	nc	nc	nc
Sum of 2,3,7,8-PCDD/Fs (inc ½ LODs)[2]	287	399	487	526	589
Sum of 2,3,7,8-PCDD/Fs (exc LODs)[2]	270	387	474	518	582
PCDD/F TEQ (inc ½ LODs)[2]	6.69	9.27	12.6	16.1	20.7
PCDD/F TEQ (exc LODs)[2]	6.54	9.18	12.6	16.1	20.7

1. For any individual congener, calculation of the weighted mean includes half LODs (see Section B1.9).
2. Sum of 2,3,7,8-PCDD/Fs and TEQ data are calculated from the individual strata analysed, and not from the summarised congener data reported in the table.

nc = Not calculated (mean concentration reported only if a congener was detected in more than 66% of strata for that age group).
inc ½ LODs = Half the limits of detection were included in the sum of 2,3,7,8-PCDD/Fs and the TEQ calculation.
exc LODs = Limits of detection were excluded from the sum of 2,3,7,8-PCDD/Fs and the TEQ, by setting LOD = 0.

The mean PCDD and PCDF concentrations in serum for the four geographic regions are reported in Table 5.4. Because of the marked variation by age, the means calculated for each region are based on results only for those age groups for which comparable ethnicity–sex data were available for each of the four geographic regions. This is to ensure comparability of results for the four regions.

Application of this restriction meant that for Maori, only males in the 35–49 age group and females in the youngest three age groups are represented in the results shown in Table 5.4. The other Maori age–sex groupings did not have results available for all regions. Non-Maori males and females, for all ages, are represented in all regions. If there are general differences in exposure across the geographic regions of the study, it is likely that these differences would be apparent, even with an incomplete representation of age and ethnicity–sex groupings. On this basis, the data indicates that, in general, PCDD and PCDF concentrations in the two northern regions (Northland/Auckland, 14.2 ng TEQ kg^{-1} lipid and Waikato/Bay of Plenty, 14.9 ng TEQ kg^{-1} lipid) tend to be higher than in the two southern regions (Lower North Island, 11.4 ng TEQ kg^{-1} lipid and South Island, 12.7 ng TEQ kg^{-1} lipid).

Table 5.4 Weighted mean concentrations of PCDDs and PCDFs in serum, by geographic region[1]

Congener	Concentration, ng kg^{-1} lipid weight basis[2]			
	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island
2,3,7,8-TCDD	2.5	2.6	2.4	2.2
1,2,3,7,8-PeCDD	5.3	5.7	4.1	4.8
1,2,3,4,7,8-HxCDD	3.2	3.8	2.5	2.6
1,2,3,6,7,8-HxCDD	24.0	26.6	19.2	20.2
1,2,3,7,8,9-HxCDD	4.7	5.0	3.7	4.1
1,2,3,4,6,7,8-HpCDD	46.3	44.9	34.1	37.1
OCDD	400	397	317	367
2,3,7,8-TCDF	nc	nc	nc	nc
1,2,3,7,8-PeCDF	nc	nc	nc	nc
2,3,4,7,8-PeCDF	4.6	4.4	3.8	4.1
1,2,3,4,7,8-HxCDF	2.3	2.6	1.9	2.2
1,2,3,6,7,8-HxCDF	2.7	3.0	2.2	2.7
2,3,4,6,7,8-HxCDF	0.8	0.8	0.7	0.8
1,2,3,7,8,9-HxCDF	nc	nc	nc	nc
1,2,3,4,6,7,8-HpCDF	nc	nc	nc	nc
1,2,3,4,7,8,9-HpCDF	0.4	nc	nc	nc
OCDF	nc	nc	nc	nc
Sum of 2,3,7,8-PCDD/Fs (inc ½ LODs)[3]	522	513	396	473
Sum of 2,3,7,8-PCDD/Fs (exc LODs)[3]	508	498	388	461
PCDD/F TEQ (inc ½ LODs)[3]	14.2	14.9	11.4	12.7
PCDD/F TEQ (exc LODs)[3]	14.1	14.8	11.3	12.5

1. Weighted means calculated excluding data from the following strata: Maori males age groups 15–24, 25–34, 50–64, 65+; and Maori females 50–64 and 65+ (see text).
2. For any individual congener, calculation of the weighted mean includes half LODs (see Section B1.9).
3. Sum of 2,3,7,8-PCDD/Fs and TEQ data are calculated from the individual strata analysed, and not from the summarised congener data reported in the table.

nc = Not calculated (mean concentration reported only if a congener was detected in more than 66% of strata for that geographic region).

inc ½ LODs = Half the limits of detection were included in the sum of 2,3,7,8-PCDD/Fs and the TEQ calculation.

exc LODs = Limits of detection were excluded from the sum of 2,3,7,8-PCDD/Fs and the TEQ, by setting LOD = 0.

Mean levels for PCDD and PCDF TEQ, stratified by age and geographic region, are presented in Figure 5.1.[7] The TEQ data used to prepare this bar chart include half the LOD values for non-detected PCDD and PCDF congeners. The number at the top of each column represents the number of individual serum samples that contributed to the mean for that geographic region and age group.

As discussed earlier, an age-related increase in TEQ levels is apparent (see Table 5.3), along with a tendency for higher TEQ levels in the two upper North Island regions (Northland/Auckland and Waikato/Bay of Plenty) relative to the two more southern regions (Lower North Island and South Island) (see Table 5.4).

7 Unlike the data reported in Table 5.4 (which, in calculating mean concentrations omits some ethnicity–sex data for some age groups), Figure 5.1 is based on TEQ data from all 60 strata analysed.

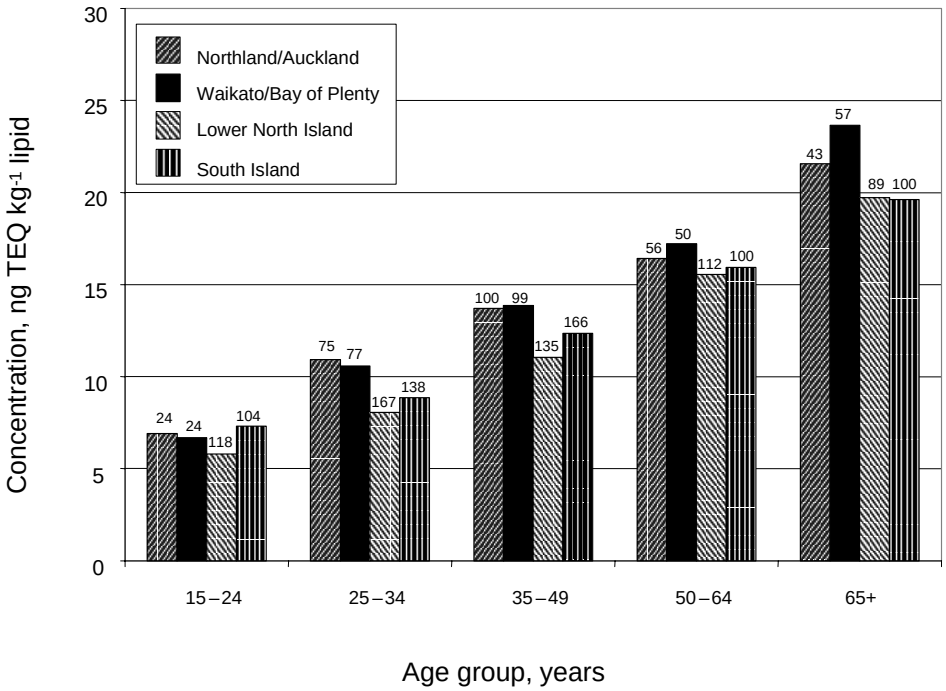

Figure 5.1 Mean PCDD and PCDF TEQ in serum, by age and geographic region
[The number at the top of each column represents the number of individual serum samples that contributed to the mean concentration.]

Mean PCDD and PCDF concentrations stratified by ethnicity and sex are reported in Table 5.5. Again, to ensure comparability when comparing results across ethnicity–sex groupings, mean concentrations are based only on those age groups and regions for which there were data available for each of the four Maori/non-Maori and male/female categories. The implication of this restriction has meant that the data used to calculate means were limited to the Lower North Island and the South Island regions in the 15–24, 25–34 and 35–49 age groups. As the two oldest age groups were not included, concentrations appear lower than concentrations shown in other tables and figures. Inclusion of the older age groups (who have higher concentrations of PCDDs and PCDFs) would have produced a misleading pattern of higher levels in non-Maori relative to Maori, as there were data for non-Maori from all regions in all age groups but data from only one region for Maori in the 50–64 age group and no data from any region for Maori in the 65+ age group. Nevertheless, using data for only two of the four regions and for the three youngest age groups does not preclude an analysis of differences between the sexes or between Maori and non-Maori.

The data in Table 5.5 do not appear to show any consistent difference in individual congener concentrations between males and females. For some congeners, such as 1,2,3,4,6,7,8-HpCDD and OCDD, females had marginally higher concentrations than males, and vice-versa for other congeners, such as 2,3,4,7,8-PeCDF and the HxCDFs. Similarly, there appears to be no consistent differences between Maori and non-Maori. As such, PCDD and PCDF TEQ levels were similar in all four ethnicity–sex groups, as shown by the mean concentrations, which were in the range 8.57–9.46 ng TEQ kg^{-1} lipid. Overall, therefore, the congener profile of PCDDs and PCDFs provides no evidence of consistent differences in exposure patterns between Maori and non-Maori or males and females when considered across the adult New Zealand population, at least for New Zealanders aged 15–49 years.

Table 5.5 Weighted mean concentrations of PCDDs and PCDFs in serum, by ethnicity and sex[1]

	Concentration, ng kg^{-1} lipid weight basis[2]			
	Female		Male	
Congener	Maori	Non-Maori	Maori	Non-Maori
2,3,7,8-TCDD	1.5	1.5	1.4	1.3
1,2,3,7,8-PeCDD	3.2	3.5	3.5	3.5
1,2,3,4,7,8-HxCDD	1.9	1.9	2.2	2.0
1,2,3,6,7,8-HxCDD	11.0	14.9	13.6	14.8
1,2,3,7,8,9-HxCDD	3.6	3.5	2.7	2.8
1,2,3,4,6,7,8-HpCDD	31.8	32.0	27.9	26.1
OCDD	380	344	256	245
2,3,7,8-TCDF	nc	0.2	nc	nc
1,2,3,7,8-PeCDF	nc	nc	nc	nc
2,3,4,7,8-PeCDF	2.6	3.0	3.4	3.2
1,2,3,4,7,8-HxCDF	1.7	1.6	1.8	1.6
1,2,3,6,7,8-HxCDF	1.9	1.9	2.3	2.0
2,3,4,6,7,8-HxCDF	0.6	0.6	0.8	0.7
1,2,3,7,8,9-HxCDF	nc	nc	nc	nc
1,2,3,4,6,7,8-HpCDF	nc	5.1	nc	nc
1,2,3,4,7,8,9-HpCDF	nc	nc	nc	nc
OCDF	nc	nc	nc	nc
Sum of 2,3,7,8-PCDD/Fs (inc ½ LODs)[3]	464	425	331	313
Sum of 2,3,7,8-PCDD/Fs (exc LODs)[3]	440	412	313	306
PCDD/F TEQ (inc ½ LODs)[3]	8.57	9.42	9.46	9.11
PCDD/F TEQ (exc LODs)[3]	8.40	9.36	9.18	9.05

1. Weighted means calculated using data only from the Lower North Island and South Island regions and for the 15–24, 25–34 and 35–49 age groups (see text).
2. For any individual congener, calculation of the weighted mean includes half LODs (see Section B1.9).
3. Sum of 2,3,7,8-PCDD/Fs and TEQ data are calculated from the individual strata analysed, and not from the summarised congener data reported in the table.

nc = Not calculated (mean concentration reported only if a congener was detected in more than 66% of strata for that ethnicity–sex group).

inc ½ LODs = Half the limits of detection were included in the sum of 2,3,7,8-PCDD/Fs and the TEQ calculation.

exc LODs = Limits of detection were excluded from the sum of 2,3,7,8-PCDD/Fs and the TEQ, by setting LOD = 0.

The variation in mean PCDD and PCDF TEQ levels for the four ethnicity–sex groups, by age, is shown in Figure 5.2.[8] The TEQ data used to prepare this bar chart include half LOD values for non-detected PCDD and PCDF congeners. Again, the trend of increasing PCDD and PCDF concentrations with age is evident. Three further observations stand out.

1. Generally, there is little difference in the mean TEQ levels between males and females and Maori and non-Maori within the three younger age groups, consistent with the data reported in Table 5.5.
2. The mean TEQ level in Maori females in the 50–64 age group is markedly higher than for Maori females in any other age group. However, this result is based on the analysis of a single pooled sample made up only five individual serum samples. Consequently, this result should

[8] Unlike the data reported in Table 5.5 (which, in calculating mean concentrations, uses results only from the Lower North Island and South Island regions for the three youngest age groups), Figure 5.2 is based on TEQ data from all 60 strata analysed.

not be taken as being indicative of mean serum PCDD and PCDF concentrations in Maori females aged 50–64 years.

3. In the 65+ age group, non-Maori females had appreciably higher TEQ levels than non-Maori males. This cannot be explained by a difference in the average age of men and women in that group (which might have been expected, given the longer life expectancy of women compared with men) as both sexes had an identical mean age of 72.9 years. The reason for the comparatively higher concentration in non-Maori females aged 65+ is not known.

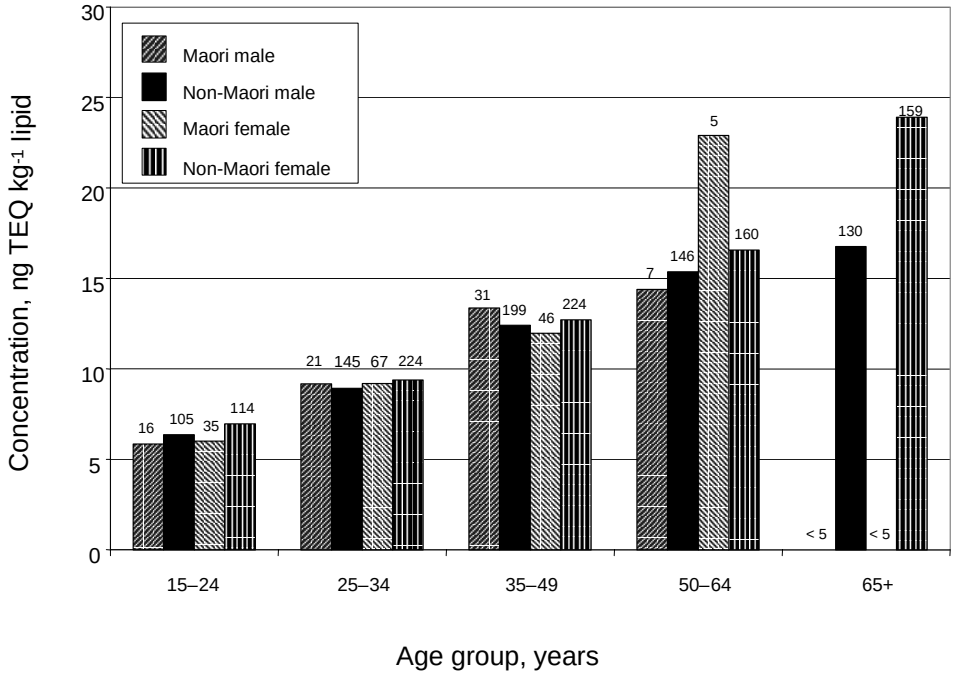

Figure 5.2 Mean PCDD and PCDF TEQ in serum, by age, ethnicity and sex
[The number at the top of each column represents the number of individual serum samples that contributed to the mean concentration. If insufficient serum samples (less than 5) were collected from an ethnicity–sex group for analytical measurements to be made, a < 5 notation is shown where the column would otherwise have been.]

No comparison of PCDD and PCDF concentrations between Maori and non-Maori can be made for the 65+ age group, as there were insufficient serum samples collected from Maori aged 65+ to meet the eligibility criteria for inclusion in this study (see Appendix A, Section A5). This is indicated in Figure 5.2 by a '< 5' where the column would otherwise have been.

5.3 Polychlorinated biphenyls

Minimum, maximum, weighted median and weighted mean concentrations for selected PCB congeners, sum of PCB congeners and PCB TEQ are reported in Table 5.6. This table presents data only for those congeners that were frequently detected. As noted earlier, median and mean concentrations were calculated only if a congener was detected on more than 66% of occasions across all strata analysed. Stratum-specific data for all target PCB congeners are reported in Appendix E.

Table 5.6 Concentrations of PCBs in the serum of New Zealanders

Congener	Number of positives	Concentration, µg kg^{-1} lipid weight basis[1] Minimum	Maximum	Weighted median	Weighted mean (n = 60)
PCB #126	60	0.011	0.065	0.023	0.030
PCB #169	60	0.0076	0.038	0.021	0.020
PCB #74	20	< 4	10.9	nc	nc
PCB #118	20	< 4	10.0	nc	nc
PCB #153	60	6.1	49.9	24.6	23.7
PCB #138 + #158	56	< 6	36.2	15.6	15.3
PCB #187	30	< 4	15.3	nc	nc
PCB #180	57	< 7	44.6	20.0	20.3
PCB #170	42	< 5	18.6	8.6	8.4
PCB #194	22	< 6	9.2	nc	nc
Sum of PCBs (inc ½ LODs)[2]		127	286	192	201
Sum of PCBs (exc LODs)[2]		6.12	208	81.9	79.0
		Concentration, ng TEQ kg^{-1} lipid weight basis			
PCB TEQ (inc ½ LODs)[3]		4.29	11.9	6.42	6.86
PCB TEQ (exc LODs)[3]		1.21	10.2	2.46	3.33

1. For any individual congener, calculation of the weighted median includes LOD values and calculation of the weighted mean includes half LOD values (see Appendix B, Section B1.9).
2. Sum of PCBs is the sum of all 42 targeted congeners analysed.
3. PCB TEQ is the TEQ calculated for the 10 dioxin-like PCB congeners analysed (see Section 4.4).

nc = Not calculated (median or mean concentration reported only if a congener was detected on more than 66% of occasions across all strata).

inc ½ LODs = Half the limits of detection were included in the sum of PCBs and the TEQ calculation.

exc LODs = Limits of detection were excluded from the sum of PCBs and the TEQ calculation, by setting LOD = 0.

Of the four non-*ortho* PCBs, congeners #126 and #169 were detected in all strata (mean concentrations of 0.030 µg kg^{-1} and 0.020 µg kg^{-1} lipid respectively). Conversely, PCB #81 was detected in only three strata (at a maximum concentration of 0.0029 µg kg^{-1} lipid), whilst PCB #77 was not detected in any strata. Limits of detection for PCB #81 were in the range < 0.002 to < 0.02 µg kg^{-1} lipid and for PCB #77 in the range < 0.03 to < 0.2 µg kg^{-1} lipid.

Of the *ortho*-substituted congeners, those consistently detected in most strata and at the highest concentrations were PCBs #153, #138 + #158 and #180 (Table 5.6). Congeners #74, #118, #187, #170 and #194 were detected to a lesser extent (primarily in the older age groups) and at comparatively lower concentrations.

In addition to the PCBs reported in Table 5.6, a few other *ortho*-substituted congeners were detected in a limited number of strata, namely PCBs #146 (detected in eight strata), #156 (11 strata), #183 (two strata), #177 (three strata), #201 (eight strata) and #196 + #203 (eight strata). No other targeted

PCBs were detected in any strata to the limits of detection reported in Appendix E. Typical limits of detection for *ortho*-substituted congeners ranged from < 4 to < 20 µg kg^{-1} lipid.

For ease of comparison with the PCDD and PCDF TEQ data reported in Table 5.3, PCB TEQ levels are expressed as ng kg^{-1} lipid, rather than µg kg^{-1} lipid (the concentration unit used to report data for individual congeners and sum of PCB congeners). Comparison of the PCDD and PCDF TEQs (Table 5.3) with the PCB TEQs (Table 5.6) shows that, when assuming LOD = 0 in the TEQ calculation, the PCBs contribute approximately 15–30% of the total sum of PCDD and PCDF TEQ + PCB TEQ determined in serum from the adult New Zealand population. This comparison of TEQ levels assuming congeners reported as LODs are present at zero concentration is justified because, as noted earlier, for the PCBs the TEQs determined were markedly affected by inclusion of non-detected congeners in the TEQ calculation, especially for the younger age groups.

Mean PCB concentrations for each of the five age groups are reported Table 5.7. These data summarise results for all 60 strata analysed. The congeners shown are limited to those that were frequently detected, at least for the oldest age groups. As with the PCDDs and PCDFs (Table 5.3), there is a general trend of increasing PCB concentration with age. This age trend is evident from the individual congener data, the sum of PCB congeners and the PCB TEQ, especially when LODs are excluded from the sum of congeners and the TEQ calculation. The mean PCB TEQ level across all strata is 6.86 ng TEQ kg^{-1} (including half LODs) and 3.33 ng TEQ kg^{-1} lipid (excluding LODs) (Table 5.6).

Table 5.7 Weighted mean concentrations of PCBs in serum, by age

	Concentration, µg kg^{-1} lipid weight basis[1]				
Congener	**15–24 yrs**	**25–34 yrs**	**35–49 yrs**	**50–64 yrs**	**65+ yrs**
PCB #126	0.014	0.019	0.023	0.035	0.045
PCB #169	0.010	0.015	0.023	0.027	0.030
PCB #74	nc	nc	nc	4.7	7.5
PCB #118	nc	nc	nc	4.9	7.0
PCB #153	9.1	16.1	25.2	32.6	36.6
PCB #138 + #158	5.6	10.6	15.9	20.9	24.2
PCB #187	nc	nc	5.2	7.2	8.5
PCB #180	7.3	13.5	22.2	28.1	30.9
PCB #170	nc	nc	9.3	11.6	12.7
PCB #194	nc	nc	nc	5.1	5.9
Sum of PCBs (inc ½ LODs)[2]	170	172	210	219	237
Sum of PCBs (exc LODs)[2]	20.8	44.9	81.8	118	139
	Concentration, ng TEQ kg^{-1} lipid weight basis				
PCB TEQ (inc ½ LODs)[3]	5.90	5.80	6.50	7.60	9.20
PCB TEQ (exc LODs)[3]	1.50	2.00	2.70	4.80	6.50

1. For any individual congener, calculation of the weighted mean includes half LOD values (see Section B1.9).
2. Sum of PCBs is the sum of all 42 targeted congeners analysed.
3. PCB TEQ is the TEQ calculated for the 10 dioxin-like PCB congeners analysed (see Section 4.4).

nc = Not calculated (mean concentration reported only if a congener was detected in more than 66% of strata for that age group).

inc ½ LODs = Half the limits of detection were included in the sum of PCBs and the TEQ calculation.

exc LODs = Limits of detection were excluded from the sum of PCBs and the TEQ calculation, by setting LOD = 0.

Mean PCB concentrations for the four geographic regions are reported in Table 5.8. Again, as in Table 5.4, to ensure comparability when comparing results across regions, mean concentrations are based only on those age groups for which comparable ethnicity–sex data were available for each of the four geographic regions. This has meant that for Maori, only males in the 35–49 age group and females in the three youngest age groups are represented in the results presented in Table 5.8. The PCB congeners shown are those for which, in at least one geographic region, that congener was quantified on at least 66% of occasions.

Table 5.8 Weighted mean concentrations of PCBs in serum, by geographic region[1]

	Concentration, µg kg^{-1} lipid weight basis[2]			
Congener	**Northland/ Auckland**	**Waikato/ Bay of Plenty**	**Lower North Island**	**South Island**
PCB #126	0.032	0.032	0.024	0.024
PCB #169	0.024	0.024	0.020	0.021
PCB #153	28.9	29.7	22.7	21.6
PCB #138 + #158	18.0	19.4	14.7	13.8
PCB #180	23.2	26.1	19.7	19.1
PCB #170	10.1	11.3	7.7	nc
Sum of PCBs (inc ½ LODs)[3]	224	215	192	199
Sum of PCBs (exc LODs)[3]	96.3	105	77.4	70.4
	Concentration, ng TEQ kg^{-1} lipid weight basis			
PCB TEQ (inc ½ LODs)[4]	7.90	7.50	6.50	6.70
PCB TEQ (exc LODs)[4]	4.20	4.10	3.30	3.00

1. Weighted means calculated excluding data from the following strata: Maori males age groups 15–24, 25–34, 50–64, 65+; and Maori females 50–64 and 65+ (see text).
2. For any individual congener, calculation of the weighted mean includes half LOD values (see Section B1.9).
3. Sum of PCBs is the sum of all 42 targeted congeners analysed.
4. PCB TEQ is the TEQ calculated for the 10 dioxin-like PCB congeners analysed (see Section 4.4).

nc = Not calculated (mean concentration reported only if a congener was detected in more than 66% of strata for that geographic region).

inc ½ LODs = Half the limits of detection were included in the sum of PCBs and the TEQ calculation.

exc LODs = Limits of detection were excluded from the sum of PCBs and the TEQ calculation, by setting LOD = 0.

As was observed with the PCDDs and PCDFs, there is a tendency for PCB concentrations to be marginally higher in the two northern study regions (Northland/Auckland and Waikato/Bay of Plenty) compared to the two southern regions (Lower North Island and South Island). This trend is also reflected in Figures 5.3 and 5.4, which show the regional variation in PCB concentrations by age.[9] For Figure 5.3, results are shown as PCB TEQ, with half the LODs for non-detected congeners included in the TEQ for comparability with Figure 5.1. For Figure 5.4, results are expressed as the sum of PCB congeners, for which measurements lower than the LOD were set at zero (i.e. excluded from the summation). A trend of increasing PCB concentrations with age is particularly apparent in Figure 5.4. The same trend is less marked in Figure 5.3, reflecting attenuation of the TEQ by the high proportion of results reported as LODs. If LOD values are set to zero concentration for the purposes of calculating PCB TEQs, a trend of increasing TEQ levels with age as marked as that seen in Figure 5.4 is observed.

[9] Unlike the data reported in Table 5.8 (which, in calculating mean concentrations, omits some ethnicity–sex data for some age groups), Figures 5.3 and 5.4 are based on data from all 60 strata analysed.

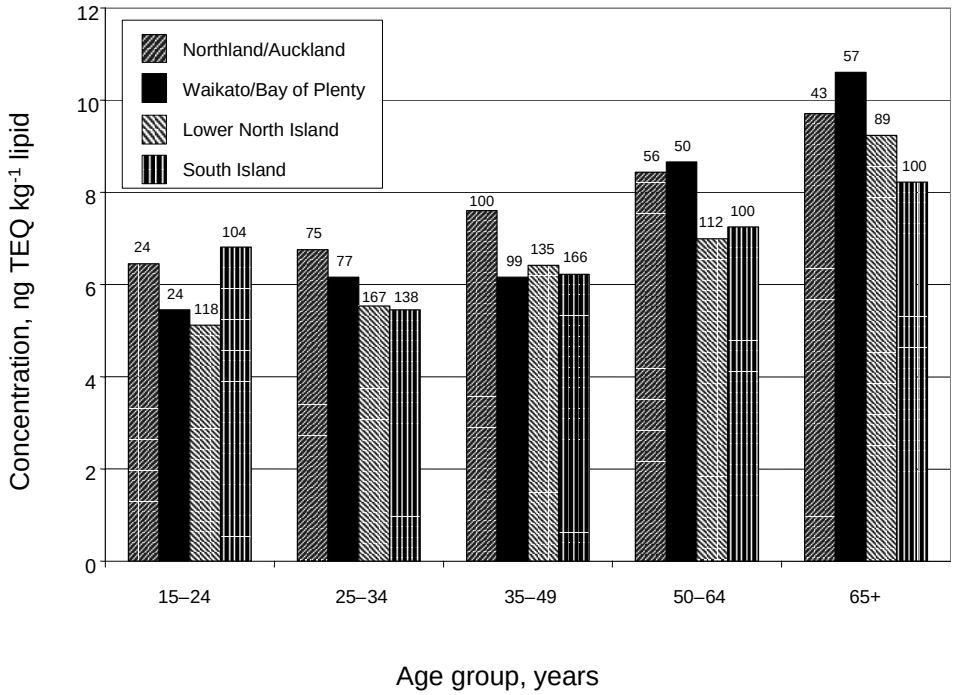

Figure 5.3 Mean PCB TEQ in serum, by age and geographic region
[For an explanation of the number at the top of each column, see Figure 5.1.]

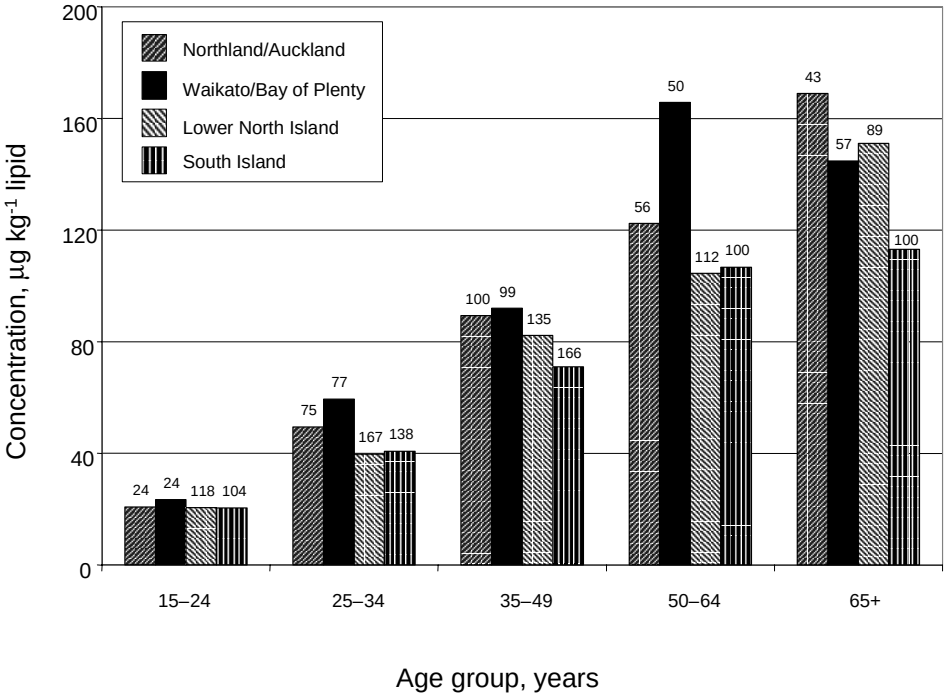

Figure 5.4 Mean sum of PCB congeners in serum, by age and geographic region
[For an explanation of the number at the top of each column, see Figure 5.1.]

To further assess the variation of PCB concentrations with age and region, two further bar charts based on data for individual PCB congeners are provided. For the purposes of preparing these figures, concentration data from all 60 strata analysed were used. Figure 5.5 shows the geographic variation by age for PCB #126, whilst Figure 5.6 shows the geographic variation by age for PCB #153. PCB #126 was selected because it is the most dioxin-like of the PCB congeners with the highest assigned TEF, and made the greatest contribution to the TEQ for any stratum when LODs were set to zero concentration. PCB #153 was selected because it was almost always present at the highest concentration of all the target PCBs analysed in the current study. In addition, because both PCB #126 and #153 were quantified in all strata, the mean concentrations presented in these figures are unaffected by limit of detection results. PCB #126 is therefore a useful 'indicator' of PCB TEQ levels, whilst PCB #153 is a useful indicator of the sum of PCB congener levels.

Both Figures 5.5 and 5.6 show an increasing PCB concentration trend with age, and the tendency for PCB concentrations to be higher in the two northern study regions (Northland/Auckland and Waikato/Bay of Plenty) compared to the two southern regions (Lower North Island and South Island).

Mean PCB concentrations stratified by ethnicity and sex are reported in Table 5.9. The congeners shown are those for which, in at least one ethnicity–sex group, that congener was quantified on at least 66% of occasions. As discussed earlier for the PCDDs and PCDFs, to ensure comparability when comparing results across ethnicity–sex groupings, mean concentrations are based only on those age groups and regions for which there were data available for each of the four Maori/non-Maori and male/female categories. As the two oldest age groups were not included, concentrations appear lower than concentrations shown in other tables and figures.

Table 5.9 Weighted mean concentrations of PCBs in serum, by ethnicity and sex[1]

	Concentration, μg kg^{-1} lipid weight basis[2]			
	Female		Male	
Congener	Maori	Non-Maori	Maori	Non-Maori
PCB #126	0.019	0.019	0.017	0.016
PCB #169	0.012	0.014	0.019	0.018
PCB #153	12.3	14.6	19.5	19.4
PCB #138 + #158	8.5	9.4	13.0	12.3
PCB #187	nc	nc	nc	5.0
PCB #180	9.0	11.9	16.9	18.0
PCB #170	nc	4.5	7.0	7.3
Sum of PCBs (inc ½ LODs)[3]	168	177	178	188
Sum of PCBs (exc LODs)[3]	30.1	38.8	58.9	62.2
	Concentration, ng TEQ kg^{-1} lipid weight basis			
PCB TEQ (inc ½ LODs)[4]	6.10	6.00	5.70	5.80
PCB TEQ (exc LODs)[4]	2.00	2.10	1.90	2.00

1. Weighted means calculated using data only from the Lower North Island and South island regions and for the 15–24, 25–34 and 35–49 age groups (see text).
2. For any individual congener, calculation of the weighted mean includes half LOD values (see Section B1.9).
3. Sum of PCBs is the sum of all 42 targeted congeners analysed.
4. PCB TEQ is the TEQ calculated for the 10 dioxin-like PCB congeners analysed (see Section 4.4).

nc = Not calculated (mean concentration reported only if a congener was detected in more than 66% of strata for that ethnicity–sex group).

inc ½ LODs = Half the limits of detection were included in the sum of PCBs and the TEQ calculation.

exc LODs = Limits of detection were excluded from the sum of PCBs and the TEQ calculation, by setting LOD = 0.

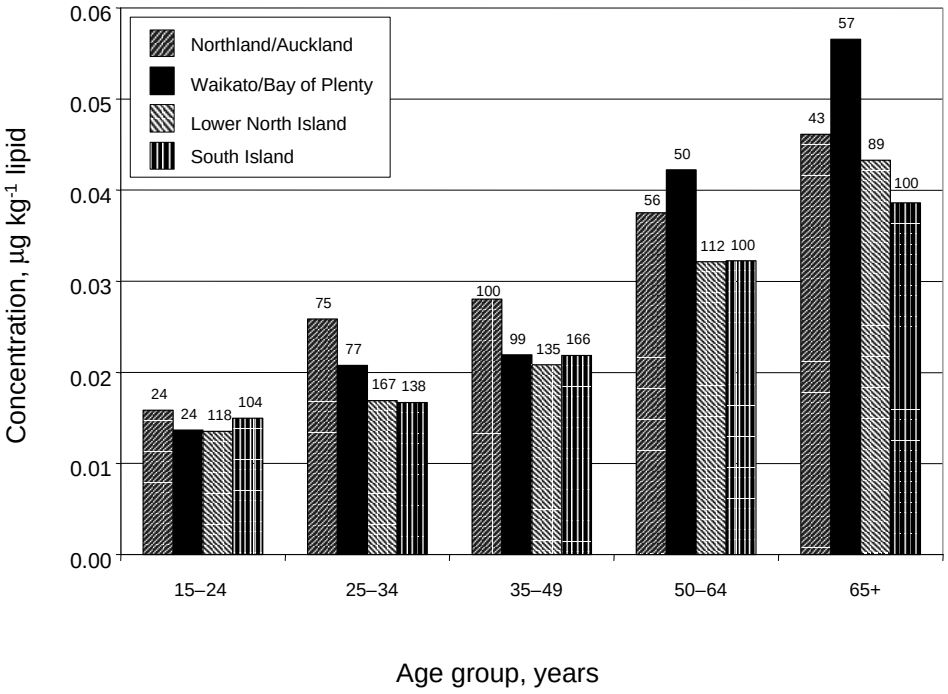

Figure 5.5 Mean concentrations of PCB #126 in serum, by age and geographic region
[For an explanation of the number at the top of each column, see Figure 5.1.]

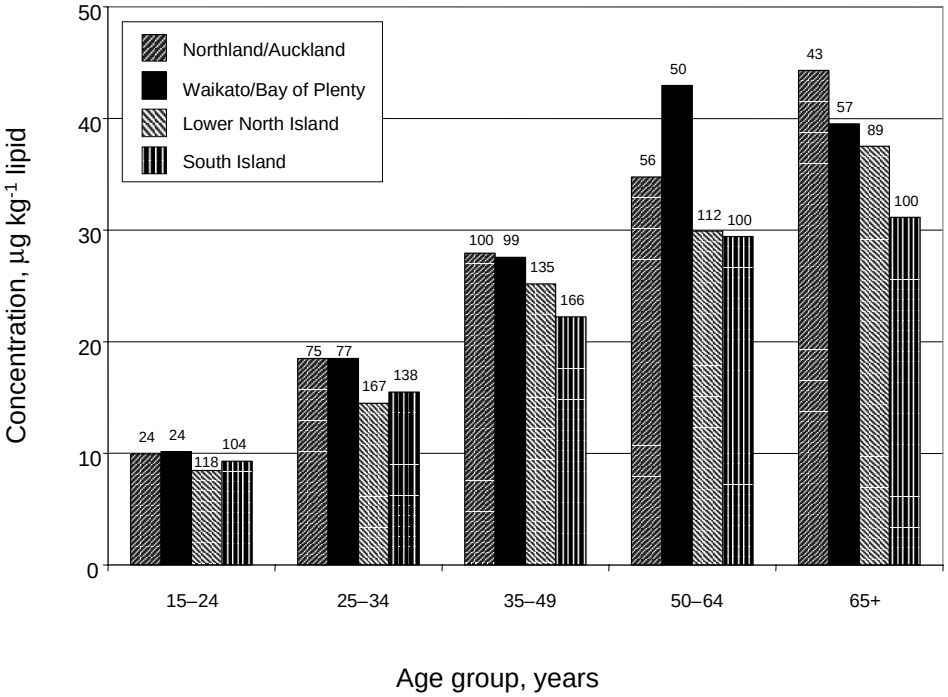

Figure 5.6 Mean concentrations of PCB #153 in serum, by age and geographic region
[For an explanation of the number at the top of each column, see Figure 5.1.]

There are no clear and consistent patterns evident from the data, although it would appear that the concentrations in males (Maori and non-Maori) tend to be similar, as do the concentrations in females (Maori and non-Maori). Furthermore, based on data assuming LODs = 0, for the three youngest age groups the sum of PCB congeners appears to be somewhat higher in males than in females. However, these seemingly higher concentrations in males are not reflected in PCB TEQ levels, indicating that those PCB congeners that are present in males at higher concentrations are not congeners considered to have dioxin-like toxicity and which have been assigned TEF values. When TEQs are calculated assuming LODs = 0, mean PCB concentrations are almost identical in all four ethnicity–sex groups for the adult population aged 15–49 years. Here, PCB TEQ levels ranged from 1.90 ng TEQ kg^{-1} lipid in Maori males to 2.10 ng TEQ kg^{-1} lipid in non-Maori females (Table 5.9).

Mean concentrations of PCBs in the four ethnicity–sex groups, by age, are presented in Figures 5.7 and 5.8.[10] In Figure 5.7, results are shown as PCB TEQ and include half LOD values for non-detected congeners, for comparability with Figure 5.2. In Figure 5.8, concentrations are expressed as the sum of PCB congeners, for which measurements lower than the LOD were set at zero (i.e. excluded from the summation). As for the comparison of Figures 5.3 and 5.4, the increase in PCB concentration with age is more apparent when data are expressed as the sum of congeners (Figure 5.8) than when they are expressed as PCB TEQ. The suggestion of higher PCB congener concentrations in males relative to females apparent in Table 5.9 is also evident in Figure 5.8. There are no other apparent consistent patterns in PCB concentrations in terms of the relationships among the four ethnicity–sex groups. However, as was observed with PCDDs and PCDFs (Figure 5.2), the PCB concentration in Maori females in the 50–64 age group appears unusually elevated. Again, this result is based on a single pooled sample made up of a minimal number (five) of individual serum samples, and cannot therefore be seen as representative.

Further analysis of the variation of PCB concentrations with age and ethnicity–sex is provided in Figures 5.9 and 5.10, for congeners #126 and #153 respectively. These figures use data from all 60 strata analysed. As noted earlier when assessing geographic variation (Figures 5.5 and 5.6), PCB #126 is a useful indicator of PCB TEQ and PCB #153 a useful indicator of the sum of PCB congeners. As before, these data are not affected by limit of detection results, as both these congeners were detected in every stratum.

Both Figures 5.9 and 5.10 show an increasing PCB concentration trend with age. Figure 5.10 also shows the mean concentrations for congener #153 to be marginally higher in males than in females, consistent with the results reported for the sum of PCB congeners (when LOD = 0) in Table 5.9 and Figure 5.8. In contrast, there is no apparent consistent difference in concentrations of PCB #126 between males and females across all age groups (Figure 5.9). A comparatively elevated concentration of PCB #126 is found in Maori females aged 50–64 years. However, as noted previously, as this result is from a single pooled serum sample prepared from only five individuals, it may not be truly representative of this age–ethnicity–sex population.

[10] Unlike the data reported in Table 5.9 (which, in calculating mean concentrations, uses results only from the Lower North Island and South Island regions for the three youngest age groups), Figures 5.7 and 5.8 are based on data from all 60 strata analysed.

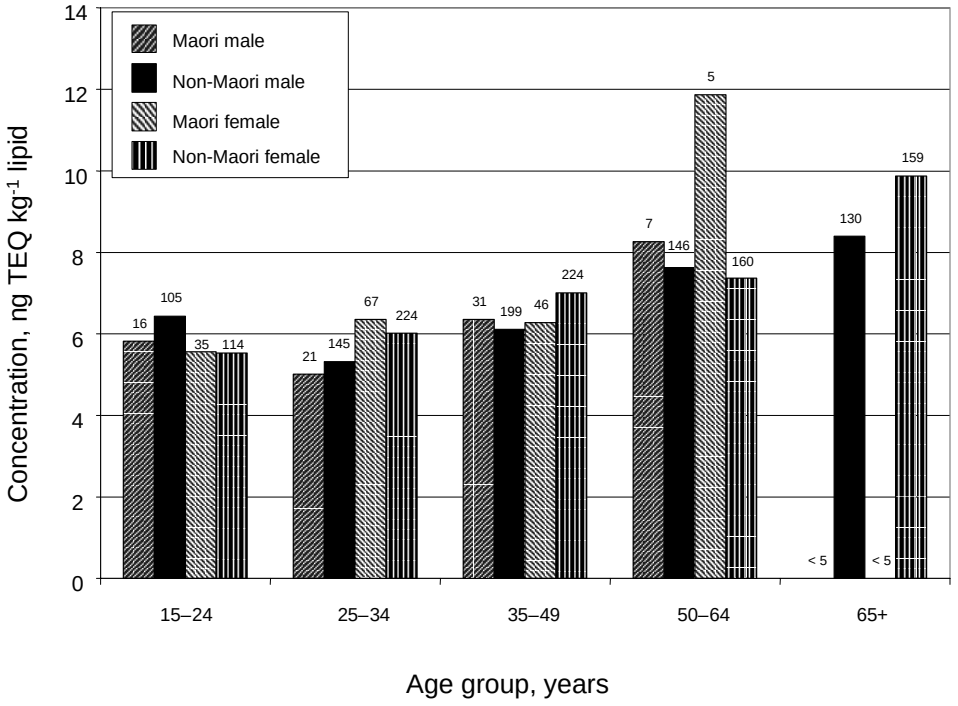

Figure 5.7 Mean PCB TEQ in serum, by age, ethnicity and sex
[For an explanation of the number at the top of each column, see Figure 5.2.]

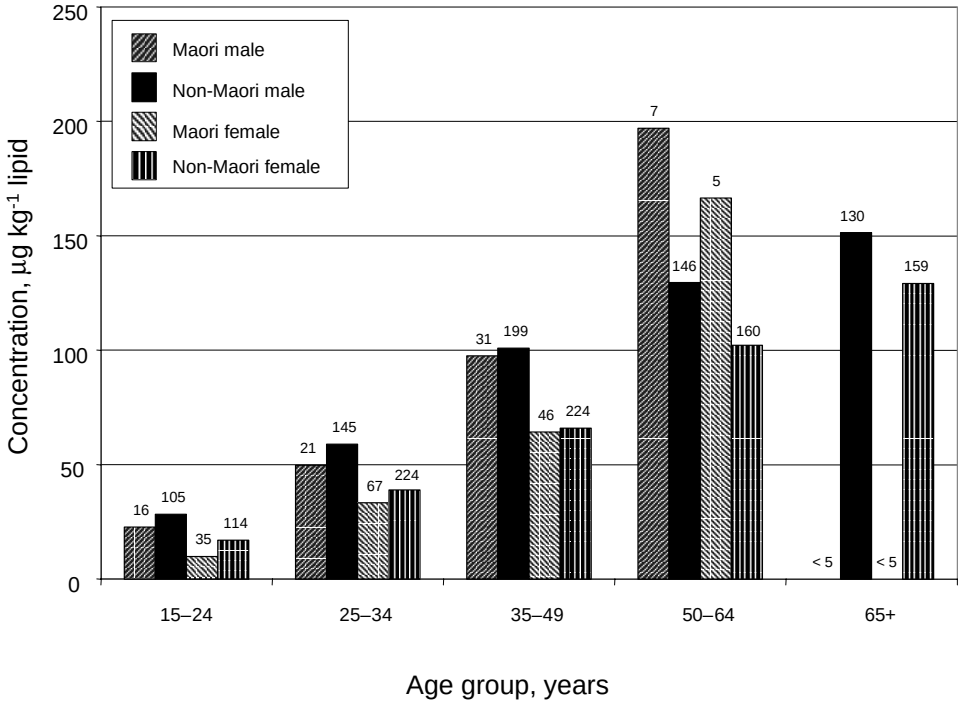

Figure 5.8 Mean sum of PCB congeners in serum, by age, ethnicity and sex
[For an explanation of the number at the top of each column, see Figure 5.2.]

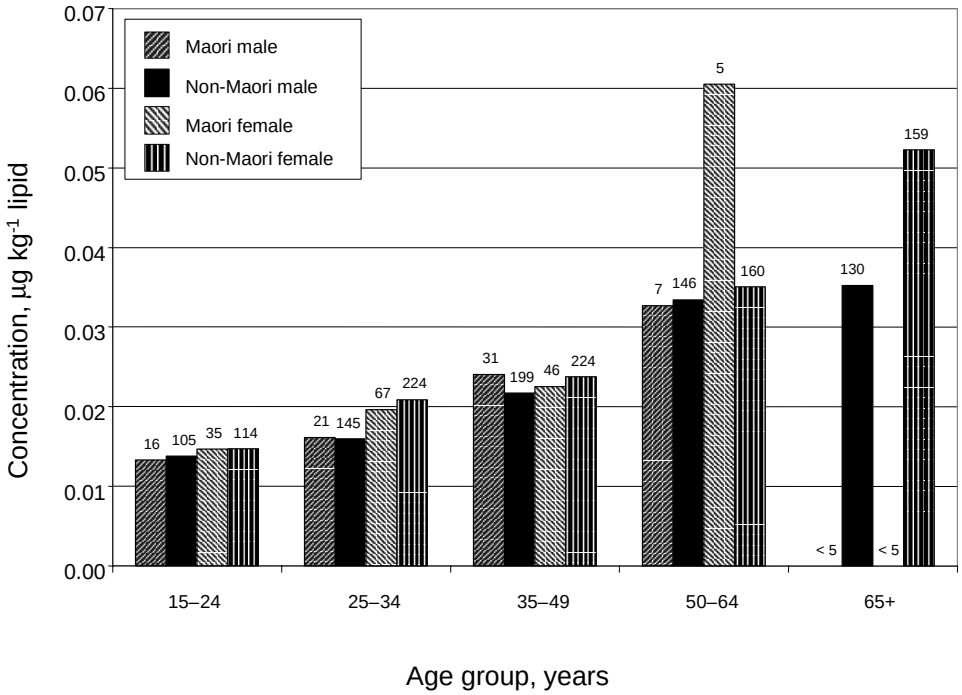

Figure 5.9 Mean concentrations of PCB #126 in serum, by age, ethnicity and sex
[For an explanation of the number at the top of each column, see Figure 5.2.]

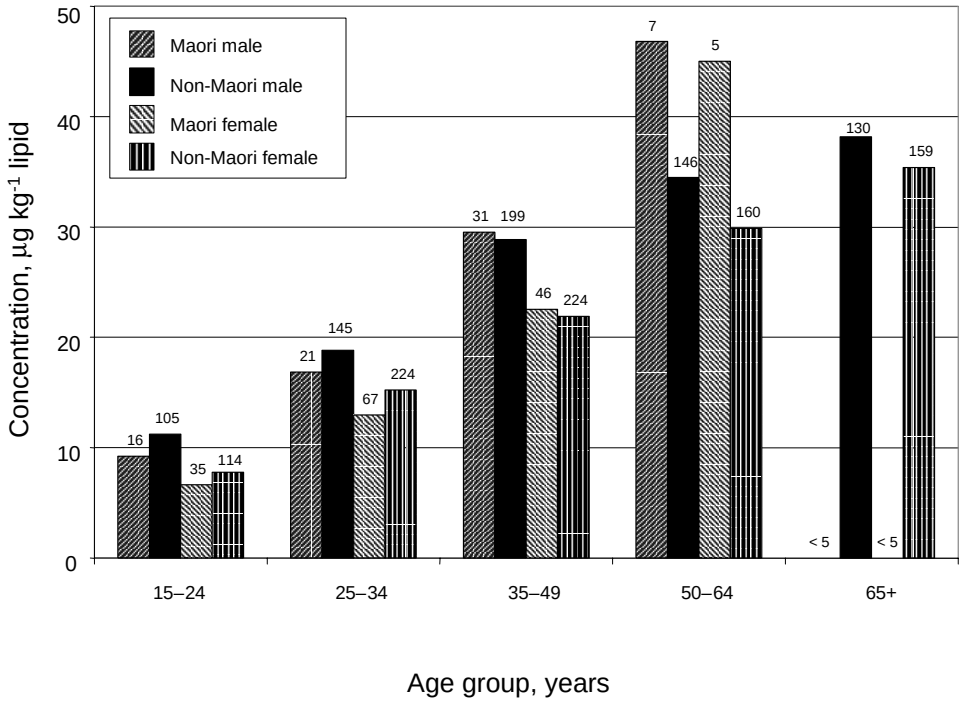

Figure 5.10 Mean concentrations of PCB #153 in serum, by age, ethnicity and sex
[For an explanation of the number at the top of each column, see Figure 5.2.]

There also appears to be a markedly higher concentration of PCB #126 in non-Maori females compared to non-Maori males for the 65+ age group (Figure 5.9). This observation is similar to the apparently higher PCDD and PCDF TEQ observed in non-Maori females aged 65+ years, relative to non-Maori males (Figure 5.2).

No comparison of PCB concentrations between Maori females and Maori males for the 65+ age group can be made, as there were insufficient serum samples collected from Maori aged 65+ to meet the eligibility criteria for inclusion in this study (see Appendix A, Section A5).

5.4 Organochlorine pesticides

Minimum, maximum, weighted median and weighted mean concentrations for organochlorine pesticides, including degradation products, across all strata are presented in Table 5.10. Limits of detection have been excluded from the mean calculation (i.e. for any pesticide, means were calculated using data only for strata that reported a quantified level of that pesticide). As noted earlier, median and mean results were calculated only if a pesticide was detected on more than 66% of occasions across all 60 strata analysed. Stratum-specific data are reported in Appendix F.

Table 5.10 Concentrations of organochlorine pesticides in the serum of New Zealanders

		Concentration, μg kg^{-1} lipid weight basis[1]			
Pesticide	**Number of positives**	**Minimum**	**Maximum**	**Weighted median**	**Weighted mean (n = 60)[2]**
β-HCH	40	< 7	73.1	10.7	19.7
γ-HCH	1	< 5	91.1	nc	nc
HCB	4	< 20	53.6	nc	nc
Aldrin	0	< 3	< 8	nc	nc
Dieldrin	57	< 8	28.4	11.5	14.2
Endrin	0	< 5	< 9	nc	nc
Heptachlor epoxide	0	< 3	< 8	nc	nc
Oxychlordane	0	< 3	< 8	nc	nc
t-Nonachlor	3	< 5	8.4	nc	nc
pp'-DDE	60	413	2780	919	1080
op'-DDT	0	< 10	< 20	nc	nc
pp'-DDT	18	< 20	49.2	nc	nc
Mirex	0	< 3	< 10	nc	nc

1. For any individual pesticide, calculation of the weighted median includes LOD values and calculation of the weighted mean excludes LOD values (see Appendix B, Section B1.9).
2. n = 59 for β-HCH, γ-HCH, aldrin, heptachlor epoxide, oxychlordane, t-nonachlor and op'-DDT
   n = 55 for endrin.

nc = Not calculated (median or mean concentration reported only if a congener was detected on more than 66% of occasions across all strata).

The most frequently detected pesticides were pp'-DDE (detected in all 60 strata), dieldrin (57 strata), β-HCH (40 strata) and pp'-DDT (18 strata). All of the other pesticides were either not detected, or detected on less than 10% of occasions (i.e. detected in less than six strata).

In the following discussion, the analysis of pesticide concentration data are limited to β-HCH, dieldrin, and pp'-DDE, which were the only pesticides detected on more than 66% of occasions

across all strata. The mean concentrations of these pesticides for each of the five age groups are reported in Table 5.11. These data summarise results for all 60 strata analysed. For dieldrin and pp'-DDE there is a tendency for increasing concentration with age. No such age-related increase is observed with β-HCH, although any trend may be obscured because this pesticide was only infrequently detected in the two youngest age groups. When the β-HCH concentration data are analysed by geographic region, an age-related trend is apparent (Figure 5.11).

Table 5.11 Weighted mean concentrations of organochlorine pesticides in serum, by age

	Concentration, µg kg^{-1} lipid weight basis[1]				
Pesticide	**15–24 yrs**	**25–34 yrs**	**35–49 yrs**	**50–64 yrs**	**65+ yrs**
β-HCH	nc	nc	24.9	18.2	24.0
Dieldrin	10.8	11.5	12.0	16.1	22.4
pp'-DDE	646	771	1060	1310	1780

1. For any individual pesticide, calculation of the weighted mean excludes LODs (see Section B1.9).
nc = Not calculated (mean concentration reported only if a pesticide was detected in more than 66% of strata for that age group).

The mean concentrations of β-HCH, dieldrin, and pp'-DDE for each of the four geographic regions are reported in Table 5.12. This summary again excludes certain Maori age groups, for the same reasons outlined in Section 5.2. No consistent pattern emerges, although β-HCH appears to be particularly high in the Northland/Auckland region, at a concentration of 31.9 µg kg^{-1} lipid, and there is a markedly increasing north–south trend for pp'-DDE, from a concentration of 777 µg kg^{-1} lipid in Northland/Auckland to 1230 µg kg^{-1} lipid in the South Island.

Table 5.12 Weighted mean concentrations of organochlorine pesticides in serum, by geographic region[1]

	Concentration, µg kg^{-1} lipid weight basis[2]			
Pesticide	**Northland/ Auckland**	**Waikato/ Bay of Plenty**	**Lower North Island**	**South Island**
β-HCH	31.9	13.5	16.2	20.3
Dieldrin	13.9	13.9	14.2	14.4
pp'-DDE	777	993	1150	1230

1. Weighted means calculated excluding data from the following strata: Maori males age groups 15–24, 25–34, 50–64, 65+; and Maori females 50–64 and 65+ (see text).
2. For any individual pesticide, calculation of the weighted mean excludes LODs (see Section B1.9).

Mean concentrations of β-HCH, dieldrin and pp'-DDE, stratified by age and geographic region, are presented in Figures 5.11, 5.12 and 5.13, respectively.[11]

[11] Unlike the data reported in Table 5.12 (which, in calculating mean concentrations, omits some ethnicity–sex data for some age groups), Figures 5.11, 5.12 and 5.13 are based on data from all strata that reported a quantified level of β-HCH, dieldrin and pp'-DDE (i.e. for β-HCH, Figure 5.11, n = 40; for dieldrin, Figure 5.12, n = 57; for pp'-DDE, Figure 5.13, n = 60).

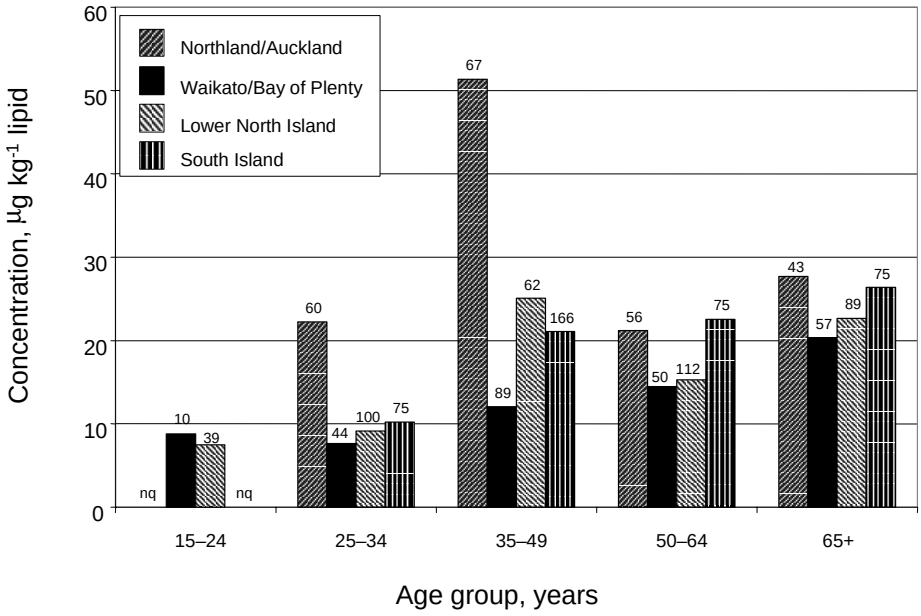

Figure 5.11 Mean concentrations of β-HCH in serum, by age and geographic region
[For an explanation of the number at the top of each column, see Figure 5.1. nq = no β-HCH quantified in any pooled sample from this geographic region for this age group.]

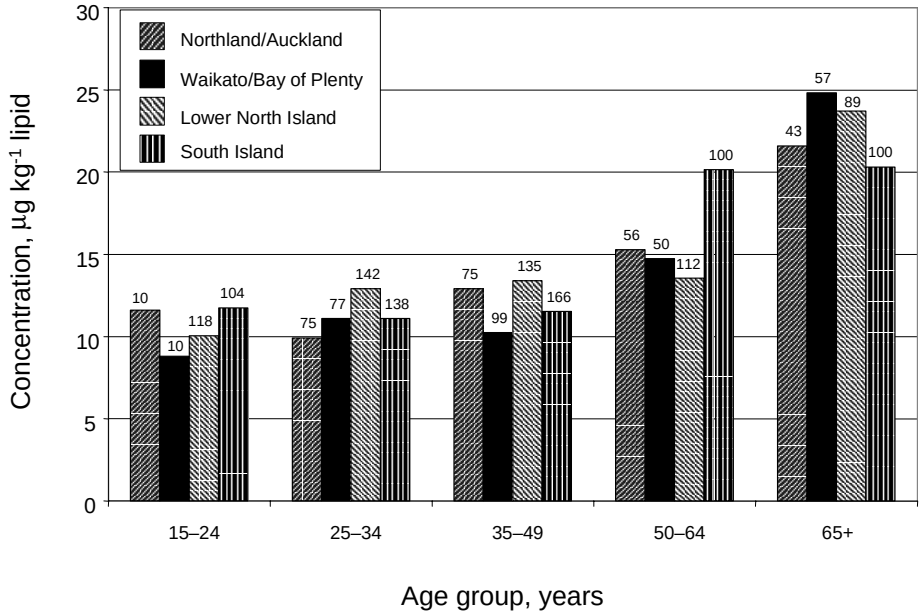

Figure 5.12 Mean concentrations of dieldrin in serum, by age and geographic region
[For an explanation of the number at the top of each column, see Figure 5.1.]

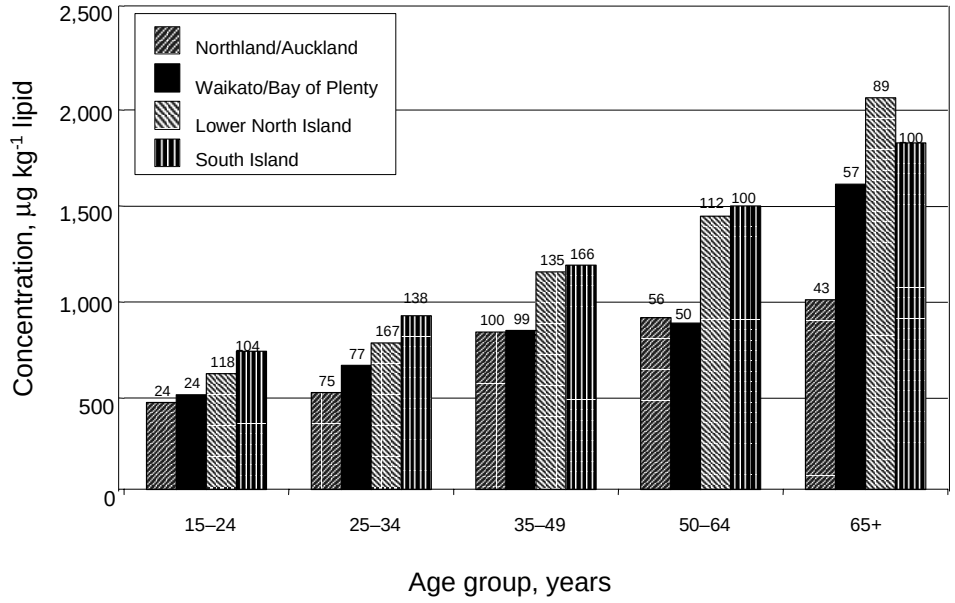

Figure 5.13 Mean concentrations of pp'-DDE in serum, by age and geographic region
[For an explanation of the number at the top of each column, see Figure 5.1.]

The mean concentration of β-HCH for Northland/Auckland in the 35–49 age group appears elevated in comparison with the other regions (Figure 5.11). This is not accounted for by a small number of contributing serum samples. Nevertheless, there is, overall, a general trend of increasing concentration with age. For dieldrin (Figure 5.12), mean concentrations are roughly similar across the first three age groups, but then increase in the 50–64 age group and even more so in the oldest age group.

Concentrations of pp'-DDE in serum generally increased with age, as illustrated in Figure 5.13. As was observed from the data reported in Table 5.12, there is a tendency for concentrations to increase in a north–south direction. This north–south trend is evident in all five age groups. Such a geographic variation is consistent with the observation of higher pp'-DDE concentrations in the breast milk of South Island (Christchurch and Canterbury) women relative to concentrations in the breast milk of women living in the upper North Island (Northland and Auckland) as previously reported by Bates *et al*. (1994; 2001).

Mean concentrations of β-HCH, dieldrin, and pp'-DDE stratified by ethnicity and sex are reported in Table 5.13. As discussed earlier for the PCDDs, PCDFs (Section 5.2) and PCBs (Section 5.3), mean concentrations are based only on those age groups and regions for which there were data available for each of the four Maori/non-Maori and male/female categories, and, therefore, concentrations appear lower than concentrations shown in other tables and figures. Nevertheless, on average, when considered across the three youngest age groups, concentrations of pp'-DDE appear to be marginally higher in males than in females, whilst concentrations of dieldrin in males and females are roughly similar.

Table 5.13 Weighted mean concentrations of organochlorine pesticides in serum, by ethnicity and sex[1]

	Concentration, µg kg^{-1} lipid weight basis[2]			
	Female		Male	
Pesticide	Maori	Non-Maori	Maori	Non-Maori
β-HCH	nc	9.4	nc	21.0
Dieldrin	14.6	10.9	13.5	11.7
pp'-DDE	920	782	1110	1080

1. Weighted means calculated using data only from the Lower North Island and South Island regions and for the 15–24, 25–34 and 35–49 age groups (see text).
2. For any individual pesticide, calculation of the weighted mean excludes LODs (see Section B1.9).

nc = Not calculated (mean concentration reported only if a pesticide was detected in more than 66% of strata for that ethnicity–sex group).

Mean concentrations of β-HCH, dieldrin and pp'-DDE in the four ethnicity–sex groups, by age, are presented in Figures 5.14, 5.15 and 5.16 respectively.[12] Again, there is evidence of a trend of increasing concentration with age for all three compounds. For β-HCH, non-Maori males in the 35–49 age group had a mean concentration across all geographic regions that was clearly elevated compared to other age groups (Figure 5.14). This cannot be explained on the basis of a small number of contributing serum samples, and no reason for this elevated concentration is known.

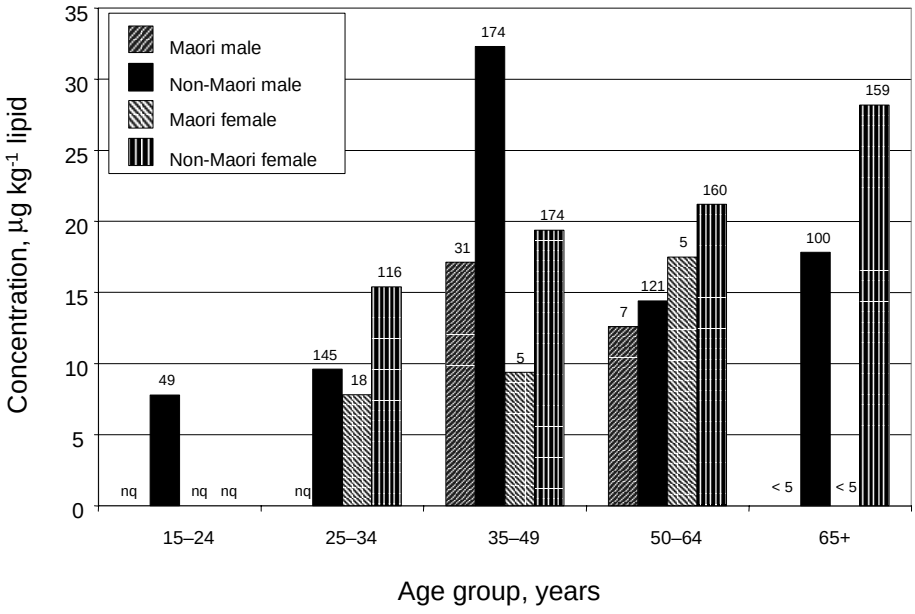

Figure 5.14 Mean concentrations of β-HCH in serum, by age, ethnicity and sex
[For an explanation of the number at the top of each column, see Figure 5.2. nq = no β-HCH quantified in any pooled sample from this age–ethnicity–sex grouping.]

12 Unlike the data reported in Table 5.13 (which presents results only from the Lower North Island and South Island regions for the three youngest age groups), Figures 5.14, 5.15 and 5.16 are based on data from all strata that reported a quantified level of β-HCH, dieldrin and pp'-DDE (i.e. for β-HCH, Figure 5.14, n = 40; for dieldrin, Figure 5.15, n = 57; for pp'-DDE, Figure 5.16, n = 60).

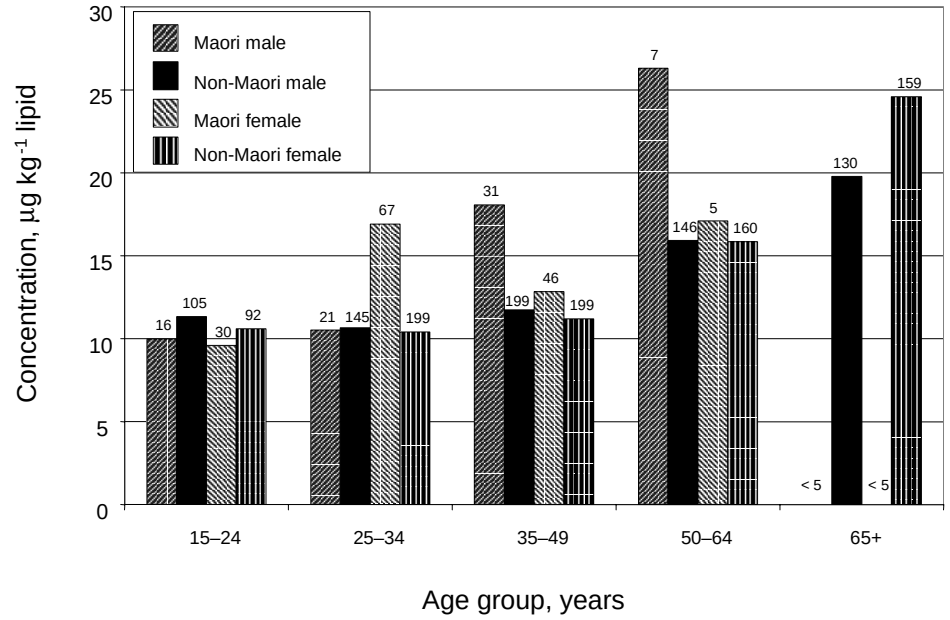

Figure 5.15 Mean concentrations of dieldrin in serum, by age, ethnicity and sex
[For an explanation of the number at the top of each column, see Figure 5.2.]

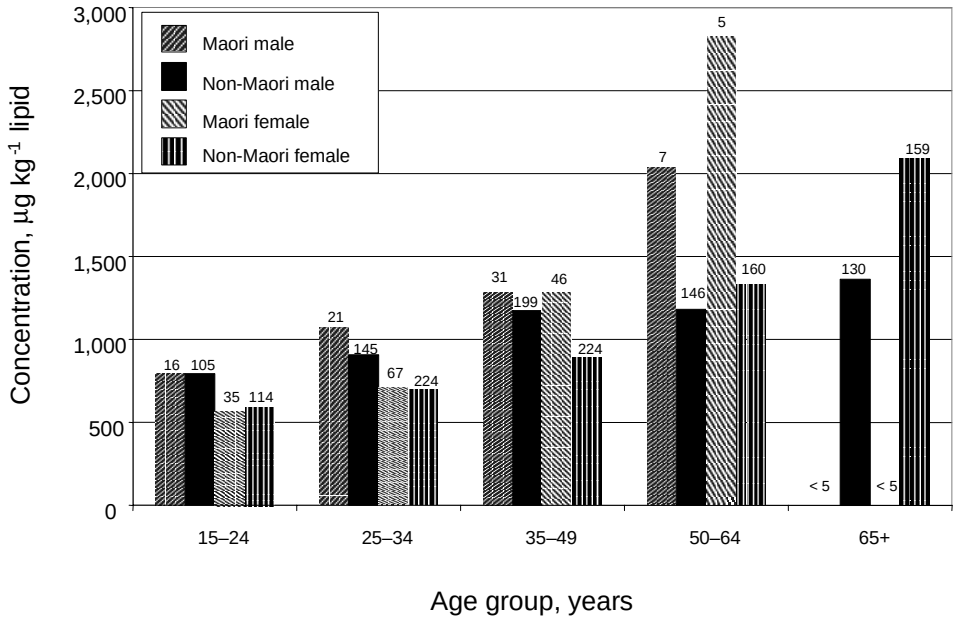

Figure 5.16 Mean concentrations of pp'-DDE in serum, by age, ethnicity and sex
[For an explanation of the number at the top of each column, see Figure 5.2.]

A comparatively elevated β-HCH concentration was also observed for the 35–49 age group in the Northland/Auckland region (Figure 5.11). However, in this case, the elevated concentration was due to higher β-HCH levels in both non-Maori males and non-Maori females.

Aside from the age-related trend, there are no consistent patterns for dieldrin or pp'-DDE concentrations within the age groups with respect to ethnicity and sex. Although the mean concentration of dieldrin for Maori males in the 50–64 age group is higher than the mean concentrations for other ethnicity–sex groupings in this age category, this result is based on a total of only seven individual serum samples in the pooled sample analysed. Similarly, Maori males and Maori females had higher mean concentrations of pp'-DDE in the 50–64 age group. Again, however, these results are based on small numbers of contributing serum samples. Because of the limited number of individuals included in these serum pools analysed, it is uncertain whether the mean concentrations shown in Figures 5.15 and 5.16 are typical of the serum levels that may be present in the general Maori population aged 50–64 years. The suggestion from the mean concentration data reported in Table 5.13 that pp'-DDE concentrations are higher in males compared to females is only apparent when the data are considered across the younger age groups (Figure 5.16). When the data for the two oldest age groups are considered, the opposite would appear to be the case, with mean pp'-DDE concentrations being higher in females than in males.

5.5 Estimate of inter-pool variance

Estimates of standard errors calculated for PCDDs, PCDFs, PCBs and organochlorine pesticides for those strata for which more than one pooled sample was analysed are reported in Appendix G. The estimated standard errors are for pooled samples, and may be used to make comparisons between strata. However, such comparisons should be made with caution, as the estimated standard errors are each based on only two or three mean concentrations in pooled samples, each containing 25 individual serum samples.

The standard deviation for the pooled sample results may be calculated by multiplying the standard error for the pooled samples by the square root of the number of pools involved in the calculation (2 or 3, depending on the stratum). Estimates of the standard deviations for the range of *individual sample* measurements within strata may be calculated by multiplying the stratum-specific standard deviation by the square root of the number of individual sample measurements that made up each of the pooled samples.

Standard errors were calculated as follows:

$$\text{Standard error} = \sqrt{\frac{\sum_{i=1}^{n}(c_i - \bar{c})^2}{n(n-1)}}$$

Where: n = number of analyte values
c_i = the *i*th analyte concentration
$\bar{c}$ = average analyte concentration

Standard deviations for pooled sample results may be calculated by multiplying the standard errors by the square root of n, the number of pools contributing (n = 2 or 3). An estimate of the standard

deviation for individual samples can then be calculated by multiplying that figure by 5 (from the square root of 25).

From the standard error estimates for the pooled samples, coefficients of variation of the mean (CV_M) were calculated as follows:

$$CV_M = \frac{\text{Standard error}}{\text{Mean}}$$

Coefficients of variation of the mean for the pooled samples are reported in Table 5.14 for the PCDDs, PCDFs, PCBs, β-HCH, dieldrin and pp'-DDE. Congener-specific data reported for the PCDDs, PCDFs, and PCBs are for those congeners that were most frequently detected and/or made the greatest contribution to the TEQ level or sum of congener result.

Table 5.14 Coefficients of variation of the mean for selected organochlorine contaminants from analysis of pooled serum samples

Organochlorine	Coefficient of variation, %	
	Range	Median value
2,3,7,8-TCDD	4–29	11
1,2,3,7,8-PeCDD	0–18	7
1,2,3,6,7,8-HxCDD	2–26	11
1,2,3,4,6,7,8-HpCDD	4–33	10
OCDD	0.2–32	10
2,3,4,7,8-PeCDF	0.8–14	9
PCDD/F TEQ (inc ½ LODs)	1–19	7
PCB #126	2–24	12
PCB #169	0–12	8
PCB #153	1–24	6
PCB #138 + #158	0.3–23	8
PCB #180	0.5–18	6
Sum of PCBs (exc LODs)	1–29	8
β-HCH	2–42	10
Dieldrin	3–31	8
pp'-DDE	2–25	11

From this data, the following observations can be made.

1. There is good analytical precision for the methods used in the current study for the determination of organochlorine contaminants. This observation is supported by the coefficient of variation data obtained from replicate analysis of a serum quality control data (Appendix B, Tables B7 and B8).
2. Recognising that the data are a measure of the variability between *pooled* samples, and as such are only indicative of the variability between *individual* samples, for those organochlorine contaminants that were frequently detected, the coefficients of variation suggest a high degree of homogeneity in contaminant concentrations between the individual samples from which the pooled samples were prepared.

6 Assessment of the New Zealand exposure data

A consistent trend found throughout the results of this study was a tendency for serum concentrations to increase progressively with age. This was apparent with the PCDDs and PCDFs, the PCBs, and the organochlorine pesticides, especially dieldrin and pp'-DDE. In theoretical terms, one would expect that, given constant exposure over a long period, levels would plateau and stay fairly constant from the point at which the level of excretion equalled the level of absorption (i.e. once a steady state had been reached). There is uncertainty about the half-lives in humans of many of the chemicals studied. However, one chemical that has been extensively investigated, and for which a number of estimates of the half-life exist, is 2,3,7,8-TCDD. Half-life estimates for this chemical range from several years to several decades, with typically a value of 7.5 years being quoted.[13] Assuming a half-life of 7.5 years, and given constant exposure to TCDD, it can be calculated that the body burden (as reflected in serum concentrations) would plateau at about age 30–40 years, or after four to five half-lives. Such a plateauing has not been observed in the current study. For example, of the five age groups used in this study, weighted mean serum concentrations of 2,3,7,8-TCDD in non-Maori, with increasing age, were 1.0, 1.4, 2.0, 3.1, and 4.6 ng kg^{-1} lipid. On a TEQ basis, weighted mean PCDD and PCDF concentrations for the five age groups were 6.69, 9.27, 12.6, 16.1 and 20.7 ng TEQ kg^{-1} lipid (Table 5.3).

The absence of a plateau would suggest that earlier exposures to all the chemicals investigated was higher than in more recent time periods. However, to explain the monotonic increasing trends found, such earlier exposures would have needed to be much higher than the more recent exposures. Evidence for higher historical exposures to organochlorines comes from the results of a recently published study of organochlorine levels in the breast milk of New Zealand women. This study found that over a 10 year period from 1988 to 1998, concentrations of PCDDs, PCDFs, PCBs and some organochlorine pesticides in breast milk fell by as much as 70% (Bates *et al*., 2001). This finding is consistent with results of studies in other countries, which have shown that population exposures to organochlorines have fallen in the preceding two decades (Liem *et al.*, 2000; Päpke, 1998; Wittsiepe *et al.*, 2000).

An alternative explanation for the monotonic trend may be that there is variation in half-life by age, such that excretion slows down as people get older. What is known about half-lives of organochlorines in humans, particularly for TCDD, is based on studies that have investigated exposed populations of workers and younger people (Smith and Lopipero, 2001). The assumption has generally been made that results obtained for such groups can be generalised across the entire population, but this may not be so. If the mechanisms in the human body for the elimination of persistent organochlorine chemicals are common to the range of these chemicals, then changes in these mechanisms with age might produce the observed results.

Also noted in this study were indications of geographic variations in serum concentrations of some of the organochlorines investigated. In particular, PCDDs, PCDFs and PCBs were generally marginally higher in the northern study regions than in the two southern-most regions (Figures 5.1, and 5.3 to 5.6). This may be a reflection of the higher population density and level of industrialisation in the north of New Zealand, relative to the south.

[13] For a more detailed discussion of TCDD half-life, see Smith and Lopipero, 2001.

The reverse pattern was found with pp'-DDE, for which concentrations were higher in the south than in the north. This observation of a north–south trend for pp'-DDE is consistent with other New Zealand population exposure studies. In a 1988 study of organochlorines in the breast milk of New Zealand women, higher levels of pp'-DDE were found in South Island (Christchurch and Canterbury) women, compared with women living in the upper North Island (Northland and Auckland). This was considered to reflect the relative historical levels of use of DDT for control of grass grub (*Costelytra zelandica*) (Bates *et al*., 1994). A similar result has again been found in a repeat breast milk study, undertaken in 1998 in the same regions, although the differences in concentrations between the South Island and upper North Island were not as great as found in the original 1988 study (Bates *et al*., 2001). In addition to the relative historical differences in DDT use, a further explanation that may explain the north–south trend observed for pp'-DDE is the process of continual volatilisation and condensation from warmer to colder climates. The terms 'global fractionation' and the 'grasshopper effect' are often used to refer to the way chemicals move to colder climates, and ultimately polar regions, in this manner (Bidleman, 1999; Wania and Mackay, 1993; 1995; 1996).

No general differences in serum concentrations between the sexes or between Maori and non-Maori were noted. However, there was some evidence that women in the highest age group tended to have higher serum concentrations than men in the same age group. This was particularly evident for PCDDs and PCDFs (when measured as TEQ; Figure 5.2), PCB #126 (Figure 5.9) and for β-HCH, dieldrin and pp'-DDE (Figures 5.14 to 5.16). The possibility that this might be accounted for by women in this age group being, on average, older than the men was considered. However, the average ages of men and women in this age category were identical (72.9 years in both groups). If there are changes in elimination mechanisms associated with aging, it is also possible that these changes vary with sex, such that the rate of elimination is slower in older women relative to older men. No further data are available to develop this hypothesis, and this observation warrants further investigation.

Because the chemical analyses were carried out on pooled samples, an effort was made to identify and exclude anyone who was likely to have had occupational exposure to any of the chemicals being investigated. This was to minimise the possibility that inclusion of serum samples from such people in a pooled serum sample could have produced a result that was not truly representative for that particular stratum. A minimum number of five serum samples in a pooled sample was also required to further attempt to minimise the likelihood of non-representative results. Despite these efforts, some of the results obtained suggest that the study protocols may not have succeeded in entirely eliminating unusually highly exposed people from the study population. For example, in the pooled sample representing Maori women aged 50–64 from the Lower North Island, PCDD and PCDF TEQ, PCB #126, and, to a lesser extent, PCB TEQ are all elevated above what might be expected based on a comparison with the other strata. This is illustrated for the PCDDs and PCDFs in Figure 5.2, for the PCBs in Figures 5.7 and 5.8 and for PCB #126 in Figure 5.9. The pooled sample that generated the results for this stratum contained serum from only five individuals. It is most likely that the elevated levels are the result of comparatively higher concentrations in the serum of an individual woman contributing to the pooled sample. However, whether these higher PCDD and PCDF concentrations are associated with historical exposure to PCBs is unclear. PCBs were primarily contaminated with PCDFs rather than PCDDs, and the PCDF concentrations in the pooled sample were not unduly elevated. The increase in PCDD and PCDF TEQ for this stratum is

driven by comparatively higher concentrations relative to other strata of two PCDD congeners, namely 2,3,7,8-TCDD and 1,2,3,7,8-PeCDD.

Other results, such as the relatively high concentrations of β-HCH in non-Maori males and females aged 35–49 living in Northland/Auckland (Figure 5.11, and Appendix F, Table F6) and in non-Maori males in the same age group from the Lower North Island and South Island regions (Figure 5.14, and Appendix F, Table F6), are not as easily explained by small numbers of contributors to serum pools. It is possible that these results represent a population that was, at some point, subject to comparatively higher exposures to β-HCH relative to other New Zealanders of the same age, although it is not clear why that would have been the case.

This study has succeeded in characterising the concentrations of a range of persistent organochlorine compounds across the non-occupationally exposed New Zealand population aged 15 years and older. It is believed to be the first time such a study has been carried out for PCDD, PCDF and PCB contaminants on a sample representative of an entire national adult population.

6.1 Ministry of Health breast milk study

The Ministry of Health has recently released the results of a study on the concentrations of PCDDs, PCDFs, PCBs and organochlorine pesticides in the breast milk of New Zealand women (Bates *et al*., 2001). As the samples for this breast milk study were collected during the period October 1998 to May 1999, comparable to the sampling dates for the current serum study (December 1996 to November 1997), it is useful to compare the results of these two independent exposure studies. A summary of results from both these studies is provided in Table 6.1.

Table 6.1 Comparative concentrations of organochlorines in serum and breast milk from New Zealand women

Organochlorine	Serum study[1]	Breast milk study[2]
	Mean concentration, ng TEQ kg^{-1} lipid weight basis	
PCDD/F TEQ (inc ½ LODs)	8.6	6.3
PCDD/F TEQ (exc LODs)	8.5	6.2
PCB TEQ (inc ½ LODs)	5.9	4.2
PCB TEQ (exc ½ LODs)	2.0	3.1
	Mean concentration, µg kg^{-1} lipid weight basis	
Sum of PCBs (inc ½ LODs)[3]	164	46.1
Sum of PCBs (exc LODs)[3]	30.2	45.3
β-HCH	12.6	16.3
Dieldrin	11.4	15.4
pp'-DDE	661	626

1. Weighted mean across all regions, Maori and non-Maori women, for the 15–24 and 25–34 age groups.
2. Mean concentration across all four centres (Auckland, Christchurch, Northland and Canterbury).
3. Sum of 42 congeners for the serum study and sum of 34 congeners for the breast milk study; 24 congeners were common to both studies.

inc ½ LODs = Half the limits of detection were included in the TEQ calculation and the sum of PCBs.
exc LODs = Limits of detection were excluded from the TEQ calculation and the sum of PCBs, by setting LOD = 0.

The breast milk study collected samples from first-time mothers from two urban centres (Auckland [n = 20] and Christchurch [n = 15]) and two rural centres (Northland [n = 16] and Canterbury [n = 2]). The average age of mothers, across all samples, was 26.8 years. As this mean age is at the lower end of the 25–34 age group used in the serum study, and because contaminant concentrations have been shown to increase markedly with age, the mean concentrations for women in the 15–24 and 25–34 age groups in the serum study are considered to be the most equivalent to the data from the breast milk study for comparative purposes.

Although the two studies analysed for a different suite of individual PCB congeners (42 congeners in the serum study, and 34 congeners in the breast milk study), 24 of the target congeners were common to both. These 24 PCB congeners, which are the congeners most commonly detected in human tissue, contributed on average greater than 95% of the concentrations measured for the sum of PCBs for both studies.

With the exception of the serum study result for the sum of PCB congeners that includes half LOD values (which, as discussed in Section 5, is markedly affected by the non-detected congeners), there is excellent overall agreement in the concentrations of organochlorines determined in the two media when reported on a lipid weight basis. This is consistent with findings in the international literature, which report an equilibrium of organochlorine contaminant concentrations between various lipid-containing matrices (Kanja *et al*., 1992; Patterson *et al*, 1988; Pauwels *et al*., 2000)

6.2 Comparison with international data

To assist in the interpretation of the organochlorine concentration data found in the current study, it is useful to know how these concentrations compare with data on non-exposed populations in other countries. Care must be taken, however, in making such comparisons, because no two studies are ever alike. Studies may vary in terms of design, data reporting, etc, and these variations may mask or heighten *real* differences in results between the studies.

This section summarises graphically the New Zealand concentration data and comparable overseas data for the PCDDs and PCDFs (Figure 6.1), the PCBs (Figures 6.2 and 6.3) and the organochlorine pesticide metabolite pp'-DDE (Figure 6.4).

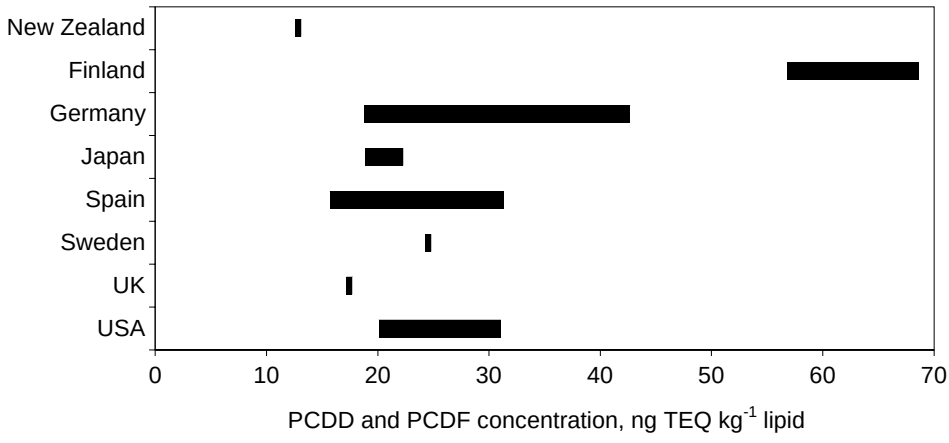

Figure 6.1 Comparative mean concentrations of PCDDs and PCDFs in non-exposed populations from various countries
[Reproduced from Figure H1, Appendix H.]

The comparative data on which Figures 6.1 to 6.4 are based are tabulated and reviewed in Appendix H. The findings of the comparisons of the New Zealand and overseas data are also discussed in this appendix.

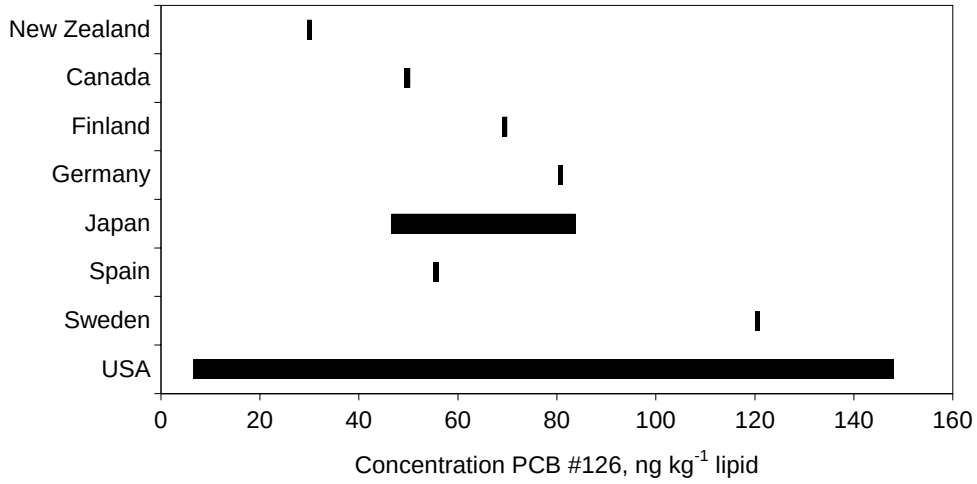

Figure 6.2 Comparative mean concentrations of PCB #126 in non-exposed populations from various countries
[Reproduced from Figure H2, Appendix H.]

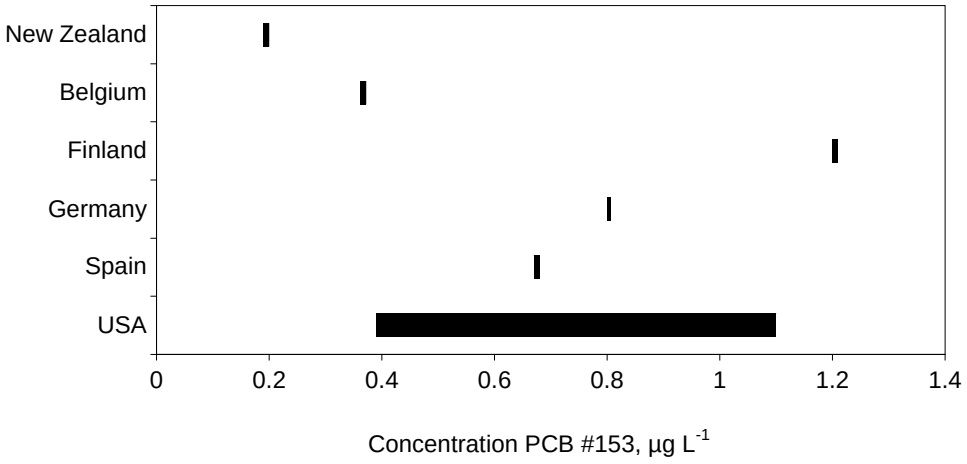

Figure 6.3 Comparative mean concentrations of PCB #153 in non-exposed populations from various countries
[Reproduced from Figure H3, Appendix H.]

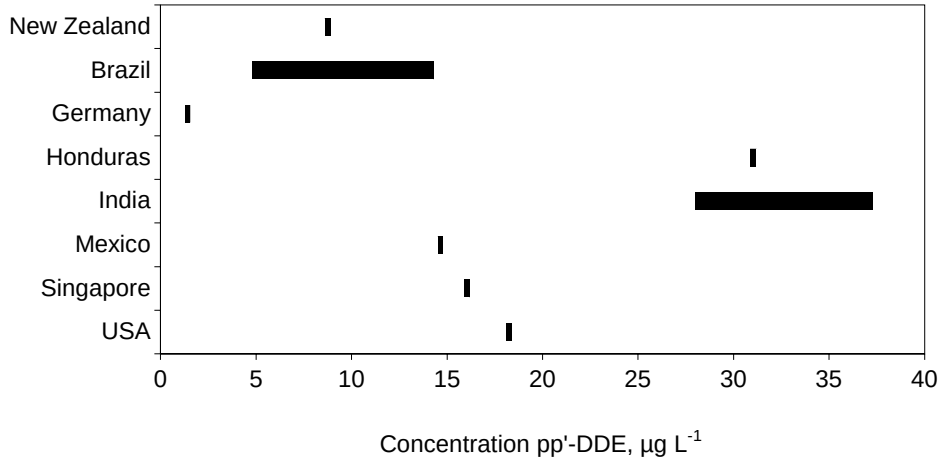

Figure 6.4 Comparative mean concentrations of pp'-DDE in non-exposed populations from various countries
[Reproduced from Figure H4, Appendix H.]

In summary, from a comparison of the New Zealand exposure data with the overseas data presented in Appendix H, the following conclusions can be drawn.

1. The concentrations of PCDDs and PCDFs in the serum of adult New Zealanders tend to be towards the lower end of the range, particularly for the younger age groups, when compared to other developed countries.

2. The concentration of PCBs in the serum of New Zealanders appears to be at the low end of the concentration range relative to the levels found in other developed countries.

3. The comparatively lower concentrations of PCDDs, PCDFs and PCBs in the adult population are consistent with New Zealand's lower environmental levels of these contaminants relative to more industrialised countries.

4. The concentrations of the three pesticides that were routinely detected in the current study (pp'-DDE, dieldrin and β-HCH) were variable relative to the available international data. Concentrations of β-HCH in adult New Zealanders are at the low end of the range of concentrations reported for overseas populations. In contrast, concentrations of pp'-DDE in the New Zealand population are generally comparable to the concentrations measured in overseas populations, being, *in most cases*, neither markedly higher nor markedly lower. For dieldrin, there were insufficient overseas data available for this pesticide for any meaningful comparison with the New Zealand exposure data to be made.

It should be noted that when comparing pesticide residue levels, there is a qualitative difference to such comparisons for the PCDDs, PCDF and PCBs. Residues of the PCDDs, PCDFs and PCBs tend to reflect levels of pollution and industrialisation, whereas levels of pesticides or their metabolites, such as pp'-DDE, are likely to reflect local use patterns, at least historically.

6.3 Overall findings of the New Zealand serum study

This study represents the first ever cross-sectional survey of concentrations of PCDDs, PCDFs, PCBs and organochlorine pesticides in a representative sample of the non-occupationally exposed adult New Zealand population. It is believed to be, at least for the PCDDs, PCDFs and PCBs, the first truly national survey of its kind ever undertaken by any country. The study has provided important data against which future serum surveys can be compared, either to monitor temporal trends in concentrations at a national or regional level, or for the assessment of exposed or potentially exposed sub-populations.

The serum study made the following findings.

1. PCDD, PCDF and PCB congeners were consistently detected across all ages, geographic regions, sex and ethnic groups. Three pesticides (including degradation products) were also consistently detected: β-HCH, dieldrin and pp'-DDE. Of these, pp'-DDE was quantified at concentrations typically 50 to 100 times the level found for any other pesticide.
2. There was a consistent trend of increasing organochlorine concentrations with age.
3. There were no *consistent* differences in contaminant concentrations between Maori and non-Maori or between males and females. Some variation in organochlorine concentrations between males and females for the oldest age group (65+ years) was observed, as was variation in the concentrations of the sum of PCB congeners, which tended to be marginally higher in males than in females for all age groups.
4. There were some regional differences in organochlorine concentrations:
    - PCDD, PCDF and PCB concentrations appeared to be marginally higher in the two upper North Island regions (Northland/Auckland and Waikato/Bay of Plenty) relative to the two more southern regions (Lower North Island and South Island); these differences may reflect the higher population density and level of industrialisation in the north of the country
    - pp'-DDE concentrations increased markedly in a north–south direction; this may reflect historical use patterns of the pesticide pp'-DDT, and the atmospheric transportation of pp'-DDE from warmer to colder climates by a continual volatilisation/condensation process (often referred to as the 'cold condensation hypothesis' or 'grasshopper effect').
5. Concentrations of PCDDs, PCDFs and PCBs in the serum of New Zealanders tended to be at the lower end of the range compared to population exposure data for other developed countries, as did concentrations of the pesticide β-HCH. In contrast, serum concentrations of pp'-DDE tended to be similar to levels measured in overseas populations.
6. The concentrations of organochlorines measured in the serum of New Zealand women were in good agreement with concentrations measured in the breast milk of New Zealand women when reported on a lipid weight basis. This result is consistent with an equilibration within the body of organochlorine contaminants between serum and breast milk, and demonstrates the applicability of serum as the most relevant human matrix to assess population exposures for males and females across age groups.

Appendix A Sampling methodology

This appendix provides an overview of the serum sampling programme. It details:

A1 Sampling frame

A2 Sample collection, processing and transportation

A3 Elimination of serum samples with potential occupational exposure

A4 Serum sample numbers

A5 Serum pooling criteria

A6 Sub-sampling within strata

A7 Final selection of samples for pooling and analysis

A1 Sampling frame

Collection of serum samples was carried out in conjunction with the National Nutrition Survey (NNS) (Quigley and Watts, 1997). The NNS was a cross-sectional population survey to provide information on food and nutrient intakes, dietary habits and body measurement of a representative sample of New Zealanders, aged 15 years and older, living in households throughout New Zealand. The NNS was conducted by the University of Otago and funded by the Ministry of Health. A consequence of linking this current serum study and the NNS was that the sampling frame for this serum study was dependent on the sampling frame for the NNS, which was itself linked to the sampling frame for the New Zealand Health Survey (NZHS). The aim of the NZHS was to provide information on the health status, use of health services, and health risk factors of New Zealanders (Ministry of Health, 1999). The sampling frame for the NZHS and the NNS was developed in consultation with Statistics New Zealand.

The NZHS/NNS sampling frame used was based on 'primary sampling units' (PSUs), equivalent to mesh blocks, which are geographical areas containing between 50 and 100 dwellings. The required study samples were chosen through a three-stage sampling of:

1. a set of PSUs
2. households within these PSUs
3. a single respondent (adult aged 15 years or older) within a household.[14]

Using a stratified random approach, Statistics New Zealand selected 1,752 PSUs from the 18,800 New Zealand mesh blocks, derived from 1991 Census data. The number of households randomly selected within each PSU varied. To increase the number of Maori and Pacific Island people in the NZHS, additional households were selected from PSUs in which there was a high proportion of Maori or Pacific Island people. A single adult, aged 15 years or older, was selected on a random basis from each selected household.

The selected sample invited to participate in the NZHS consisted of 10,600 individuals. Of this initial sample, 7,016 completed the NZHS, and of these, 5,613 agreed that they could be contacted for participation in the NNS. Of these, 4,644 were actually interviewed and 3,376 provided a blood sample for the NNS.

During the period December 1996 to November 1997, subjects were interviewed, body measurements were taken, and, from each, up to three vacutainers of blood were collected by trained phlebotomists. The first two vacutainers were used for the measurement of haematological parameters for the NNS. The third vacutainer of blood was collected for the current organochlorine serum study. Of the 3,376 subjects who provided a blood sample for the NNS, 2,925 people responded to questions on occupational exposure to organochlorines and supplied a third vacutainer of blood for organochlorine analysis.

14 Exclusions made were: (1) people living in non-private dwellings; (2) long-term residents of rest homes; (3) people in hospitals and psychiatric institutions; (4) inmates of penal institutions; (5) members of the permanent armed forces; (6) diplomats living overseas; (7) overseas visitors who expected to be resident in New Zealand for less than 12 months; and (8) people living on offshore islands (except Waiheke Island).

A2 Sample collection, processing and transportation

A2.1 Sample collection and processing

Blood was collected at people's homes by trained phlebotomists from the University of Otago, Dunedin. Samples were couriered from the field to the University laboratory in chilly bins with frozen Slika pads for cooling, reaching the laboratory within 24 hours of collection. On arrival at the laboratory, the blood was centrifuged and the separated serum stored in vials at -70 ^{o}C. Each vial was identified by a respondent bar-code and a unique number indicating location in the freezer.

A2.2 Transport of samples to the analytical laboratory

Only samples of non-occupationally exposed participants were analysed in the current study (see Section A3). These samples were transported to the Dioxin Laboratory, Centers for Disease Control and Prevention (CDC), 4770 Buford Highway, Atlanta, Georgia, USA, where they were pooled and analysed for PCDDs, PCDFs, PCBs and organochlorine pesticides.

Samples were transported by international courier in several consignments. Initially trial packages were sent to test the integrity of the system, particularly to ensure that serum remained frozen on arrival at CDC. Each consignment consisted of one or more packages, labelled in accordance with IATA Packaging Instruction 650. Each package consisted of two large plastic containers held firmly in a styrofoam container inside a solid plastic box. The void inside each container was filled with dry ice.

Each plastic container within the package held the serum vials belonging to one or more strata. A comprehensive system of documentation, involving a chain-of-custody form, was used to ensure that there was double checking of the contents of each consignment at despatch and receipt, and to confirm that the consignment arrived intact and with serum samples still frozen. Following receipt and checking of the consignment, the completed chain-of-custody form was faxed to the co-ordinating laboratory in New Zealand.

A3 Elimination of serum samples with potential occupational exposure

One of the aims of the serum study was to determine baseline levels of organochlorines in the New Zealand population. Without exclusion of occupationally exposed individuals, a single individual with occupational exposure to organochlorines could potentially affect the analytical results for a pooled serum sample.

The questionnaire administered to participants in the NNS contained a number of questions for the purposes of the present study. These questions were used to identify individuals who had had previous occupational exposure to organochlorines, so that they might be excluded from the final pooling of serum samples (see below). The relevant questions (and optional answers) are provided in Table A1.

On the basis of people's answers to these questions, all persons judged to have been, at least potentially, occupationally exposed to any of the categories of organochlorine compounds were excluded from the pooling. People who, in response to questions, stated that they had used organochlorine pesticides only for domestic purposes (e.g. DDT and γ-HCH (lindane) were quite widely used in home gardens until the late 1990s), people who had used treated timber (e.g. in

building or carpentry), and people who reported they had only washed the work clothing of other family members who had had occupational exposure to organochlorines, were not considered themselves to have been occupationally exposed.

Table A1 Questionnaire to identify occupationally exposed people

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

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 ☐

Comment _____

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 ☐

Comment _____

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 shown on this card?

Yes ☐ No ☐ Don't know ☐

Comment _____

[For question 3 a showcard was produced that listed the pesticides DDT, dieldrin, aldrin, lindane, HCB, heptachlor and chlordane].

A4 Serum sample numbers

Of the 2,925 subjects who supplied a third vacutainer of blood for organochlorine analysis and responded to the questions on occupational exposure to organochlorines, 2,788 provided at least 2 mL of serum. Of these, 2,497 samples (1,487 females and 1,010 males) were judged eligible for inclusion in this study on the basis of there being no evidence of occupational exposure (see Table A2).

Because, from any one person, an insufficient volume of serum was collected for analysis for the full suite of organochlorine contaminants being studied, it was necessary to pool individual serum samples, and undertake analysis of the pooled samples. The serum pooling criteria that were applied are detailed in Section A5. To maximise the volume of serum available for analysis, and

because it was necessary to use equal volumes of individual serum samples for those pooled within a stratum, only 1,834 samples (1,034 females and 800 males) of the total 2,497 eligible samples were actually included in pooled samples (see Table A3).

A5 Serum pooling criteria

From each participant, up to 10 mL of whole blood (equivalent to approximately 5–6 mL of serum) was collected and processed to provide serum for analysis (see Section A2). The optimal volume of serum required to achieve the necessary limits of detection for PCDD, PCDF and non-*ortho* PCB analysis was approximately 50 mL. Therefore, to achieve adequate volumes for analysis, individual serum samples were pooled according to certain stratification, selection and pooling criteria described below.

A5.1 Stratification criteria

The serum was pooled according to specified stratification criteria based on age, ethnicity, sex and geographic region, as outlined below. This stratification provided a total of 80 strata for the study. However, of these, only pooled serum from 60 strata were analysed for organochlorine contaminants, due to some strata having either insufficient sample numbers or an insufficient pooled sample volume (see Section A5.2, and Table A2).

Age stratification

- 15–24 years
- 25–34 years
- 35–49 years
- 50–64 years
- 65+ years

Ethnicity stratification

- Maori
- Non-Maori

This stratification was based on the indigenous people of New Zealand (Maori) and non-Maori, which included Pakeha (European, Caucasian), Pacific Islanders and Asians.

Sex stratification

- Male
- Female

Geographic stratification

- Northland/Auckland
- Waikato/Bay of Plenty
- Lower North Island
- South Island

These regions were selected based on geographical boundaries (Figure A1) and approximately equivalent populations (Northland/Auckland, population 1,303,200; Waikato/Bay of Plenty, 603,600; Lower North Island, 960,100; South Island, 925,500).[15]

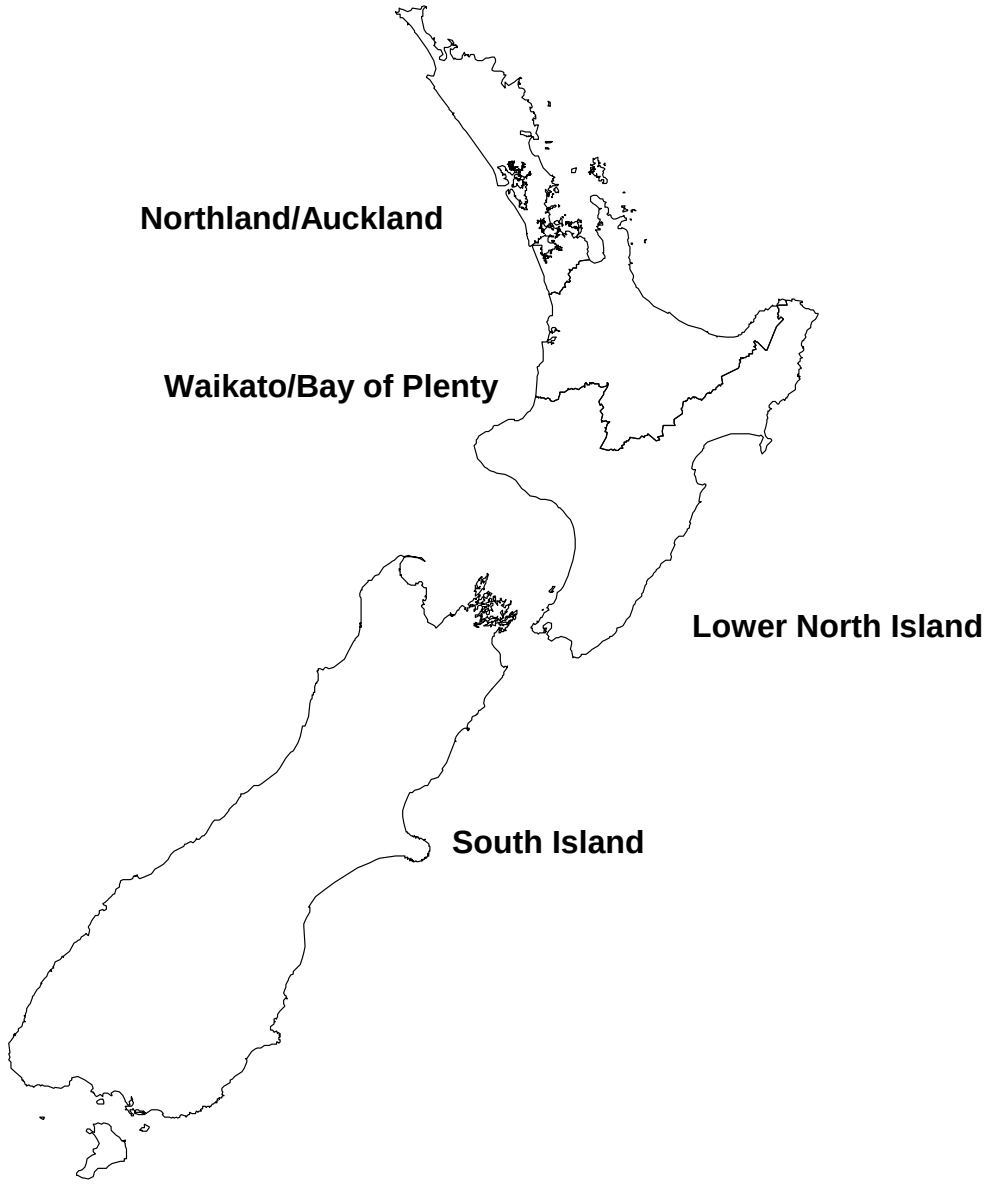

Figure A1 Geographic regions for serum stratification

[15] Populations based on 1998 Census data (Statistics New Zealand).

A5.2 Serum selection criteria

In addition to the exclusion of serum samples from potentially occupationally exposed individuals, the following criteria were also applied when selecting serum samples for pooling.

1. A minimum of five eligible subjects were required for pooling in any stratum to reduce the possible impact of outliers. When five eligible subjects were not available in a particular stratum, then no pooled serum sample was prepared and no organochlorine concentration data were obtained for that stratum.

2. A minimum pooled serum volume of 25 mL for each stratum was required for inclusion in this study, although a volume of 50 mL was preferred in order to optimise limits of detection for the PCDDs, PCDFs and non-*ortho* PCBs. For those strata where the total volume was between 25 and 50 mL, some of the PCDD and PCDF congeners that are typically present at lower levels in human serum were not necessarily quantifiable, and the detection limits achieved were higher than for other strata for which larger analytical sample volumes were available.

Applying these criteria, 20 strata were excluded from the study, leaving a total of 60 strata for which pooled serum samples were prepared and organochlorine contaminant concentration data were obtained.

A5.3 Serum pooling criteria

For the 60 strata that were to have pooled samples prepared for analysis, serum was pooled according to the following protocols.

1. Strata where there were less than 25 individual samples: for each stratum, the largest possible total pooled serum volume was calculated such that each contributing individual sample contributed an equal volume. This meant that, in some cases, to maximise the volume of serum available for analysis, not all eligible samples were necessarily included in a pool. For example, if a stratum contained 17 eligible samples and two samples comprised 2 mL whilst the 15 others had 3.5 mL or more, it was optimal to use 3.5 mL from the 15 samples (giving a total volume of 52.5 mL) rather than to take 2 mL from all 17 samples (which would give a total volume of 34 mL).

2. Strata for which there were more than 25 individual samples (excluding those strata used for variance estimation): 2 mL of serum from each individual sample was pooled and a 50 mL volume from this total pool was taken for analysis.

3. Strata used to produce data for variance estimation (see Section A6): each pooled sample consisted of 25 randomly selected serum samples from that stratum. Each individual sample contributed 2 mL of serum, providing a volume of 50 mL for each pool.

The numbers of eligible subjects plus the total available serum volume for each stratum are summarised in Table A2. These data are for subjects for whom at least 2 mL of serum was available and for whom there was no evidence of occupational exposure. The shaded areas in the table indicate those strata (20 in total) where there were either insufficient numbers of individual serum samples for pooling (17 strata) or an insufficient volume of serum (less than 25 mL) in the pooled sample (three strata).

The volumes shown in Table A2 are the total serum volumes available for use in the study. However, because an equal-volume-per-subject criterion was applied for the purposes of pooling samples (see Section A6), the volumes actually taken for chemical analysis were less than those given in the table.

Table A2 Numbers of eligible samples and total serum volumes, by strata[1,2]

		Northland/Auckland				Waikato/Bay of Plenty				Lower North Island				South Island				
Sex	**Age**	**Maori**		**Non-Maori**		**Maori**		**Non-Maori**		**Maori**		**Non-Maori**		**Maori**		**Non-Maori**		
		No.	**Vol[3]**	**No.**	**Vol**	**No.**	**Vol**	**No.**	**Vol**	**No.**	**Vol**	**No.**	**Vol**	**No.**	**Vol**	**No.**	**Vol**	
F	**15–24**	6	24	17	69	9	33	15	51	20	90	50	226	10	42	45	200	
	25–34	17	69	48	181	18	75	34	131	28	118	109	490	7	29	113	487	
	35–49	13	48	66	268	14	52	52	221	23	93	106	463	8	35	144	609	
	50–64	1	4	43	156	5	19	28	106	5	25	85	352	3	12	99	421	
	65+	1	4	23	96	0	0	42	152	3	13	72	296	0	0	105	447	
	Total	38		197		46		171		79		422		28		506		1487
M	**15–24**	1	4	16	64	3	9	13	46	17	62	42	164	6	26	50	191	
	25–34	3	9	22	86	4	16	26	101	16	62	64	238	7	29	62	244	
	35–49	5	19	44	164	10	36	33	124	12	48	89	347	12	50	120	485	
	50–64	2	6	24	79	2	6	26	94	10	37	57	231	4	16	63	247	
	65+	0	0	23	80	2	8	21	74	2	8	44	177	2	10	51	205	
	Total	11		129		21		119		57		296		31		346		1010

1. Samples were judged to be *eligible* for inclusion in the study on the basis of their being no evidence of occupational exposure to the organochlorines being studied.
2. Strata that had either insufficient numbers of samples for pooling (i.e. No. < 5) or an insufficient volume of serum for analysis (i.e. Vol < 25 mL) are shaded. These strata were not included in the study.
3. Volumes (Vol) reported as mL.

A6 Sub-sampling within strata

Some strata had relatively large numbers of eligible serum samples, which allowed additional analyses to be undertaken for the purposes of estimating the inter-pool variance. The rationale for this was that if analytical results were obtained for more than one pooled sample from the same stratum, with each pool comprising the same number of randomly selected individual serum samples with equal serum volumes from each sample, the inter-pool variance could be used to generate an estimate of the inter-individual sample variance.

The results of standard error calculations to estimate inter-pool variance are reported in Tables G1 to G12 (Appendix G).

For this calculation to be valid, it was essential that:

1. for those strata where inter-pool variance was assessed, each pool within each stratum must have been made up of the same number of individual serum samples
2. each serum sample must have contributed an equal volume of serum to its pool.

Taking this into account, the procedures for the pooling of sub-samples within strata were as follows.

1. Only strata with at least 50 eligible serum samples were used to estimate inter-pool variance.
2. Depending on the number of eligible samples in that stratum, either two or three pools were prepared. In either case, each pooled sample consisted of 25 randomly selected serum samples from within that stratum, each comprising 2 mL. This provided a volume of 50 mL for each pool.

A7 Final selection of samples for pooling and analysis

Table A3 shows the final sample pooling and analysis regime implemented. The columns headed 'P' specify the numbers of pools analysed for each stratum (up to three). Twenty strata had either insufficient numbers of samples for analysis or an insufficient volume of serum (indicated by P = 0) and therefore no results were obtained for these strata (see Section A5.3). The columns headed 'S' specify the total number of individual serum samples included in the pool(s) for each stratum.

Table A3 Numbers of pools and serum samples analysed for each stratum[1]

		Northland/Auckland				Waikato/Bay of Plenty				Lower North Island				South Island				
Sex	Age	Maori		Non-Maori		Maori		Non-Maori		Maori		Non-Maori		Maori		Non-Maori		
		P	S	P	S	P	S	P	S	P	S	P	S	P	S	P	S	
F	15–24	0	0	1	14	1	5	1	9	1	20	1	48	1	10	1	43	
	25–34	1	15	1	41	1	18	1	33	1	28	3	75	1	6	3	75	
	35–49	1	8	2	50	1	10	1	49	1	23	2	50	1	5	3	75	
	50–64	0	0	1	36	0	0	1	24	1	5	2	50	0	0	2	50	
	65+	0	0	1	23	0	0	1	36	0	0	2	50	0	0	2	50	
	Total		23		164		33		151		76		273		21		293	1034
M	15–24	0	0	1	10	0	0	1	10	1	11	1	39	1	5	1	46	
	25–34	0	0	1	19	0	0	1	26	1	14	2	50	1	7	2	50	
	35–49	0	0	1	42	1	8	1	32	1	12	2	50	1	11	3	75	
	50–64	0	0	1	20	0	0	1	26	1	7	2	50	0	0	2	50	
	65+	0	0	1	20	0	0	1	21	0	0	1	39	0	0	2	50	
	Total		0		111		8		115		44		228		23		271	800

1. Strata that had either insufficient numbers of samples for pooling or an insufficient volume of serum for analysis are shaded. These strata were not included in the study.

P = Number of pools analysed for that stratum (up to 3).

S = Total number of individual serum samples included in the pool(s) for that stratum.

Appendix B Analytical methodology

This appendix describes the analytical methodologies employed for analysis of the serum samples for polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs) and organochlorine pesticides. It includes:

B1.1 Sample extraction

B1.2 Sample analysis

B1.3 Analyte identification and quantification criteria

B1.4 Quantification

B1.5 Limits of detection

B1.6 Recoveries of ^{13}C labelled standards

B1.7 Quality control procedures

B1.8 Method precision data

B1.9 Data reporting

The methodology used for the determination of total lipids in serum is also detailed.

B1 Organochlorine contaminants

B1.1 Sample extraction

PCDDs, PCDFs and non-ortho PCBs

A $^{13}C_{12}$ labelled PCDD, PCDF and non-*ortho* PCB surrogate standard (spiking solution) was prepared from stock solutions purchased from Cambridge Isotope Laboratories (CIL), Woburn, Massachusetts, USA. The nominal concentration of each $^{13}C_{12}$ congener in the spiking solution is given in Table B1.

Each analytical batch consisted of a laboratory blank, two quality control (QC) and seven 'unknown' serum samples. A volume of serum (25–50 mL) was spiked with 10 µL of the standard spiking solution. The spiked serum was equilibrated, then mixed with a volume of formic acid equal to the weight of the serum. The serum was swirled and allowed to degas. A volume of water equal to the volume of formic acid was added to the serum and the solution gently mixed.

The serum mixture was extracted through a 10 g activated C_{18} solid phase extraction (SPE) column using a peristaltic pump to control the flow through the adsorbent. The C_{18} was dried, the PCDDs, PCDFs and non-*ortho* PCBs eluted with hexane, and the hexane eluate pumped directly onto an acid/neutral/basic silica column on the Fluid Management Universal Prep System. The PCDDs, PCDFs and non-*ortho* PCBs were eluted with 2% dichloromethane (DCM) in hexane onto an acid alumina column. The 2% DCM in hexane was discharged to waste, and the analytes eluted onto carbon with 50% DCM in hexane. The PCDDs, PCDFs and non-*ortho* PCBs were eluted from the carbon in the reverse direction with toluene. The toluene was evaporated to 350 µL at 50 °C under nitrogen, transferred to an autosampler vial with 1 µL dodecane keeper, and evaporated to dryness in a desiccator.

Ortho-substituted PCBs and organochlorine pesticides

A $^{13}C_{12}$ labelled PCB standard (spiking solution) was prepared from a $^{13}C_{12}$ labelled PCB mixture synthesised, purified, and characterised at the Centers for Disease Control and Prevention, Atlanta, Georgia, and supplemented with commercially available (from CIL) PCB stock solutions. This standard contained the following ^{13}C PCB congeners: #28, #52, #74, #66, #101, #99, #110, #118, #105, #149, #153, #138, #128, #167, #156, #178, #187, #180, #170, #189, #201, #196, #194, #206 and #209. The precise concentrations of the $^{13}C_{12}$ PCBs in the spiking solution are not known. However, these concentrations are exactly the same as the concentrations of the $^{13}C_{12}$ PCBs in the calibration standards (Table B2), and therefore knowing the precise concentrations is unnecessary.

A ^{13}C labelled pesticide standard (spiking solution) was prepared from stock solutions purchased from CIL. This standard contained the following ^{13}C pesticides: β-HCH, γ-HCH, HCB, dieldrin, pp'-DDE, pp'-DDT and mirex. The nominal concentration of each ^{13}C labelled pesticide in the spiking solution was approximately 250 pg μL^{-1}, except for pp'-DDE, which was approximately 500 pg μL^{-1}. These concentrations are exactly the same as the ^{13}C pesticide concentrations in the calibration standards (Table B3).

Each analytical batch consisted of a laboratory blank, two QC and seven 'unknown' serum samples. A volume of serum (approximately 1 mL) was spiked with 10 µL each of the ^{13}C labelled standard

spiking solution for PCBs and organochlorine pesticides. The spiked serum was equilibrated, then mixed with a volume of formic acid equal to the weight of the serum. The serum was swirled and allowed to degas. A volume of water equal to the volume of formic acid was added to the serum and the solution gently mixed.

The serum mixture was extracted through a 1 g activated C_{18} SPE column using a vacuum manifold to control the flow through the adsorbent. The C_{18} SPE column was dried and removed from its vacuum port. A conditioned 1 g Florisil SPE column was attached to the vacuum manifold and the C_{18} SPE column was attached above it with an adaptor. *Ortho*-substituted PCBs and organochlorine pesticides were eluted from the C_{18} with hexane onto the Florisil. The C_{18} column was removed and the PCBs and pesticides were eluted from the Florisil, first with 20% DCM/hexane, followed by 50% DCM/hexane, into a single collection tube. The solvent was evaporated to 350 µL at 50 °C under nitrogen, transferred to an autosampler vial with 2 µL dodecane and 8 µL decane keeper, and evaporated to dryness in a desiccator.

B1.2 Sample analysis

A volume of reconstitution solution (5 µL of toluene containing $^{13}C_6$ 1,2,3,4-TCDD, $^{13}C_6$ 1,2,3,4,7,8,9-HpCDF and $^{13}C_6$ 3,3',5,5'-TCB as a percent recovery standard for PCDDs, PCDFs and non-*ortho* PCBs, and 10 µL for *ortho*-substituted PCBs and organochlorine pesticides) was added to the dried extract immediately prior to mass spectral analysis. Before the sample extract was injected, the solution was drawn into the microlitre syringe and applied repeatedly to the wall of the conical portion of the vial to bring the entire sample into solution. Analysis was carried out using a 2 µL sample volume, which was injected manually by the splitless '*hot needle*' injection technique.

Table B1 Calibration solutions for PCDDs, PCDFs and non-*ortho* PCBs

PCDD/PCDF/PCB	Native concentration in calibration standard, pg μL^{-1}									Nominal conc. of $^{13}C_{12}$ in each calibration standard, pg μL^{-1}	Nominal conc. of $^{13}C_{12}$ in surrogate standard spiking solution, pg μL^{-1}	Reconstituting standard solution, pg μL^{-1}
	9	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**			
2,3,7,8-TCDD	50	35	20	7	2	1	0.2	0.1	0.04	50	25	-
1,2,3,7,8-PeCDD	20	10	5	2	1	0.5	0.2	0.1	0.04	50	25	-
1,2,3,4,7,8-HxCDD	20	10	5	2	1	0.5	0.2	0.1	0.04	120	60	-
1,2,3,6,7,8-HxCDD	50	25	12.5	5	2.50	1.25	0.5	0.25	0.10	120	60	-
1,2,3,7,8,9-HxCDD	30	25	20	10	5	2	1	0.5	0.2	120	60	-
1,2,3,4,6,7,8-HpCDD	200	100	50	25	20	10	5	2	1	120	60	-
1,2,3,4,6,7,9-HpCDD	20	10	5	2	1	0.5	0.2	0.1	0.04	-	-	-
OCDD	600	500	400	300	200	100	50	20	10	250	125	-
2,3,7,8-TCDF	10	7.5	5	2	1	0.5	0.2	0.1	0.04	50	25	-
1,2,3,7,8-PeCDF	10	7.5	5	2	1	0.5	0.2	0.1	0.04	50	25	-
2,3,4,7,8-PeCDF	10	7.5	5	2	1	0.5	0.2	0.1	0.04	50	25	-
1,2,3,4,7,8-HxCDF	10	7.5	5	2	1	0.5	0.2	0.1	0.04	125	62.5	-
1,2,3,6,7,8-HxCDF	10	7.5	5	2	1	0.5	0.2	0.1	0.04	125	62.5	-
1,2,3,7,8,9-HxCDF	10	7.5	5	2	1	0.5	0.2	0.1	0.04	125	62.5	-
2,3,4,6,7,8-HxCDF	10	7.5	5	2	1	0.5	0.2	0.1	0.04	125	62.5	-
1,2,3,4,6,7,8-HpCDF	30	25	20	10	5	2	1	0.5	0.2	125	62.5	-
1,2,3,4,7,8,9-HpCDF	10	7.5	5	2	1	0.5	0.2	0.1	0.04	-	-	-
OCDF	10	7.5	5	2	1	0.5	0.2	0.1	0.04	250	125	-
3,3',4,4'-TCB (PCB #77)	160	80	40	20	16	8	4	1.6	0.80	48	24	-
3,4,4',5-TCB (PCB #81)	160	80	40	20	16	8	4	1.6	0.80	48	24	-
3,3',4,4',5-PeCB (PCB #126)	160	80	40	20	16	8	4	1.6	0.8	72	36	-
3,3',4,4',5,5'-HxCB (PCB #169)	160	80	40	20	16	8	4	1.6	0.8	96	48	-
$^{13}C_6$ 1,2,3,4-TCDD										25	-	25
$^{13}C_{12}$ 1,2,3,4,7,8,9-HpCDF										62.5	-	62.5
$^{13}C_{12}$ 3,3',5,5'-TCB (PCB #77)										48	-	48

Table B2 Calibration solutions for *ortho*-substituted PCBs

Calibration standard #	Native PCB concentration, pg µL^{-1}	$^{13}C_{12}$ in each standard[1]	$^{13}C_6$ 1,2,3,4-TCDD in each standard[2], pg µL^{-1}
P01	0.1	mixed std.	250
P02	0.5	mixed std.	250
P03	1.0	mixed std.	250
P04	5.0	mixed std.	250
P05	10.0	mixed std.	250
P06	25.0	mixed std.	250
P07	50.0	mixed std.	250
P08	75.0	mixed std.	250
P09	100	mixed std.	250
P10	500	mixed std.	250
P11	1000	mixed std.	250

1. The $^{13}C_{12}$ surrogate standard (spiking solution) contains the same concentrations of $^{13}C_{12}$ PCBs as the calibration standards, and therefore knowing its exact concentration is not necessary. The concentrations of the labelled PCBs in the spiking solution are not the same for all PCBs because their concentrations in the synthesised $^{13}C_{12}$ PCBs mixture varies.
2. The sample reconstitution solution (recovery standard) contains 250 pg µL^{-1} of $^{13}C_6$ 1,2,3,4-TCDD.

Table B3 Calibration solutions for organochlorine pesticides

Calibration standard #	Native pesticide concentration, pg µL^{-1}	^{13}C in each standard[1], pg µL^{-1}	$^{13}C_6$ 1,2,3,4-TCDD in each standard[2], pg µL^{-1}
T01	1.0	250	250
T02	5.0	250	250
T03	10.0	250	250
T04	25.0	250	250
T05	50.0	250	250
T06	75.0	250	250
T07	100	250	250
T08	500	250	250
T09	1000	250	250
T10	2000	250	250
T11	3000	250	250

1. The ^{13}C surrogate standard (spiking solution) contains the same concentrations of all ^{13}C organochlorine pesticides as the calibration standards (approximately 250 pg µL^{-1}) with the exception of pp'-DDE (approximately 500 pg µL^{-1}).
2. The sample reconstitution solution (recovery standard) contains 250 pg µL^{-1} of $^{13}C_6$ 1,2,3,4-TCDD.

PCDDs, PCDFs and non-ortho PCBs

Extracts were analysed by gas chromatography mass spectrometry (GCMS) on an HP5890 Series GC interfaced to a Micromass Ultima high resolution mass spectrometer. All analytes were separated on a DB-5MS capillary column. The chromatographic and mass spectrometer conditions are given below. The mass spectral ions monitored for PCDDs and PCDFs are listed in Table B4 and for non-*ortho* PCBs in Table B5.

Column	30 m x 0.25 mm i.d. x 0.25 µm thickness DB-5MS
Injection port temperature	260 °C
Injection	2 µL splitless
Oven temperature programme	100 °C, hold 2 min; 25 °C min^{-1} to 220 °C, hold 2 min; 15 °C min^{-1} to 250 °C, hold 10.3 min; 25 °C min^{-1} to 300 °C, hold 3.4 min.
Carrier gas	Helium

Ion source	High sensitivity
Ionising electron energy	28–32 eV
Accelerating voltage	8,000 V
Trap current	500 µA
Source temperature	250–280 °C
Transfer line temperature	250 °C
Resolution	10,000

Table B4 Ions monitored and ion ratios for PCDDs and PCDFs

PCDD/PCDF	Ions monitored	Theoretical ion ratio	Acceptance range[1] (99% confidence)
TCDD	319.8965/321.8936	0.76	0.576–0.987
$^{13}C_{12}$ TCDD	331.9368/333.9338	0.76	0.628–0.936
TCDF	303.9016/305.8987	0.76	0.576–0.987
$^{13}C_{12}$ TCDF	315.9419/317.9389	0.76	0.628–0.936
PeCDD	355.8546/357.8517	0.625	0.460–0.789
$^{13}C_{12}$ PeCDD	367.8949/369.8919	0.625	0.501–0.748
PeCDF	339.8597/341.8568	0.625	0.460–0.789
$^{13}C_{12}$ PeCDF	351.9000/353.8970	0.625	0.501–0.748
HxCDD	389.8156/391.8127	1.251	0.921–1.580
$^{13}C_{12}$ HxCDD	401.8559/403.8530	1.251	1.004–1.498
HxCDF	373.8207/375.8178	1.251	0.921–1.580
$^{13}C_{12}$ HxCDF	385.8610/387.8580	1.251	1.004–1.498
HpCDD	423.7769/425.7737	1.042	0.768–1.316
$^{13}C_{12}$ HpCDD	435.8169/437.8140	1.042	0.836–1.248
HpCDF	407.7818/409.7788	1.042	0.768–1.316
$^{13}C_{12}$ HpCDF	419.8220/421.8191	1.042	0.836–1.248
OCDD	457.7377/459.7348	0.893	0.658–1.128
$^{13}C_{12}$ OCDD	469.7780/471.7750	0.893	0.717–1.069
OCDF	441.7428/443.7398	0.893	0.658–1.128
$^{13}C_{12}$ OCDF	453.7831/455.7800	0.893	0.717–1.069

1. Each congener has its own confidence intervals. These ranges are the minimum and maximum value within each homologue group.

Ortho-substituted PCBs

Extracts were analysed by GCMS on an HP5890 Series GC interfaced to a Micromass Ultima high resolution mass spectrometer. All analytes were separated on a DB-5MS capillary column. The chromatographic and mass spectrometer conditions are given below. The mass spectral ions monitored are listed in Table B5.

Column	30 m x 0.25 mm i.d. x 0.25 µm thickness DB-5MS
Injection port temperature	260 °C
Injection	2 µL splitless
Oven temperature programme	100 °C, hold 1 min; 25 °C min^{-1} to 200 °C, hold 5 min; 4.5 °C min^{-1} to 250 °C, hold 0 min; 25 °C min^{-1} to 320 °C, hold 1.5 min.
Carrier gas	Helium
Ion source	High sensitivity
Ionising electron energy	28–32 eV
Accelerating voltage	8,000 V
Trap current	500 µA
Source temperature	250–280 °C
Transfer line temperature	250 °C
Resolution	10,000

Table B5 Ions monitored and ion ratios for *ortho* and non-*ortho* PCBs

PCBs	Ions monitored	Theoretical ion ratio	Acceptance range[1] (99% confidence)
Tri-CB[2]	255.9613/257.9584	1.014	0.747–1.281
$^{13}C_{12}$ Tri-CB	268.0016/269.9986	1.014	0.813–1.214
Tetra-CB[3]	289.9224/291.9194	0.762	0.561–0.916
$^{13}C_{12}$ Tetra-CB	301.9626/303.9597	0.762	0.611–0.912
Penta-CB[4]	323.8834/325.8804	0.610	0.449–0.770
$^{13}C_{12}$ Penta-CB	335.9237/337.9207	0.610	0.489–0.730
Hexa-CB[5]	359.8415/361.8385	1.219	0.898–1.540
$^{13}C_{12}$ Hexa-CB	371.8817/373.8788	1.219	0.978–1.460
Hepta-CB[6]	393.8025/395.7995	1.017	0.749–1.285
$^{13}C_{12}$ Hepta-CB	405.8428/407.8398	1.017	0.816–1.218
Octa-CB[7]	427.7635/429.7606	0.872	0.642–1.102
$^{13}C_{12}$ Octa-CB	439.8038/441.8008	0.872	0.700–1.044
Nona-CB[8]	463.7216/465.7187	1.308	0.963–1.652
$^{13}C_{12}$ Nona-CB	475.7619/477.7589	1.308	1.050–1.566
Deca-CB[9]	497.7818/499.7788	1.145	0.843–1.446
$^{13}C_{12}$ Deca-CB	509.7229/511.7199	1.145	0.919–1.371

1. Each congener has its own confidence intervals. These ranges are the minimum and maximum value within each homologue group.
2. PCB #18, #28.
3. PCB #52, #49, #44, #74, #66, **#81**, **#77**.
4. PCB #101, #99, #87, #110, #118, #105, **#126**.
5. PCB #151, #149, #146, #153, #138, #158, #128, #167, #156, #157, **#169**.
6. PCB #178, #187, #183, #177, #172, #180, #170, #189.
7. PCB #201, #196, #203, #195, #194.
8. PCB #206.
9. PCB #209.

The bolded congeners (#81, #77, #126, #169) were analysed from the same mass spectrometer run as the PCDDs and PCDFs, and not from the *ortho*-substituted PCB mass spectrometer run.

Organochlorine pesticides

Extracts were analysed by GCMS on an HP5890 Series GC interfaced to a Micromass Ultima high resolution mass spectrometer. All analytes were separated on a DB-5MS capillary column. The chromatographic and mass spectrometer conditions are given below. The mass spectral ions monitored are listed in Table B6.

Column	30 m x 0.25 mm i.d. x 0.25 µm thickness DB-5MS
Injection port temperature	240 °C
Injection	2 µL splitless
Oven temperature programme	100 °C, hold 1 min; 18 °C min^{-1} to 200 °C, hold 1 min; 1°C min^{-1} to 206 °C, hold 0 min; 40 °C min^{-1} to 300 °C, hold 2 min.
Carrier gas	Helium
Ion source	High sensitivity
Ionising electron energy	28–32 eV
Accelerating voltage	8,000 V
Trap current	500 µA
Source temperature	250–280 °C
Transfer line temperature	240 °C
Resolution	10,000

Table B6 Ions monitored and ion ratios for organochlorine pesticides

Pesticide	Ions monitored	Theoretical ion ratio	Acceptance range (99% confidence)
β-HCH	180.9380/182.9349	1.014	0.747–1.281
$^{13}C_6$ β-HCH	186.9580/188.9550	1.014	0.814–1.214
γ-HCH	180.9380/182.9349	1.014	0.747–1.281
$^{13}C_6$ γ-HCH	186.9580/188.9550	1.014	0.814–1.214
HCB	283.8102/285.8072	1.219	0.899–1.540
$^{13}C_6$ HCB	289.8303/291.8273	1.219	0.978–1.460
Aldrin	260.8599/262.8570	0.610	0.449–0.770
Dieldrin	260.8859/262.8570	0.610	0.449–0.770
$^{13}C_4$ Dieldrin	264.8733/266.8704	0.610	0.489–0.730
Endrin	260.8599/262.8570	0.610	0.449–0.770
Heptachlor epoxide	352.8442/354.8413	1.219	0.898–1.540
trans-Nonachlor	406.7870/408.7840	0.872	0.642–1.102
Oxychlordane	386.8052/388.8023	1.017	0.749–1.285
pp'-DDE	246.0003/247.9974	1.514	1.115–1.913
$^{13}C_{12}$ pp'-DDE	258.0406/260.0376	1.514	1.215–1.813
op'-DDT	235.0081/237.0052	1.514	1.115–1.913
pp'-DDT	235.0081/237.0052	1.514	1.115–1.913
$^{13}C_{12}$ pp'-DDT	247.0484/249.0454	1.514	1.215–1.813
Mirex	271.8102/273.8072	1.219	0.898–1.540
$^{13}C_8$ Mirex	275.8236/277.8206	1.219	0.978–1.460

B1.3 Analyte identification and quantification criteria

For the positive identification and quantification of target analytes, the following criteria had to be met.

- The ion current responses for each mass of a particular analyte or primary surrogate standard must maximise to within ±1 second of each other.
- The ion current intensities for a particular analyte must be ≥ 3 times the noise level (S/N ≥ 3).
- The isotope ratio of the analyte and the primary surrogate standard must fall within the confidence intervals established for each analyte (Tables B4, B5, B6). The confidence intervals are periodically updated.
- The recovery of each ^{13}C labelled surrogate standard should be between 10–120%.
- The instrument resolving power ratio for each sample must be within the upper 99th percentile established for this ratio.
- The capillary column isomer specificity ratio for each sample must be within the 99% confidence intervals established for this ratio.
- The relative retention time of each analyte peak in a sample must be within three parts-per-thousand of the relative retention time as determined for each analyte in the analytical standard which was analysed at the beginning of the analytical run.

B1.4 Quantification

Quantification was by the isotope dilution mass spectrometry technique using calibration standards containing $^{13}C_{12}$ labelled and unlabelled analytes. The PCDD, PCDF and non-*ortho* PCB calibration standards are listed in Table B1. PCDDs, PCDFs and non-*ortho* PCBs that did not have their own labelled standard were quantified against a labelled congener with the same degree of chlorine substitution and a similar retention time.

The calibration standards for the *ortho*-substituted PCBs are listed in Table B2. The following is a list of PCBs analysed for using its Ballschmiter number (Ballschmiter and Zell, 1980): 18 (28); 28; 52; 49 (52); 44 (52); 74; 66; 101; 99; 87 (110); 110; 118; 105; 151 (149); 149; 146 (153); 153; 138/158 (coelute); 128; 167; 156; 157; 178; 187; 183 (187); 177 (180); 172 (180); 180; 170; 189; 201; 196/203 (coelute); 195 (194); 194; 206; and 209. The PCB numbers in parentheses indicate alternative $^{13}C_{12}$ labelled PCB surrogate standards used for isotope dilution quantification.

The calibration standards for the organochlorine pesticides are listed in Table B3. The following is a list of pesticides analysed for: β-HCH; γ-HCH; HCB; aldrin (pp$^{'}$-DDE); dieldrin; endrin (pp$^{'}$-DDE); hepachlor epoxide (pp$^{'}$-DDE); *trans*-nonachlor (pp$^{'}$-DDE); oxychlordane (pp$^{'}$-DDE); pp$^{'}$-DDE; op$^{'}$-DDT (pp$^{'}$-DDT); pp$^{'}$-DDT; and mirex. The pesticides in parentheses indicate alternative ^{13}C labelled pesticide standards used for isotope dilution quantification.

Each of the calibration standards in Tables B1, B2 and B3 was analysed many times under the same conditions as the samples. A $\log_{10}$–$\log_{10}$ regression ($\log_{10}$ concentration versus $\log_{10}$ response factor) was used to determine the $\log_{10}$ slope and the $\log_{10}$ y-intercept of the standard curve for each analyte. The standard curve for a given analyte was used to compute the concentration of that analyte in a given sample. The calculated $\log_{10}$ slopes and the $\log_{10}$ y-intercepts of the standard curves were verified periodically.

B1.5 Limits of detection

The standard deviation at any concentration level is an estimate of the expected precision at that level. Long-term standard deviations, estimated from multiple measurements of low-level standards, were plotted as a function of observed concentrations, and a straight line was fitted to the points using linear regression. The value for S_0, the estimate of the standard deviation as concentration approaches zero, corresponds to the intercept term of the linear equation. The limit of detection (LOD) was defined as $LOD = 3S_0$, and was the lowest concentration level that can be determined to be statistically different from a blank. The detection limit values, based on standards, were calculated to correspond to weight-corrected samples.

When there was a significant amount of analyte in the blank sample, the LOD becomes the lowest concentration level that is statistically different from the blank. Here, $LOD = 3SD_{BK} + AVG_BK$ where SD_{BK} is the standard deviation of the measurement of the analyte in multiple blank samples, and AVG_BK is the average concentration of the analyte in those same blank samples.

B1.6 Recoveries of ^{13}C labelled standards

Calculation of the ^{13}C standard recoveries was based on a reconstituting standard (recovery standard) containing 25 pg μL^{-1} of $^{13}C_6$ 1,2,3,4-TCDD, 62.5 pg μL^{-1} of $^{13}C_6$ 1,2,3,4,7,8,9-HpCDF and 48 pg μL^{-1} of $^{13}C_6$ 3,3',5,5'-TCB in toluene (Table B1). This standard was used to reconstitute sample extracts before GCMS analysis for PCDDs, PCDFs and non-*ortho* PCBs. The calibration standards (Table B1) also contained 25 pg μL^{-1} of $^{13}C_6$ 1,2,3,4-TCDD, 62.5 pg μL^{-1} of $^{13}C_6$ 1,2,3,4,7,8,9-HpCDF and 48 pg μL^{-1} of $^{13}C_6$ 3,3',5,5'-TCB, and therefore a comparison between the ratio of each $^{13}C_{12}$ surrogate standard in the sample normalised to the recovery standard and each $^{13}C_{12}$ surrogate standard in the calibration standards normalised to the recovery standard can be used to calculate the absolute percent recovery of the $^{13}C_{12}$ labelled standards for each sample analysis. The recoveries of tetra-, penta- and hexa-substituted PCDDs and PCDFs were calculated using $^{13}C_6$ 1,2,3,4-TCDD. The recoveries of the hepta- and octa- substituted PCDDs and PCDFs were calculated using $^{13}C_6$ 1,2,3,4,7,8,9-HpCDF and the recoveries of the non-*ortho* PCBs were calculated using $^{13}C_6$ 3,3',5,5'-TCB.

The same procedure was used for the *ortho*-substituted PCBs and the organochlorine pesticides, but here the sample reconstituting standard (recovery standard) and the calibration standards (Tables B2 and B3) contained 250 pg μL^{-1} of $^{13}C_6$ 1,2,3,4-TCDD.

B1.7 Quality control procedures

- The resolving power of the mass spectrometer was checked at the beginning of each run by analysing a 2,3,7,8-TCDD sensitivity check standard and calculating the ratio of the peak areas for $^{13}C_{12}$ 2,3,7,8-TCDD and $^{13}C_6$ 1,2,3,4-TCDD in the m/z 331.9078 channel.
- The column isomer specificity was checked by calculating the retention time ratio of $^{13}C_6$ 1,2,3,4-TCDD relative to the retention time of $^{13}C_{12}$ 2,3,7,8-TCDD for the sensitivity check standard.
- For each standard the retention time ratio of the native analyte relative to the retention time of its ^{13}C labelled ion (RT_13) was calculated. When the RT_13 for an 'unknown' serum sample or QC sample was divided by RT_13 for the standard, the ratio had to be within 1.000 ±0.003 in order for the data to be reported.

- An analytical run consisted of 10 samples: the first was a reagent blank and the fifth and 10th were a previously characterised QC sample.
- The blank was spiked with the ^{13}C labelled surrogate standard solution and carried through the clean-up procedures.
- QC samples were large volumes of bovine sera that had been spiked with PCDDs, PCDFs, PCBs and organochlorine pesticides, dispensed in aliquots, and stored at -60 °C.
- The recoveries of all ^{13}C labelled surrogate standards were calculated. The recovery of each surrogate standard should be between 10–120%.
- The blank sample and the two QC samples associated with each set of seven 'unknown' serum samples first had to give valid results. If one or more of the requirements was not met for the blank or both QC samples, then results for the seven 'unknown' serum samples could not be reported.

B1.8 Method precision data

The coefficients of variation (CV) were calculated for each analyte from replicate analyses of a serum QC sample. These are reported in Tables B7, B8 and B9. The CVs for each calibration standard at each concentration level were also calculated.

Table B7 Coefficients of variation for PCDDs, PCDFs and non-*ortho* PCBs[1]

PCDD	CV, %	PCDF	CV, %	Non-*ortho* PCB	CV, %
2,3,7,8-TCDD	13.1	2,3,7,8-TCDF	13.6	#81	13.3
1,2,3,7,8-PeCDD	14.4	1,2,3,7,8-PeCDF	15.5	#77	17.3
1,2,3,4,7,8-HxCDD	16.3	2,3,4,7,8-PeCDF	15.4	#126	13.7
1,2,3,6,7,8-HxCDD	16.5	1,2,3,4,7,8-HxCDF	15.2	#169	15.0
1,2,3,7,8,9-HxCDD	16.0	1,2,3,6,7,8-HxCDF	15.4		
1,2,3,4,6,7,8-HpCDD	16.5	1,2,3,6,7,9-HxCDF	14.7		
1,2,3,4,6,7,9-HpCDD	20.4	2,3,4,6,7,8-HxCDF	14.8		
OCDD	16.5	1,2,3,4,6,7,8-HpCDF	17.5		
		1,2,3,4,7,8,9-HpCDF	16.1		
		OCDF	18.2		

1. n = 43.

Table B8 Coefficients of variation for *ortho*-substituted PCBs[1]

PCB	CV, %	PCB	CV, %	PCB	CV, %	PCB	CV, %
#18	33.6	#87	6.2	#128	6.1	#180	8.3
#28	12.5	#110	7.6	#167	9.6	#170	7.7
#52	11.1	#118	7.1	#156	6.7	#189	7.9
#49	12.7	#105	7.8	#157	7.4	#201	5.5
#44	13.6	#151	6.7	#178	8.3	#196/203	6.2
#74	19.7	#149	7.5	#187	8.9	#195	15.7
#66	20.0	#146	8.1	#183	11.9	#194	5.8
#101	9.6	#153	6.7	#177	16.3	#206	11.7
#99	6.8	#138/158	6.4	#172	11.6	#209	19.3

1. n = 55.

Table B9 Coefficients of variation for organochlorine pesticides[1]

Pesticide	CV, %	Pesticide	CV, %
β-HCH	9.5	*trans*-Nonachlor	12.6
γ-HCH	23.3	Oxychlordane	10.9
HCB	15.5	pp'-DDE	10.9
Aldrin	16.8	op'-DDT	34.2
Dieldrin	6.3	pp'-DDT	9.9
Endrin	22.8	Mirex	6.5
Heptachlor epoxide	14.5		

1. n = 58.

B1.9 Data reporting

The concentrations of PCDDs and PCDFs are reported in Appendix D as nanograms analyte per kilogram of serum lipid (ng kg^{-1}, equivalent to parts-per-trillion). The concentrations of non-*ortho* PCBs, *ortho*-substituted PCBs and organochlorine pesticides are reported in Appendices E (PCBs) and F (pesticides) as micrograms analyte per kilogram of serum lipid (μg kg^{-1}, equivalent to parts-per-billion). Lipid measurements were made on each serum sample (reported in Appendix C) to enable concentrations to be converted from a lipid weight basis to a serum volume basis. The median and mean concentrations reported in these appendices under the heading of 'national summary' are *unweighted* results (see below).

All TEQ data reported in this study were calculated using the 1997 WHO TEFs for PCDDs, PCDFs and PCBs (Van den Berg *et al*., 1998). Concentration data for all analytes are corrected for recovery of ^{13}C labelled surrogate standards. In general, data are reported to three significant figures or one decimal place. Limits of detection are reported to one significant figure.

The concentration data presented in Section 5, including Tables 5.1 to 5.13 and Figures 5.1 to 5.16, report *weighted* medians and *weighted* means in order to take into account the number of individuals in each pooled sample. Similarly, the New Zealand data from the current study presented in Section 6 and Appendix H, report weighted median and weighted mean concentrations.

Weighted medians

Weighted medians were calculated as follows. For any data set, the concentration data and their associated frequency were ordered. The frequency data were then summed. The weighted median was identified from the concentration associated with the mid point of the cumulative frequency. The concentration data were ordered from low to high concentration, with limit of detection values, which were included in median calculations, being ranked below the lowest measured concentration. Calculation of a weighted median is illustrated using the following hypothetical data set.

Analytical concentration, μg kg^{-1}	Frequency of occurrence	Cumulative frequency
< 6	1	1
< 8	3	4
9	4	8
12	6	14
15	8	22
16	7	29
19	2	31
21	2	33

The midpoint of the cumulative frequency is 17. This is greater than 14 but less then 22 of the cumulative frequencies, and therefore the median concentration is 15 μg kg^{-1}.

Weighted means

Weighted means were calculated from:

$$\text{Weighted mean} = \frac{\sum_{i=1}^{s} w_i c_i}{\sum_{i=1}^{s} w_i}$$

where: s = number of stratum
c_i = analyte concentration for the ith stratum
w_i = number of individuals contributing to the pooled serum sample for the ith stratum.

For the PCDDs, PCDFs and PCBs, when the analyte concentration was below the limit of detection, half the detection limit was used in the calculation of a weighted mean. For the organochlorine pesticides for which weighted means were calculated (β-HCH, dieldrin and pp'-DDE), limits of detection were excluded from the calculation. That is, when calculating a weighted mean concentration for β-HCH, dieldrin or pp'-DDE, the mean concentration was based only on data from those strata that reported a quantified level of the pesticide.

Weighted medians and weighted means were calculated only when an organochlorine was quantified on at least 66% of occasions within the data set being considered.

B2 Lipid measurements

Total lipids were measured in each sample using a 'summation' method. This approach was based on the individual measurement of the four lipid groups, which together comprise essentially all of the lipids in serum. These analytes included free (i.e. non-esterified) cholesterol, cholesterol esters, triglycerides and phospholipids. When each of these analytes was expressed in the same concentration units (e.g. mg mL^{-1}), a simple summation of the four individual values gave a serum 'total lipid' estimate. There is good agreement between this summation value and the corresponding estimate obtained through extraction and gravimetric analysis (Akins *et al.*, 1989; Cheek and Wease, 1969). Lipid measurement data are reported in Appendix C, Tables C1 to C10.

The 'total lipid' estimate was based on the average of duplicate determinations of each of the four lipid groups. Serum total lipids (TL) were calculated from the expression:

$$TL = 1.677 * (TC - FC) + FC + TG + PL$$

Where: TC = total cholesterol
FC = free cholesterol
TG = triglycerides
PL = phospholipids.

The constant 1.677 is a factor derived from the ratio of the mean molecular weight of serum cholesterol esters to the molecular weight of cholesterol, and it is included to correct for the weight of fatty acids in the cholesterol ester fraction (represented by the first term in the above expression). Derivation of the constant term has been described by Akins *et al*. (1989).

Total cholesterol and triglycerides were determined in duplicate using standard enzymatic methods on a DuPont ACA III analyser (DuPont Corp., Wilmington, Denver). In the cholesterol analysis, the esters were first cleaved with cholesterol esterase and the total serum cholesterol was then measured by a cholesterol oxidase-peroxidase method in which the hydrogen peroxide formed in the cholesterol oxidase reaction was used to oxidise N,N-diethylaniline HCl/4-aminoantipyrene to produce a chromophore that absorbs at 540 nm. In the triglyceride assays, glycerides were hydrolysed with a fungal lipase and the liberated glycerol was estimated in the presence of glycerol dehydrogenase. This method measures total glycerol; no corrections were made for the free glycerol content of serum.

Free (i.e. non-esterified) cholesterol was measured in duplicate by an enzymatic method similar to that used for total cholesterol but in the absence of cholesterol esterase. Here the hydrogen peroxide that was formed in the cholesterol oxidase reaction was used to couple 4-aminoantipyrene and phenol to produce a quinoneimine dye with an absorbance maximum at 505 nm. Serum phospholipids were also measured in duplicate by an enzymatic method. In this procedure serum choline-containing phospholipids were hydrolysed to free choline by phospholipase D. The choline was then oxidised to betaine by choline oxidase with the concomitant production of hydrogen peroxide. The latter was measured in a manner similar to that used for cholesterol determinations. An Abbott Super VP automated analyser has been adapted to perform the free cholesterol and phospholipid analyses.

Appendix C Serum lipid contents

This appendix provides information on the lipid content of the serum samples analysed for organochlorines.

Table C1	Serum lipid content of Maori aged 15–24 years
Table C2	Serum lipid content of non-Maori aged 15–24 years
Table C3	Serum lipid content of Maori aged 25–34 years
Table C4	Serum lipid content of non-Maori aged 25–34 years
Table C5	Serum lipid content of Maori aged 35–49 years
Table C6	Serum lipid content of non-Maori aged 35–49 years
Table C7	Serum lipid content of Maori aged 50–64 years
Table C8	Serum lipid content of non-Maori aged 50–64 years
Table C9	Serum lipid content of Maori aged 65+ years
Table C10	Serum lipid content of non-Maori aged 65+ years

Table C1 Serum lipid content of Maori aged 15–24 years (%, w/v)

	Maori female				Maori male				National summary: Maori aged 15–24 years		
	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Minimum	Maximum	Mean
Total cholesterol	*	0.182	0.191	0.186	*	*	0.200	0.201	0.182	0.201	0.192
Free cholesterol	*	0.040	0.041	0.037	*	*	0.042	0.044	0.037	0.044	0.041
Phospholipids	*	0.205	0.236	0.218	*	*	0.229	0.218	0.205	0.236	0.221
Triglycerides	*	0.123	0.178	0.114	*	*	0.159	0.116	0.114	0.178	0.138
Total lipid	*	0.607	0.706	0.619	*	*	0.695	0.642	0.607	0.706	0.654

* = Insufficient sample collected for organochlorine analysis therefore no lipid determination carried out

Table C2 Serum lipid content of non-Maori aged 15–24 years (%, w/v)

	Non-Maori female				Non-Maori male				National summary: non-Maori aged 15–24 years		
	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Minimum	Maximum	Mean
Total cholesterol	0.174	0.179	0.199	0.190	0.182	0.190	0.255	0.175	0.174	0.255	0.193
Free cholesterol	0.038	0.038	0.045	0.042	0.040	0.040	0.055	0.038	0.038	0.055	0.042
Phospholipids	0.209	0.208	0.232	0.224	0.209	0.211	0.300	0.207	0.207	0.300	0.225
Triglycerides	0.100	0.109	0.123	0.107	0.141	0.166	0.233	0.148	0.100	0.233	0.141
Total lipid	0.575	0.591	0.658	0.620	0.628	0.668	0.922	0.623	0.575	0.922	0.661

Table C3 Serum lipid content of Maori aged 25–34 years (%, w/v)

	Maori female				Maori male				National summary: Maori aged 25–34 years		
	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Minimum	Maximum	Mean
Total cholesterol	0.199	0.205	0.197	0.196	*	*	0.237	0.216	0.196	0.237	0.208
Free cholesterol	0.044	0.044	0.043	0.042	*	*	0.053	0.047	0.042	0.053	0.046
Phospholipids	0.225	0.239	0.228	0.227	*	*	0.259	0.229	0.225	0.259	0.234
Triglycerides	0.120	0.155	0.143	0.163	*	*	0.273	0.123	0.120	0.273	0.163
Total lipid	0.649	0.708	0.672	0.690	*	*	0.893	0.683	0.649	0.893	0.716

* = Insufficient sample collected for organochlorine analysis therefore no lipid determination carried out

Table C4 Serum lipid content of non-Maori aged 25–34 years (%, w/v)

	Non-Maori female				Non-Maori male				National summary: non-Maori aged 25–34 years		
	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island (n=3)[1]	South Island (n=3)[1]	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island (n=2)[1]	South Island (n=2)[1]	Minimum	Maximum	Mean
Total cholesterol	0.202	0.211	0.204	0.206	0.203	0.213	0.272	0.205	0.202	0.272	0.214
Free cholesterol	0.046	0.047	0.047	0.048	0.043	0.047	0.060	0.046	0.043	0.060	0.048
Phospholipids	0.230	0.251	0.233	0.237	0.226	0.240	0.306	0.229	0.226	0.306	0.244
Triglycerides	0.140	0.119	0.127	0.113	0.174	0.135	0.177	0.165	0.113	0.177	0.144
Total lipid	0.677	0.692	0.671	0.662	0.711	0.700	0.898	0.707	0.662	0.898	0.715

1 = Mean of two (n=2) or three (n=3) unique sub-samples prepared for this stratum (see Appendix A, Section A6)

Table C5 Serum lipid content of Maori aged 35–49 years (%, w/v)

	Maori female				Maori male				National summary: Maori aged 35–49 years		
	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Minimum	Maximum	Mean
Total cholesterol	0.201	0.207	0.211	0.211	*	0.241	0.240	0.238	0.201	0.241	0.221
Free cholesterol	0.044	0.046	0.049	0.045	*	0.054	0.052	0.053	0.044	0.054	0.049
Phospholipids	0.222	0.239	0.235	0.237	*	0.268	0.256	0.246	0.222	0.268	0.243
Triglycerides	0.114	0.170	0.138	0.205	*	0.253	0.249	0.166	0.114	0.253	0.185
Total lipid	0.644	0.724	0.693	0.765	*	0.888	0.871	0.775	0.644	0.888	0.766

* = Insufficient sample collected for organochlorine analysis therefore no lipid determination carried out

Table C6 Serum lipid content of non-Maori aged 35–49 years (%, w/v)

	Non-Maori female				Non-Maori male				National summary: non-Maori aged 35–49 years		
	Northland/Auckland (n=2)[1]	Waikato/Bay of Plenty	Lower North Island (n=2)[1]	South Island (n=3)[1]	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island (n=2)[1]	South Island (n=3)[1]	Minimum	Maximum	Mean
Total cholesterol	0.207	0.213	0.224	0.222	0.230	0.243	0.273	0.230	0.207	0.273	0.230
Free cholesterol	0.046	0.049	0.052	0.050	0.051	0.055	0.061	0.052	0.046	0.061	0.052
Phospholipids	0.238	0.253	0.255	0.250	0.249	0.260	0.308	0.252	0.238	0.308	0.258
Triglycerides	0.128	0.136	0.167	0.141	0.234	0.206	0.224	0.199	0.128	0.234	0.179
Total lipid	0.682	0.712	0.762	0.729	0.834	0.836	0.949	0.802	0.682	0.949	0.788

1 = Mean of two (n=2) or three (n=3) unique sub-samples prepared for this stratum (see Appendix A, Section A6)

Table C7 Serum lipid content of Maori aged 50–64 years (%, w/v)

	Maori female				Maori male				National summary: Maori aged 50–64 years		
	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Minimum	Maximum	Mean
Total cholesterol	*	*	0.229	*	*	*	0.271	*	0.229	0.271	0.250
Free cholesterol	*	*	0.052	*	*	*	0.062	*	0.052	0.062	0.057
Phospholipids	*	*	0.233	*	*	*	0.294	*	0.233	0.294	0.264
Triglycerides	*	*	0.162	*	*	*	0.221	*	0.162	0.221	0.191
Total lipid	*	*	0.743	*	*	*	0.927	*	0.743	0.927	0.835

* = Insufficient sample collected for organochlorine analysis therefore no lipid determination carried out

Table C8 Serum lipid content of non-Maori aged 50–64 years (%, w/v)

	Non-Maori female				Non-Maori male				National summary: non-Maori aged 50–64 years		
	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island (n=2)[1]	South Island (n=2)[1]	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island (n=2)[1]	South Island (n=2)[1]	Minimum	Maximum	Mean
Total cholesterol	0.239	0.246	0.246	0.259	0.230	0.234	0.238	0.243	0.230	0.259	0.242
Free cholesterol	0.054	0.057	0.057	0.059	0.051	0.053	0.056	0.056	0.051	0.059	0.055
Phospholipids	0.269	0.286	0.267	0.282	0.248	0.259	0.267	0.264	0.248	0.286	0.268
Triglycerides	0.164	0.177	0.170	0.165	0.202	0.240	0.217	0.206	0.164	0.240	0.192
Total lipid	0.796	0.838	0.810	0.840	0.800	0.855	0.845	0.840	0.796	0.855	0.828

1 = Mean of two unique sub-samples prepared for this stratum (see Appendix A, Section A6)

Table C9 Serum lipid content of Maori aged 65+ years (%, w/v)

	Maori female				Maori male				National summary: Maori aged 65+ years		
	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Minimum	Maximum	Mean
Total cholesterol	*	*	*	*	*	*	*	*	-	-	-
Free cholesterol	*	*	*	*	*	*	*	*	-	-	-
Phospholipids	*	*	*	*	*	*	*	*	-	-	-
Triglycerides	*	*	*	*	*	*	*	*	-	-	-
Total lipid	*	*	*	*	*	*	*	*	-	-	-

* = Insufficient sample collected for organochlorine analysis therefore no lipid determination carried out

Table C10 Serum lipid content of non-Maori aged 65+ years (%, w/v)

	Non-Maori female				Non-Maori male				National summary: non-Maori aged 65+ years		
	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island (n=2)[1]	South Island (n=2)[1]	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island (n=2)[1]	Minimum	Maximum	Mean
Total cholesterol	0.254	0.257	0.245	0.269	0.218	0.238	0.247	0.232	0.218	0.269	0.245
Free cholesterol	0.060	0.060	0.060	0.063	0.052	0.058	0.060	0.056	0.052	0.063	0.058
Phospholipids	0.284	0.291	0.273	0.291	0.232	0.280	0.268	0.257	0.232	0.291	0.272
Triglycerides	0.188	0.199	0.211	0.205	0.158	0.300	0.190	0.200	0.158	0.300	0.207
Total lipid	0.858	0.880	0.854	0.904	0.720	0.941	0.833	0.809	0.720	0.941	0.850

1 = Mean of two unique sub-samples prepared for this stratum (see Appendix A, Section A6)

Appendix D Concentrations of PCDDs and PCDFs in the serum of New Zealanders

This appendix reports the concentrations of PCDDs and PCDFs in the serum of New Zealanders.

Results are provided for all 2,3,7,8-PCDDs and PCDFs. Data for the sum of congeners are reported both excluding LOD values and including half LOD values. PCDD and PCDF TEQ levels are reprted both excluding LOD values and including half LOD values using the 1997 WHO TEFs (Van den Berg, *et al.,* 1998). Median and mean concentrations reported in this appendix (under the heading of 'national summary') are unweighted concentrations. That is, they do not take into account the number of individual samples that were combined to prepare each pooled sample, as described in Section B1.9, Appendix B.

PCDD and PCDF data are reported in the following tables:

Table D1	Concentrations in serum from Maori aged 15–24 years
Table D2	Concentrations in serum from non-Maori aged 15–24 years
Table D3	Concentrations in serum from Maori aged 25–34 years
Table D4	Concentrations in serum from non-Maori aged 25–34 years
Table D5	Concentrations in serum from Maori aged 35–49 years
Table D6	Concentrations in serum from non-Maori aged 35–49 years
Table D7	Concentrations in serum from Maori aged 50–64 years
Table D8	Concentrations in serum from non-Maori aged 50–64 years
Table D9	Concentrations in serum from Maori aged 65+ years
Table D10	Concentrations in serum from non-Maori aged 65+ years
Table D11	Concentrations in serum sub-samples from non-Maori aged 25–34 years
Table D12	Concentrations in serum sub-samples from non-Maori aged 35–49 years
Table D13	Concentrations in serum sub-samples from non-Maori aged 50–64 years
Table D14	Concentrations in serum sub-samples from non-Maori aged 65+ years
Table D15	Concentrations in serum on a congener-specific basis

Table D1 Concentrations of PCDDs and PCDFs in serum from Maori aged 15–24 years (ng kg^{-1}, lipid wt basis)

	Maori female				Maori male				National summary for Maori aged 15–24 years				
Congener	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Number of positives	Minimum	Maximum[3]	Median[4]	Mean[5]
2, 3, 7, 8 TCDD	*	1.1	1.1	1.1	*	*	1.0	< 1	4	< 1	1.1	1.1	0.96
1, 2, 3, 7, 8 PeCDD	*	2.8	2.3	2.3	*	*	2.3	2.6	5	2.3	2.8	2.3	2.5
1, 2, 3, 4, 7, 8 HxCDD	*	1.9	1.2	1.3	*	*	1.4	< 2	4	< 2	1.9	1.3	1.4
1, 2, 3, 6, 7, 8 HxCDD	*	8.5	< 0.7	11.1	*	*	5.6	5.7	4	< 0.7	11.1	5.7	6.3
1, 2, 3, 7, 8, 9 HxCDD	*	3.5	3.0	3.3	*	*	2.4	2.3	5	2.3	3.5	3.0	2.9
1, 2, 3, 4, 6, 7, 8 HpCDD	*	27.0	20.4	27.1	*	*	20.2	< 50	4	< 50	27.1	20.4	23.9
OCDD	*	242	191	339	*	*	170	178	5	170	339	191	224
2, 3, 7, 8 TCDF	*	< 1	< 0.4	< 0.8	*	*	< 0.6	< 1	0	< 0.4	< 1	-	-
1, 2, 3, 7, 8 PeCDF	*	< 2	< 0.4	< 1	*	*	< 0.7	< 1	0	< 0.4	< 2	-	-
2, 3, 4, 7, 8 PeCDF	*	2.1	2.1	2.5	*	*	2.6	2.7	5	2.1	2.7	2.5	2.4
1, 2, 3, 4, 7, 8 HxCDF	*	1.3	1.1	1.5	*	*	1.5	1.7	5	1.1	1.7	1.5	1.4
1, 2, 3, 6, 7, 8 HxCDF	*	1.6	1.4	1.7	*	*	1.7	2.1	5	1.4	2.1	1.7	1.7
2, 3, 4, 6, 7, 8 HxCDF	*	< 2	0.4	0.8	*	*	0.8	< 2	3	< 2	0.8	-	-
1, 2, 3, 7, 8, 9 HxCDF	*	< 1	< 0.5	< 0.6	*	*	< 0.8	< 2	0	< 0.5	< 2	-	-
1, 2, 3, 4, 6, 7, 8 HpCDF	*	< 40	< 10	< 20	*	*	< 20	< 30	0	< 10	< 40	-	-
1, 2, 3, 4, 7, 8, 9 HpCDF	*	< 2	< 0.6	< 0.9	*	*	< 1	< 2	0	< 0.6	< 2	-	-
OCDF	*	< 5	< 2	< 50	*	*	< 2	< 4	0	< 2	< 50	-	-
Sum of 2,3,7,8-PCDD/Fs (inc)[1]	*	319	232	426	*	*	221	246		221	426	246	289
Sum of 2,3,7,8-PCDD/Fs (exc)[2]	*	292	224	392	*	*	210	195		195	392	224	262
PCDD/F TEQ (inc)[1]	*	7.39	5.53	7.10	*	*	6.35	6.49		5.53	7.39	6.49	6.57
PCDD/F TEQ (exc)[2]	*	6.92	5.38	6.92	*	*	6.16	5.15		5.15	6.92	6.16	6.11

1 = Including half LOD values
2 = Excluding LOD values
3 = Excludes any LOD value which is greater than a maximum measured value for that congener
4 = Median concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 4 positive determinations). LODs are included in the median calculation
5 = Mean concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 4 positive determinations). For any individual congener, calculation of the mean includes half LOD values
* = Insufficient sample collected for analysis

Table D2 Concentrations of PCDDs and PCDFs in serum from non-Maori aged 15–24 years (ng kg^{-1}, lipid wt basis)

	Non-Maori female				Non-Maori male				National summary for non-Maori aged 15–24 years				
Congener	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Number of positives	Minimum	Maximum[3]	Median[4]	Mean[5]
2, 3, 7, 8 TCDD	1.0	1.2	1.0	1.2	1.4	1.0	0.7	1.1	8	0.7	1.4	1.1	1.1
1, 2, 3, 7, 8 PeCDD	2.5	2.5	2.5	2.9	3.8	2.8	2.0	3.0	8	2.0	3.8	2.7	2.8
1, 2, 3, 4, 7, 8 HxCDD	1.4	1.3	1.2	1.4	< 2	1.3	1.0	1.5	7	< 2	1.5	1.3	1.3
1, 2, 3, 6, 7, 8 HxCDD	9.0	8.9	10.8	10.9	< 2	9.9	7.2	8.7	7	< 2	10.9	9.0	8.3
1, 2, 3, 7, 8, 9 HxCDD	3.0	2.2	2.8	3.4	< 2	2.5	1.7	2.6	7	< 2	3.4	2.6	2.4
1, 2, 3, 4, 6, 7, 8 HpCDD	21.0	< 30	22.3	29.3	21.3	25.4	14.2	20.0	7	< 30	29.3	21.2	21.1
OCDD	203	254	207	366	189	299	143	196	8	143	366	205	232
2, 3, 7, 8 TCDF	< 0.5	< 0.8	< 0.3	< 0.3	< 0.8	< 0.7	< 0.3	0.4	1	< 0.3	0.4	-	-
1, 2, 3, 7, 8 PeCDF	< 0.6	< 1	< 0.3	< 0.3	< 0.9	< 0.9	< 0.3	< 0.4	0	< 0.3	< 1	-	-
2, 3, 4, 7, 8 PeCDF	2.4	1.9	2.2	2.4	3.1	2.3	1.8	2.5	8	1.8	3.1	2.4	2.3
1, 2, 3, 4, 7, 8 HxCDF	1.3	1.1	1.0	1.6	1.6	1.5	0.9	1.5	8	0.9	1.6	1.4	1.3
1, 2, 3, 6, 7, 8 HxCDF	1.5	1.1	1.4	1.8	1.8	1.6	1.1	1.8	8	1.1	1.8	1.6	1.5
2, 3, 4, 6, 7, 8 HxCDF	0.7	< 0.9	0.3	0.5	1.0	0.7	0.4	0.6	7	< 0.9	1.0	0.6	0.6
1, 2, 3, 7, 8, 9 HxCDF	< 0.7	< 0.9	< 0.3	< 0.3	< 1	< 0.6	< 0.3	< 0.5	0	< 0.3	< 1	-	-
1, 2, 3, 4, 6, 7, 8 HpCDF	< 20	< 20	< 7	7.2	< 20	< 10	< 7	< 10	1	< 7	7.2	-	-
1, 2, 3, 4, 7, 8, 9 HpCDF	< 1	< 1	< 0.4	0.5	< 1	< 0.8	< 0.4	< 0.6	1	< 0.4	0.5	-	-
OCDF	< 2	< 50	< 1	< 70	< 2	< 100	< 1	< 2	0	< 1	< 100	-	-
Sum of 2,3,7,8-PCDD/Fs (inc)[1]	259	325	257	465	240	406	178	246		178	465	258	297
Sum of 2,3,7,8-PCDD/Fs (exc)[2]	247	274	253	429	223	348	174	240		174	429	250	273
PCDD/F TEQ (inc)[1]	6.80	6.54	6.67	7.71	7.95	7.15	5.05	7.37		5.05	7.95	6.97	6.90
PCDD/F TEQ (exc)[2]	6.62	6.14	6.59	7.67	7.42	6.98	4.98	7.28		4.98	7.67	6.80	6.71

1 = Including half LOD values
2 = Excluding LOD values
3 = Excludes any LOD value which is greater than a maximum measured value for that congener
4 = Median concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are included in the median calculation
5 = Mean concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 6 positive determinations). For any individual congener, calculation of the mean includes half LOD values

Table D3 Concentrations of PCDDs and PCDFs in serum from Maori aged 25–34 years (ng kg^{-1}, lipid wt basis)

	Maori female				Maori male				National summary for Maori aged 25–34 years				
Congener	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Number of positives	Minimum	Maximum[3]	Median[4]	Mean[5]
2, 3, 7, 8 TCDD	1.8	1.7	1.4	< 2	*	*	1.4	1.3	5	< 2	1.8	1.4	1.4
1, 2, 3, 7, 8 PeCDD	3.2	4.1	3.2	4.0	*	*	3.3	4.0	6	3.2	4.1	3.7	3.6
1, 2, 3, 4, 7, 8 HxCDD	1.9	2.3	nr	nr	*	*	1.9	2.5	4	1.9	2.5	2.1	2.2
1, 2, 3, 6, 7, 8 HxCDD	20.1	20.2	11.1	12.5	*	*	13.1	16.2	6	11.1	20.2	14.7	15.5
1, 2, 3, 7, 8, 9 HxCDD	3.7	4.5	3.5	3.9	*	*	2.5	2.7	6	2.5	4.5	3.6	3.5
1, 2, 3, 4, 6, 7, 8 HpCDD	42.8	36.9	27.8	51.9	*	*	24.9	30.4	6	24.9	51.9	33.7	35.8
OCDD	387	391	280	912	*	*	231	386	6	231	912	387	431
2, 3, 7, 8 TCDF	< 0.4	< 0.4	< 0.3	< 2	*	*	< 0.4	< 1	0	< 0.3	< 2	-	-
1, 2, 3, 7, 8 PeCDF	< 0.4	< 0.4	< 0.3	< 3	*	*	< 0.8	< 1	0	< 0.3	< 3	-	-
2, 3, 4, 7, 8 PeCDF	2.6	2.8	2.2	2.6	*	*	3.0	4.0	6	2.2	4.0	2.7	2.9
1, 2, 3, 4, 7, 8 HxCDF	1.6	1.6	1.6	2.1	*	*	1.5	2.3	6	1.5	2.3	1.6	1.8
1, 2, 3, 6, 7, 8 HxCDF	2.1	2.0	1.8	2.6	*	*	2.0	2.9	6	1.8	2.9	2.1	2.2
2, 3, 4, 6, 7, 8 HxCDF	0.7	0.6	0.6	1.2	*	*	0.7	< 1	5	< 1	1.2	0.7	0.7
1, 2, 3, 7, 8, 9 HxCDF	< 0.5	< 0.5	< 0.3	< 2	*	*	< 0.5	< 1	0	< 0.3	< 2	-	-
1, 2, 3, 4, 6, 7, 8 HpCDF	< 7	< 7	< 9	< 40	*	*	< 10	< 20	0	< 7	< 40	-	-
1, 2, 3, 4, 7, 8, 9 HpCDF	0.3	0.4	< 0.5	< 3	*	*	0.3	< 1	3	< 0.5	0.4	-	-
OCDF	< 20	< 30	< 2	< 200	*	*	< 2	< 70	0	< 2	< 200	-	-
Sum of 2,3,7,8-PCDD/Fs (inc)[1]	482	487	339	1,120	*	*	295	502		295	1,120	485	538
Sum of 2,3,7,8-PCDD/Fs (exc)[2]	468	468	333	989	*	*	286	452		286	989	460	499
PCDD/F TEQ (inc)[1]	9.87	10.8	7.95	9.48	*	*	8.78	10.7		7.95	10.8	9.67	9.59
PCDD/F TEQ (exc)[2]	9.78	10.7	7.87	8.14	*	*	8.64	10.3		7.87	10.7	9.21	9.24

1 = Including half LOD values
2 = Excluding LOD values
3 = Excludes any LOD value which is greater than a maximum measured value for that congener
4 = Median concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 4 positive determinations). LODs are included in the median calculation
5 = Mean concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 4 positive determinations). For any individual congener, calculation of the mean includes half LOD values
* = Insufficient sample collected for analysis
nr = Result cannot be reported because one or more of the quality assurance or quality control parameters did not meet the specified QA/QC criteria

Table D4 Concentrations of PCDDs and PCDFs in serum from non-Maori aged 25–34 years (ng kg^{-1}, lipid wt basis)

	Non-Maori female				Non-Maori male				National summary for non-Maori aged 25–34 years				
Congener	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island (n=3)[3]	South Island (n=3)[3]	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island (n=2)[3]	South Island (n=2)[3]	Number of positives	Minimum	Maximum[4]	Median[5]	Mean[6]
2, 3, 7, 8 TCDD	2.0	1.5	1.5	1.4	1.4	1.6	1.1	1.2	8	1.1	2.0	1.4	1.4
1, 2, 3, 7, 8 PeCDD	4.2	4.1	3.2	3.1	3.7	4.4	2.8	3.4	8	2.8	4.4	3.5	3.6
1, 2, 3, 4, 7, 8 HxCDD	2.2	2.6	1.9	1.3	2.1	2.5	1.6	1.9	8	1.3	2.6	2.0	2.0
1, 2, 3, 6, 7, 8 HxCDD	20.2	17.9	12.5	13.6	19.7	18.0	13.2	14.9	8	12.5	20.2	16.4	16.2
1, 2, 3, 7, 8, 9 HxCDD	4.3	4.5	3.3	3.4	3.1	3.4	2.0	3.0	8	2.0	4.5	3.4	3.4
1, 2, 3, 4, 6, 7, 8 HpCDD	41.6	40.3	32.7	31.9	41.0	25.0	21.9	28.6	8	21.9	41.6	32.3	32.9
OCDD	400	363	326	366	319	217	209	246	8	209	400	323	306
2, 3, 7, 8 TCDF	0.2	0.3	0.2	< 0.3	< 0.3	< 0.3	< 0.3	< 0.4	3	< 0.3	0.3	-	-
1, 2, 3, 7, 8 PeCDF	0.2	< 0.3	< 0.3	< 0.4	< 0.3	< 0.4	< 0.3	< 0.5	1	< 0.3	0.2	-	-
2, 3, 4, 7, 8 PeCDF	3.4	2.8	2.6	3.1	3.8	3.0	2.6	3.4	8	2.6	3.8	3.0	3.1
1, 2, 3, 4, 7, 8 HxCDF	2.0	1.6	1.4	1.8	1.9	1.9	1.2	1.7	8	1.2	2.0	1.7	1.7
1, 2, 3, 6, 7, 8 HxCDF	2.3	2.2	1.7	2.0	2.5	2.2	1.6	2.4	8	1.6	2.5	2.2	2.1
2, 3, 4, 6, 7, 8 HxCDF	0.7	0.6	0.5	0.7	1.1	0.7	0.8	0.8	8	0.5	1.1	0.7	0.7
1, 2, 3, 7, 8, 9 HxCDF	< 0.4	< 0.3	< 0.4	< 0.4	< 0.4	< 0.3	< 0.3	< 0.6	0	< 0.3	< 0.6	-	-
1, 2, 3, 4, 6, 7, 8 HpCDF	5.3	4.1	5.0	5.8	9.4	< 9	< 5	5.8	6	< 5	9.4	5.2	5.3
1, 2, 3, 4, 7, 8, 9 HpCDF	0.4	< 0.3	0.3	0.3	0.5	< 0.5	< 0.3	0.3	5	< 0.3	0.5	-	-
OCDF	< 30	< 20	< 10	< 20	< 20	< 2	< 10	< 2	0	< 2	< 30	-	-
Sum of 2,3,7,8-PCDD/Fs (inc)[1]	504	456	399	447	420	286	265	314		265	504	409	386
Sum of 2,3,7,8-PCDD/Fs (exc)[2]	489	446	389	433	409	280	257	309		257	489	399	376
PCDD/F TEQ (inc)[1]	11.6	10.5	8.53	8.76	10.6	10.7	7.42	9.09		7.42	11.6	9.78	9.66
PCDD/F TEQ (exc)[2]	11.6	10.4	8.46	8.69	10.6	10.6	7.36	8.99		7.36	11.6	9.72	9.60

1 = Including half LOD values
2 = Excluding LOD values
3 = Mean of two (n=2) or three (n=3) unique sub-samples prepared for this stratum (see Table D11 and Appendix A, Section A6)
4 = Excludes any LOD value which is greater than a maximum measured value for that congener
5 = Median concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are included in the median calculation
6 = Mean concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 6 positive determinations). For any individual congener, calculation of the mean includes half LOD values

Table D5 Concentrations of PCDDs and PCDFs in serum from Maori aged 35–49 years (ng kg^{-1}, lipid wt basis)

	Maori female				Maori male				National summary for Maori aged 35–49 years				
Congener	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Number of positives	Minimum	Maximum[3]	Median[4]	Mean[5]
2, 3, 7, 8 TCDD	2.7	1.9	2.2	2.3	*	2.6	2.1	1.6	7	1.6	2.7	2.2	2.2
1, 2, 3, 7, 8 PeCDD	4.0	5.6	4.1	4.4	*	6.2	4.8	4.1	7	4.0	6.2	4.4	4.7
1, 2, 3, 4, 7, 8 HxCDD	2.5	2.9	2.7	2.7	*	4.1	2.8	3.0	7	2.5	4.1	2.8	3.0
1, 2, 3, 6, 7, 8 HxCDD	13.1	22.7	18.8	17.8	*	29.2	19.2	20.0	7	13.1	29.2	19.2	20.1
1, 2, 3, 7, 8, 9 HxCDD	3.9	4.8	4.1	4.0	*	6.5	3.2	3.2	7	3.2	6.5	4.0	4.2
1, 2, 3, 4, 6, 7, 8 HpCDD	54.7	36.3	38.2	56.3	*	48.1	35.1	32.1	7	32.1	56.3	38.2	43.0
OCDD	689	439	417	961	*	431	308	292	7	292	961	431	505
2, 3, 7, 8 TCDF	< 0.8	< 1	< 0.4	< 0.7	*	0.7	< 0.3	< 0.6	1	< 0.3	0.7	-	-
1, 2, 3, 7, 8 PeCDF	< 0.7	< 1	< 0.5	< 0.7	*	0.7	< 0.4	< 0.6	1	< 0.4	0.7	-	-
2, 3, 4, 7, 8 PeCDF	3.4	3.6	3.5	3.5	*	4.1	4.1	4.0	7	3.4	4.1	3.6	3.7
1, 2, 3, 4, 7, 8 HxCDF	1.8	2.5	2.1	2.1	*	2.9	2.3	1.7	7	1.7	2.9	2.1	2.2
1, 2, 3, 6, 7, 8 HxCDF	2.3	2.7	2.4	2.6	*	3.6	2.7	2.5	7	2.3	3.6	2.6	2.7
2, 3, 4, 6, 7, 8 HxCDF	0.7	0.6	0.6	0.8	*	1.4	0.8	0.8	7	0.6	1.4	0.8	0.8
1, 2, 3, 7, 8, 9 HxCDF	< 1	< 1	< 0.4	< 0.7	*	< 0.8	< 0.4	< 0.7	0	< 0.4	< 1	-	-
1, 2, 3, 4, 6, 7, 8 HpCDF	21.7	< 20	< 7	15.7	*	11.5	< 10	< 20	3	< 7	21.7	-	-
1, 2, 3, 4, 7, 8, 9 HpCDF	1.2	< 0.9	< 0.4	1.1	*	1.2	< 0.7	< 0.9	3	< 0.4	1.2	-	-
OCDF	< 200	< 40	< 20	< 200	*	< 40	< 1	< 2	0	< 1	< 200	-	-
Sum of 2,3,7,8-PCDD/Fs (inc)[1]	897	553	510	1,170	*	574	392	376		376	1,170	553	639
Sum of 2,3,7,8-PCDD/Fs (exc)[2]	797	523	496	1,070	*	554	385	365		365	1,070	523	598
PCDD/F TEQ (inc)[1]	11.8	13.5	11.6	12.4	*	16.4	12.5	11.3		11.3	16.4	12.4	12.8
PCDD/F TEQ (exc)[2]	11.7	13.3	11.5	12.3	*	16.4	12.4	11.2		11.2	16.4	12.3	12.7

1 = Including half LOD values
2 = Excluding LOD values
3 = Excludes any LOD value which is greater than a maximum measured value for that congener
4 = Median concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 5 positive determinations). LODs are included in the median calculation
5 = Mean concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 5 positive determinations). For any individual congener, calculation of the mean includes half LOD values
* = Insufficient sample collected for analysis

Table D6 Concentrations of PCDDs and PCDFs in serum from non-Maori aged 35–49 years (ng kg^{-1}, lipid wt basis)

	Non-Maori female				Non-Maori male				National summary for non-Maori aged 35–49 years				
Congener	**Northland/Auckland (n=2)[3]**	**Waikato/Bay of Plenty**	**Lower North Island (n=2)[3]**	**South Island (n=3)[3]**	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island (n=2)[3]**	**South Island (n=3)[3]**	**Number of positives**	**Minimum**	**Maximum[4]**	**Median[5]**	**Mean[6]**
2, 3, 7, 8 TCDD	2.3	2.2	2.1	2.0	1.9	1.7	1.4	1.9	8	1.4	2.3	2.0	1.9
1, 2, 3, 7, 8 PeCDD	5.3	4.9	3.8	4.9	5.1	5.1	3.8	4.9	8	3.8	5.3	4.9	4.7
1, 2, 3, 4, 7, 8 HxCDD	3.3	3.5	2.6	2.6	3.4	3.6	2.6	2.8	8	2.6	3.6	3.0	3.0
1, 2, 3, 6, 7, 8 HxCDD	25.2	23.6	20.1	20.1	24.0	26.7	19.2	20.5	8	19.2	26.7	22.1	22.4
1, 2, 3, 7, 8, 9 HxCDD	5.1	4.8	3.9	3.9	4.0	4.2	3.1	3.7	8	3.1	5.1	4.0	4.1
1, 2, 3, 4, 6, 7, 8 HpCDD	48.4	40.5	34.2	37.4	40.5	44.6	32.1	33.0	8	32.1	48.4	38.9	38.8
OCDD	455	420	361	399	373	359	285	325	8	285	455	367	372
2, 3, 7, 8 TCDF	< 0.4	0.3	0.2	0.3	< 0.2	0.2	0.2	< 0.3	5	< 0.2	0.3	-	-
1, 2, 3, 7, 8 PeCDF	0.3	< 0.4	< 0.5	< 0.4	< 0.3	< 0.3	< 0.3	< 0.2	1	< 0.2	0.3	-	-
2, 3, 4, 7, 8 PeCDF	4.6	3.8	3.6	3.7	4.5	5.0	3.8	4.0	8	3.6	5.0	3.9	4.1
1, 2, 3, 4, 7, 8 HxCDF	2.2	2.3	1.8	2.0	2.3	2.4	2.0	2.2	8	1.8	2.4	2.2	2.1
1, 2, 3, 6, 7, 8 HxCDF	2.7	2.8	2.2	2.4	2.6	2.9	2.2	2.6	8	2.2	2.9	2.6	2.5
2, 3, 4, 6, 7, 8 HxCDF	0.8	0.7	0.6	0.7	0.8	1.1	0.7	0.9	8	0.6	1.1	0.8	0.8
1, 2, 3, 7, 8, 9 HxCDF	< 0.4	< 0.3	< 0.3	< 0.3	< 0.2	< 0.3	< 0.3	< 0.2	0	< 0.2	< 0.4	-	-
1, 2, 3, 4, 6, 7, 8 HpCDF	6.4	5.1	4.1	5.0	4.8	9.7	5.2	4.8	8	4.1	9.7	5.0	5.6
1, 2, 3, 4, 7, 8, 9 HpCDF	0.4	0.3	0.3	0.3	0.3	0.5	0.3	0.2	8	0.2	0.5	0.3	0.3
OCDF	< 20	< 20	< 20	< 10	< 20	< 30	< 10	< 10	0	< 10	< 30	-	-
Sum of 2,3,7,8-PCDD/Fs (inc)[1]	572	525	448	491	478	482	367	414		367	572	480	472
Sum of 2,3,7,8-PCDD/Fs (exc)[2]	559	515	440	482	467	467	361	406		361	559	467	462
PCDD/F TEQ (inc)[1]	14.3	13.3	11.2	12.4	13.5	14.0	10.5	12.5		10.5	14.3	12.9	12.7
PCDD/F TEQ (exc)[2]	14.3	13.3	11.1	12.4	13.5	14.0	10.4	12.5		10.4	14.3	12.9	12.7

1 = Including half LOD values
2 = Excluding LOD values
3 = Mean of two (n=2) or three (n=3) unique sub-samples prepared for this stratum (see Table D12 and Appendix A, Section A6)
4 = Excludes any LOD value which is greater than a maximum measured value for that congener
5 = Median concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are included in the median calculation
6 = Mean concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 6 positive determinations). For any individual congener, calculation of the mean includes half LOD values

Table D7 Concentrations of PCDDs and PCDFs in serum from Maori aged 50–64 years (ng kg^{-1}, lipid wt basis)

	Maori female				Maori male				National summary for Maori aged 50–64 years				
Congener	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Number of positives	Minimum	Maximum	Median[3]	Mean[4]
2, 3, 7, 8 TCDD	*	*	6.9	*	*	*	2.5	*	2	2.5	6.9	4.7	4.7
1, 2, 3, 7, 8 PeCDD	*	*	7.1	*	*	*	5.4	*	2	5.4	7.1	6.3	6.3
1, 2, 3, 4, 7, 8 HxCDD	*	*	3.9	*	*	*	2.9	*	2	2.9	3.9	3.4	3.4
1, 2, 3, 6, 7, 8 HxCDD	*	*	32.8	*	*	*	25.5	*	2	25.5	32.8	29.2	29.2
1, 2, 3, 7, 8, 9 HxCDD	*	*	6.4	*	*	*	3.2	*	2	3.2	6.4	4.8	4.8
1, 2, 3, 4, 6, 7, 8 HpCDD	*	*	59.9	*	*	*	34.7	*	2	34.7	59.9	47.3	47.3
OCDD	*	*	383	*	*	*	287	*	2	287	383	335	335
2, 3, 7, 8 TCDF	*	*	< 1	*	*	*	< 0.8	*	0	< 0.8	< 1	-	-
1, 2, 3, 7, 8 PeCDF	*	*	< 1	*	*	*	< 0.9	*	0	< 0.9	< 1	-	-
2, 3, 4, 7, 8 PeCDF	*	*	6.2	*	*	*	4.5	*	2	4.5	6.2	5.4	5.4
1, 2, 3, 4, 7, 8 HxCDF	*	*	3.6	*	*	*	3.0	*	2	3.0	3.6	3.3	3.3
1, 2, 3, 6, 7, 8 HxCDF	*	*	3.9	*	*	*	3.1	*	2	3.1	3.9	3.5	3.5
2, 3, 4, 6, 7, 8 HxCDF	*	*	1.0	*	*	*	0.9	*	2	0.9	1.0	1.0	1.0
1, 2, 3, 7, 8, 9 HxCDF	*	*	< 1	*	*	*	< 1	*	0	< 1	< 1	-	-
1, 2, 3, 4, 6, 7, 8 HpCDF	*	*	< 30	*	*	*	< 20	*	0	< 20	< 30	-	-
1, 2, 3, 4, 7, 8, 9 HpCDF	*	*	< 2	*	*	*	< 1	*	0	< 1	< 2	-	-
OCDF	*	*	< 4	*	*	*	< 2	*	0	< 2	< 4	-	-
Sum of 2,3,7,8-PCDD/Fs (inc)[1]	*	*	534	*	*	*	386	*		386	534	460	460
Sum of 2,3,7,8-PCDD/Fs (exc)[2]	*	*	515	*	*	*	373	*		373	515	444	444
PCDD/F TEQ (inc)[1]	*	*	23.2	*	*	*	14.6	*		14.6	23.2	18.9	18.9
PCDD/F TEQ (exc)[2]	*	*	22.9	*	*	*	14.4	*		14.4	22.9	18.6	18.6

1 = Including half LOD values
2 = Excluding LOD values
3 = Median concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 2 positive determinations). LODs are included in the median calculation
4 = Mean concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 2 positive determinations). For any individual congener, calculation of the mean includes half LOD values
* = Insufficient sample collected for analysis

Table D8 Concentrations of PCDDs and PCDFs in serum from non-Maori aged 50–64 years (ng kg^{-1}, lipid wt basis)

	Non-Maori female				Non-Maori male				National summary for non-Maori aged 50–64 years				
Congener	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island (n=2)[3]	South Island (n=2)[3]	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island (n=2)[3]	South Island (n=2)[3]	Number of positives	Minimum	Maximum[4]	Median[5]	Mean[6]
2, 3, 7, 8 TCDD	3.0	3.2	4.0	3.4	3.0	2.4	2.4	2.6	8	2.4	4.0	3.0	3.0
1, 2, 3, 7, 8 PeCDD	5.8	6.5	5.6	5.6	6.2	6.2	4.9	6.1	8	4.9	6.5	6.0	5.9
1, 2, 3, 4, 7, 8 HxCDD	3.5	4.9	3.4	3.2	3.8	4.3	2.9	3.4	8	2.9	4.9	3.5	3.7
1, 2, 3, 6, 7, 8 HxCDD	24.9	35.3	25.2	23.5	31.2	28.4	24.5	25.3	8	23.5	35.3	25.3	27.3
1, 2, 3, 7, 8, 9 HxCDD	5.5	6.7	5.3	4.9	4.5	4.5	4.1	4.6	8	4.1	6.7	4.7	5.0
1, 2, 3, 4, 6, 7, 8 HpCDD	55.2	55.6	53.3	50.0	46.9	47.7	34.1	42.9	8	34.1	55.6	48.8	48.2
OCDD	439	399	497	447	420	406	316	391	8	316	497	413	414
2, 3, 7, 8 TCDF	0.3	0.4	0.4	0.3	< 0.3	0.7	< 0.3	0.3	6	< 0.3	0.7	0.3	0.3
1, 2, 3, 7, 8 PeCDF	0.2	0.2	0.3	0.3	< 0.3	< 0.5	0.3	0.2	6	< 0.3	0.3	0.2	0.2
2, 3, 4, 7, 8 PeCDF	5.1	4.9	4.8	5.2	5.7	5.0	4.9	5.1	8	4.8	5.7	5.0	5.1
1, 2, 3, 4, 7, 8 HxCDF	2.6	3.2	2.7	2.9	2.3	2.9	2.1	2.8	8	2.1	3.2	2.7	2.7
1, 2, 3, 6, 7, 8 HxCDF	3.0	3.5	3.0	3.2	2.9	3.2	2.7	3.7	8	2.7	3.7	3.1	3.1
2, 3, 4, 6, 7, 8 HxCDF	0.9	1.0	1.0	1.0	0.7	0.9	0.9	1.3	8	0.7	1.3	0.9	1.0
1, 2, 3, 7, 8, 9 HxCDF	< 0.3	< 0.3	< 0.3	< 0.4	< 0.3	< 0.4	< 0.4	< 0.3	0	< 0.3	< 0.4	-	-
1, 2, 3, 4, 6, 7, 8 HpCDF	< 5	4.7	5.0	3.9	5.0	4.8	4.0	6.2	7	< 5	6.2	4.8	4.5
1, 2, 3, 4, 7, 8, 9 HpCDF	< 0.3	< 0.4	0.4	< 0.4	0.4	0.3	0.3	0.4	5	< 0.3	0.4	-	-
OCDF	< 1	< 1	< 30	< 7	< 20	< 20	< 10	< 20	0	< 1	< 30	-	-
Sum of 2,3,7,8-PCDD/Fs (inc)[1]	552	530	624	557	543	528	409	503		409	624	537	531
Sum of 2,3,7,8-PCDD/Fs (exc)[2]	549	529	609	554	533	517	401	495		401	609	531	523
PCDD/F TEQ (inc)[1]	16.1	18.3	16.7	16.1	17.2	16.2	13.9	15.9		13.9	18.3	16.1	16.3
PCDD/F TEQ (exc)[2]	16.0	18.3	16.7	16.0	17.1	16.2	13.8	15.8		13.8	18.3	16.1	16.3

1 = Including half LOD values
2 = Excluding LOD values
3 = Mean of two unique sub-samples prepared for this stratum (see Table D13 and Appendix A, Section A6)
4 = Excludes any LOD value which is greater than a maximum measured value for that congener
5 = Median concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are included in the median calculation
6 = Mean concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 6 positive determinations). For any individual congener, calculation of the mean includes half LOD values

Table D9 Concentrations of PCDDs and PCDFs in serum from Maori aged 65+ years (ng kg^{-1}, lipid wt basis)

	Maori female				Maori male				National summary for Maori aged 65+ years				
Congener	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Number of positives	Minimum	Maximum	Median	Mean
2, 3, 7, 8 TCDD	*	*	*	*	*	*	*	*	-	-	-	-	-
1, 2, 3, 7, 8 PeCDD	*	*	*	*	*	*	*	*	-	-	-	-	-
1, 2, 3, 4, 7, 8 HxCDD	*	*	*	*	*	*	*	*	-	-	-	-	-
1, 2, 3, 6, 7, 8 HxCDD	*	*	*	*	*	*	*	*	-	-	-	-	-
1, 2, 3, 7, 8, 9 HxCDD	*	*	*	*	*	*	*	*	-	-	-	-	-
1, 2, 3, 4, 6, 7, 8 HpCDD	*	*	*	*	*	*	*	*	-	-	-	-	-
OCDD	*	*	*	*	*	*	*	*	-	-	-	-	-
2, 3, 7, 8 TCDF	*	*	*	*	*	*	*	*	-	-	-	-	-
1, 2, 3, 7, 8 PeCDF	*	*	*	*	*	*	*	*	-	-	-	-	-
2, 3, 4, 7, 8 PeCDF	*	*	*	*	*	*	*	*	-	-	-	-	-
1, 2, 3, 4, 7, 8 HxCDF	*	*	*	*	*	*	*	*	-	-	-	-	-
1, 2, 3, 6, 7, 8 HxCDF	*	*	*	*	*	*	*	*	-	-	-	-	-
2, 3, 4, 6, 7, 8 HxCDF	*	*	*	*	*	*	*	*	-	-	-	-	-
1, 2, 3, 7, 8, 9 HxCDF	*	*	*	*	*	*	*	*	-	-	-	-	-
1, 2, 3, 4, 6, 7, 8 HpCDF	*	*	*	*	*	*	*	*	-	-	-	-	-
1, 2, 3, 4, 7, 8, 9 HpCDF	*	*	*	*	*	*	*	*	-	-	-	-	-
OCDF	*	*	*	*	*	*	*	*	-	-	-	-	-
Sum of 2,3,7,8-PCDD/Fs (inc)	*	*	*	*	*	*	*	*	-	-	-	-	-
Sum of 2,3,7,8-PCDD/Fs (exc)	*	*	*	*	*	*	*	*	-	-	-	-	-
PCDD/F TEQ (inc)	*	*	*	*	*	*	*	*	-	-	-	-	-
PCDD/F TEQ (exc)	*	*	*	*	*	*	*	*	-	-	-	-	-

* = Insufficient sample collected for analysis

Table D10 Concentrations of PCDDs and PCDFs in serum from non-Maori aged 65+ years (ng kg^{-1}, lipid wt basis)

	Non-Maori female				Non-Maori male				National summary for non-Maori aged 65+ years				
Congener	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island (n=2)[3]	South Island (n=2)[3]	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island (n=2)[3]	Number of positives	Minimum	Maximum[4]	Median[5]	Mean[6]
2, 3, 7, 8 TCDD	6.3	5.6	7.0	5.0	3.0	3.5	2.9	2.9	8	2.9	7.0	4.3	4.5
1, 2, 3, 7, 8 PeCDD	9.1	9.3	7.1	7.6	6.4	7.7	5.2	6.2	8	5.2	9.3	7.3	7.3
1, 2, 3, 4, 7, 8 HxCDD	5.9	5.7	5.3	4.2	3.5	5.0	3.0	3.7	8	3.0	5.9	4.6	4.5
1, 2, 3, 6, 7, 8 HxCDD	36.8	39.3	36.3	36.1	30.7	39.6	24.3	29.4	8	24.3	39.6	36.2	34.1
1, 2, 3, 7, 8, 9 HxCDD	8.3	7.8	6.8	6.7	4.6	6.1	4.2	4.9	8	4.2	8.3	6.4	6.2
1, 2, 3, 4, 6, 7, 8 HpCDD	85.9	65.9	59.9	56.8	38.6	57.5	30.9	42.6	8	30.9	85.9	57.1	54.8
OCDD	628	527	484	537	304	561	278	382	8	278	628	506	463
2, 3, 7, 8 TCDF	0.4	0.2	0.2	0.3	< 0.4	0.4	0.3	0.3	7	< 0.4	0.4	0.3	0.3
1, 2, 3, 7, 8 PeCDF	< 0.7	nr	< 0.4	0.3	< 0.5	< 0.3	0.2	0.2	3	< 0.3	0.3	-	-
2, 3, 4, 7, 8 PeCDF	8.3	6.8	6.7	6.5	4.4	5.6	4.9	5.6	8	4.4	8.3	6.0	6.1
1, 2, 3, 4, 7, 8 HxCDF	4.2	4.3	3.5	3.6	2.2	3.1	2.4	2.7	8	2.2	4.3	3.3	3.2
1, 2, 3, 6, 7, 8 HxCDF	4.6	4.4	3.8	4.0	2.5	3.7	3.0	3.4	8	2.5	4.6	3.8	3.7
2, 3, 4, 6, 7, 8 HxCDF	1.1	1.0	1.0	1.0	0.7	0.9	0.8	0.9	8	0.7	1.1	1.0	0.9
1, 2, 3, 7, 8, 9 HxCDF	< 0.3	< 0.2	< 0.4	< 0.3	< 0.6	< 0.4	< 0.3	< 0.3	0	< 0.2	< 0.6	-	-
1, 2, 3, 4, 6, 7, 8 HpCDF	5.5	4.3	< 9	4.4	< 10	7.1	< 7	5.2	5	< 7	7.1	-	-
1, 2, 3, 4, 7, 8, 9 HpCDF	0.3	0.2	< 0.5	< 0.6	< 0.7	0.4	< 0.4	0.2	4	< 0.4	0.4	-	-
OCDF	< 20	< 10	< 1	< 1	< 1	< 70	< 1	< 10	0	< 1	< 70	-	-
Sum of 2,3,7,8-PCDD/Fs (inc)[1]	815	687	627	674	408	737	365	499		365	815	650	601
Sum of 2,3,7,8-PCDD/Fs (exc)[2]	805	682	621	673	401	702	360	491		360	805	647	592
PCDD/F TEQ (inc)[1]	26.7	25.3	23.7	22.1	16.6	20.6	14.8	17.1		14.8	26.7	21.4	20.9
PCDD/F TEQ (exc)[2]	26.7	25.3	23.6	22.1	16.4	20.6	14.7	17.1		14.7	26.7	21.3	20.8

1 = Including half LOD values
2 = Excluding LOD values
3 = Mean of two unique sub-samples prepared for this stratum (see Table D14 and Appendix A, Section A6)
4 = Excludes any LOD value which is greater than a maximum measured value for that congener
5 = Median concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are included in the median calculation
6 = Mean concentration reported only if a PCDD/F congener detected on more than 66% of occasions (minimum of 6 positive determinations). For any individual congener, calculation of the mean includes half LOD values
nr = Result cannot be reported because one or more of the quality assurance or quality control parameters did not meet the specified QA/QC criteria

Table D11 Concentrations of PCDDs and PCDFs in serum sub-samples from non-Maori aged 25–34 years (ng kg^{-1}, lipid wt basis)[1]

	Female, Lower North Island			Female, South Island			Male, Lower North Island		Male, South Island	
Congener	SS#1	SS#2	SS#3	SS#1	SS#2	SS#3	SS#1	SS#2	SS#1	SS#2
2, 3, 7, 8 TCDD	1.4	1.7	1.3	1.2	1.2	1.7	1.1	1.0	0.9	1.4
1, 2, 3, 7, 8 PeCDD	3.1	3.6	2.8	3.3	2.8	3.3	3.0	2.5	2.9	3.8
1, 2, 3, 4, 7, 8 HxCDD	1.9	2.0	1.7	2.0	1.5	< 0.6	1.6	1.5	1.6	2.2
1, 2, 3, 6, 7, 8 HxCDD	15.7	12.1	9.7	12.4	10.8	17.7	11.4	15.0	12.8	16.9
1, 2, 3, 7, 8, 9 HxCDD	3.9	3.4	2.7	3.4	2.8	3.9	2.0	1.9	2.6	3.4
1, 2, 3, 4, 6, 7, 8 HpCDD	41.3	29.9	27.0	34.1	21.3	40.4	23.7	20.1	23.4	33.7
OCDD	406	323	249	371	271	457	190	227	218	273
2, 3, 7, 8 TCDF	< 0.3	0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.2	< 0.3	< 0.4
1, 2, 3, 7, 8 PeCDF	< 0.3	< 0.3	< 0.4	< 0.4	< 0.4	< 0.3	< 0.3	< 0.2	< 0.6	< 0.4
2, 3, 4, 7, 8 PeCDF	2.7	3.1	2.1	3.3	2.5	3.4	2.9	2.3	3.1	3.7
1, 2, 3, 4, 7, 8 HxCDF	1.5	1.4	1.2	1.9	1.5	1.9	1.3	1.1	1.5	1.9
1, 2, 3, 6, 7, 8 HxCDF	1.9	1.8	1.4	2.0	1.6	2.3	1.6	1.5	2.1	2.6
2, 3, 4, 6, 7, 8 HxCDF	0.6	0.5	0.5	0.8	0.5	0.8	1.0	0.5	0.6	0.9
1, 2, 3, 7, 8, 9 HxCDF	< 0.3	< 0.5	< 0.3	< 0.6	< 0.3	< 0.4	< 0.4	< 0.2	< 0.6	< 0.6
1, 2, 3, 4, 6, 7, 8 HpCDF	4.9	< 10	< 10	5.9	< 10	6.7	< 6	< 4	< 10	4.8
1, 2, 3, 4, 7, 8, 9 HpCDF	0.3	< 0.5	< 0.6	0.4	< 0.5	nr	< 0.4	< 0.2	< 0.7	0.3
OCDF	< 30	< 2	< 1	< 30	< 1	< 40	< 1	< 20	< 1	< 2
Sum of 2,3,7,8-PCDD/Fs (inc)[2]	501	389	306	457	324	560	244	287	278	350
Sum of 2,3,7,8-PCDD/Fs (exc)[3]	485	383	299	442	318	539	240	274	270	349
PCDD/F TEQ (inc)[2]	8.94	9.41	7.25	8.89	7.45	10.0	7.78	7.06	7.85	10.3
PCDD/F TEQ (exc)[3]	8.90	9.33	7.16	8.84	7.36	9.88	7.70	7.02	7.72	10.3

1 = These data are the results of the analyses of unique sub-samples (SS#1, SS#2, SS#3) prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6). Mean data for sub-samples reported in Table D4

2 = Including half LOD values

3 = Excluding LOD values

nr = Result cannot be reported because one or more of the quality assurance or quality control parameters did not meet the specified QA/QC criteria

Table D12 Concentrations of PCDDs and PCDFs in serum sub-samples from non-Maori aged 35–49 years (ng kg^{-1}, lipid wt basis)[1]

	Female, Northland/Auckland		Female, Lower North Island		Female, South Island			Male, Lower North Island		Male, South Island		
Congener	SS#1	SS#2	SS#1	SS#2	SS#1	SS#2	SS#3	SS#1	SS#2	SS#1	SS#2	SS#3
2, 3, 7, 8 TCDD	2.9	1.6	2.3	1.8	1.5	2.2	2.3	1.3	1.4	1.6	1.8	2.2
1, 2, 3, 7, 8 PeCDD	6.1	4.4	3.8	3.7	3.9	4.4	6.4	3.8	3.8	4.5	5.0	5.3
1, 2, 3, 4, 7, 8 HxCDD	3.8	2.7	2.5	2.7	2.4	2.3	3.0	2.8	2.4	2.3	3.1	2.9
1, 2, 3, 6, 7, 8 HxCDD	31.6	18.7	20.6	19.5	17.4	22.4	20.4	20.2	18.2	19.8	21.9	19.8
1, 2, 3, 7, 8, 9 HxCDD	6.8	3.4	3.6	4.2	3.4	4.3	4.0	3.2	2.9	3.4	3.9	3.7
1, 2, 3, 4, 6, 7, 8 HpCDD	64.3	32.5	32.5	35.9	35.3	44.6	32.2	33.7	30.5	28.8	37.4	32.9
OCDD	566	343	334	388	391	448	357	283	287	276	381	317
2, 3, 7, 8 TCDF	< 0.3	< 0.4	0.3	< 0.3	0.2	0.4	< 0.3	0.2	< 0.2	< 0.2	< 0.3	< 0.3
1, 2, 3, 7, 8 PeCDF	0.3	< 0.6	< 0.3	< 0.6	< 0.3	< 0.3	< 0.5	< 0.2	< 0.3	< 0.2	< 0.3	< 0.2
2, 3, 4, 7, 8 PeCDF	4.8	4.3	3.8	3.4	3.4	4.1	3.5	4.2	3.4	3.5	3.6	4.9
1, 2, 3, 4, 7, 8 HxCDF	2.5	1.8	1.7	1.9	1.9	2.3	1.8	2.1	1.8	2.1	2.0	2.4
1, 2, 3, 6, 7, 8 HxCDF	3.0	2.4	2.1	2.3	2.2	2.7	2.2	2.3	2.0	2.5	2.4	2.8
2, 3, 4, 6, 7, 8 HxCDF	0.9	0.7	0.6	0.6	0.7	0.8	0.7	0.8	0.6	0.9	0.8	0.9
1, 2, 3, 7, 8, 9 HxCDF	< 0.4	< 0.4	< 0.3	< 0.2	< 0.3	< 0.3	< 0.3	< 0.2	< 0.3	< 0.2	< 0.3	< 0.2
1, 2, 3, 4, 6, 7, 8 HpCDF	9.6	< 7	4.2	4.0	5.6	4.5	< 10	5.1	5.2	4.1	5.6	4.7
1, 2, 3, 4, 7, 8, 9 HpCDF	0.5	0.3	0.3	0.2	0.3	0.3	< 0.5	0.3	0.2	< 0.3	< 0.5	0.3
OCDF	< 30	< 10	< 10	< 20	< 20	< 20	< 1	< 10	< 10	< 10	< 3	< 30
Sum of 2,3,7,8-PCDD/Fs (inc)[2]	718	425	418	479	480	554	440	368	365	355	471	415
Sum of 2,3,7,8-PCDD/Fs (exc)[3]	703	416	412	468	469	543	434	363	359	350	469	400
PCDD/F TEQ (inc)[2]	17.1	11.6	11.6	10.8	10.4	12.7	14.1	10.8	10.1	11.3	12.5	13.6
PCDD/F TEQ (exc)[3]	17.1	11.5	11.5	10.8	10.4	12.7	14.0	10.8	10.1	11.3	12.5	13.6

1 = These data are the results of the analyses of unique sub-samples (SS#1, SS#2, SS#3) prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6). Mean data for sub-samples reported in Table D6

2 = Including half LOD values

3 = Excluding LOD values

Table D13 Concentrations of PCDDs and PCDFs in serum sub-samples from non-Maori aged 50–64 years (ng kg^{-1}, lipid wt basis)[1]

	Female, Lower North Island		Female, South Island		Male, Lower North Island		Male, South Island	
Congener	SS#1	SS#2	SS#1	SS#2	SS#1	SS#2	SS#1	SS#2
2, 3, 7, 8 TCDD	4.9	3.1	2.9	3.8	2.3	2.5	2.8	2.3
1, 2, 3, 7, 8 PeCDD	6.3	4.8	5.2	6.0	5.0	4.8	6.6	5.6
1, 2, 3, 4, 7, 8 HxCDD	3.8	3.0	2.9	3.4	2.9	2.8	3.4	3.4
1, 2, 3, 6, 7, 8 HxCDD	26.2	24.2	21.2	25.8	27.4	21.5	24.8	25.8
1, 2, 3, 7, 8, 9 HxCDD	6.1	4.4	4.7	5.0	4.2	4.0	4.9	4.2
1, 2, 3, 4, 6, 7, 8 HpCDD	65.5	41.0	46.7	53.2	37.5	30.7	40.5	45.2
OCDD	658	336	448	446	362	269	350	431
2, 3, 7, 8 TCDF	0.3	0.4	0.3	0.3	< 0.3	< 0.3	0.2	0.3
1, 2, 3, 7, 8 PeCDF	< 0.4	0.3	0.3	0.2	< 0.4	0.3	0.2	< 0.3
2, 3, 4, 7, 8 PeCDF	5.4	4.2	4.5	5.9	5.2	4.5	5.7	4.4
1, 2, 3, 4, 7, 8 HxCDF	3.1	2.2	2.4	3.4	2.4	1.8	2.7	2.8
1, 2, 3, 6, 7, 8 HxCDF	3.4	2.5	2.6	3.8	3.0	2.4	4.1	3.3
2, 3, 4, 6, 7, 8 HxCDF	1.0	0.9	0.8	1.2	0.9	0.9	1.5	1.0
1, 2, 3, 7, 8, 9 HxCDF	< 0.3	< 0.2	< 0.3	< 0.4	< 0.3	< 0.4	< 0.4	< 0.2
1, 2, 3, 4, 6, 7, 8 HpCDF	6.6	< 7	3.6	4.2	4.3	< 7	4.9	7.5
1, 2, 3, 4, 7, 8, 9 HpCDF	0.5	< 0.4	< 0.2	< 0.5	0.3	< 0.4	0.3	0.4
OCDF	< 50	< 1	< 10	< 1	< 20	< 1	< 1	< 30
Sum of 2,3,7,8-PCDD/Fs (inc)[2]	816	431	551	563	468	350	453	552
Sum of 2,3,7,8-PCDD/Fs (exc)[3]	791	427	546	562	457	345	453	537
PCDD/F TEQ (inc)[2]	19.1	14.3	14.4	17.7	14.5	13.3	16.9	14.8
PCDD/F TEQ (exc)[3]	19.1	14.2	14.4	17.7	14.4	13.2	16.9	14.7

1 = These data are the results of the analyses of unique sub-samples (SS#1, SS#2) prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6). Mean data for sub-samples reported in Table D8

2 = Including half LOD values

3 = Excluding LOD values

Table D14 Concentrations of PCDDs and PCDFs in serum sub-samples from non-Maori aged 65+ years (ng kg^{-1}, lipid wt basis)[1]

	Female, Lower North Island		Female, South Island		Male, South Island	
Congener	SS#1	SS#2	SS#1	SS#2	SS#1	SS#2
2, 3, 7, 8 TCDD	6.7	7.2	5.7	4.3	2.7	3.2
1, 2, 3, 7, 8 PeCDD	6.7	7.4	9.0	6.2	6.2	6.3
1, 2, 3, 4, 7, 8 HxCDD	5.7	4.8	5.0	3.4	3.2	4.2
1, 2, 3, 6, 7, 8 HxCDD	38.8	33.8	44.8	27.3	25.1	34.1
1, 2, 3, 7, 8, 9 HxCDD	6.4	7.1	7.5	5.9	4.5	5.4
1, 2, 3, 4, 6, 7, 8 HpCDD	57.4	62.3	62.7	50.8	37.4	48.3
OCDD	497	471	611	462	374	390
2, 3, 7, 8 TCDF	< 0.3	0.3	0.4	< 0.3	0.3	0.4
1, 2, 3, 7, 8 PeCDF	< 0.4	< 0.3	0.2	0.3	< 0.4	0.3
2, 3, 4, 7, 8 PeCDF	6.9	6.4	6.5	6.4	5.2	6.0
1, 2, 3, 4, 7, 8 HxCDF	3.4	3.5	3.6	3.6	2.4	3.1
1, 2, 3, 6, 7, 8 HxCDF	3.9	3.7	4.1	3.9	2.9	3.9
2, 3, 4, 6, 7, 8 HxCDF	1.0	1.0	0.9	1.1	0.8	1.1
1, 2, 3, 7, 8, 9 HxCDF	< 0.4	< 0.4	< 0.3	< 0.3	< 0.3	< 0.4
1, 2, 3, 4, 6, 7, 8 HpCDF	< 9	< 9	4.9	3.8	4.5	5.9
1, 2, 3, 4, 7, 8, 9 HpCDF	< 0.5	< 0.5	< 0.6	< 0.5	0.2	0.3
OCDF	< 1	< 1	< 2	< 1	< 10	< 20
Sum of 2,3,7,8-PCDD/Fs (inc)[2]	640	614	768	580	475	523
Sum of 2,3,7,8-PCDD/Fs (exc)[3]	634	609	766	579	469	513
PCDD/F TEQ (inc)[2]	23.5	24.0	25.3	18.9	15.9	18.3
PCDD/F TEQ (exc)[3]	23.4	23.9	25.3	18.8	15.9	18.3

1 = These data are the results of the analyses of unique sub-samples (SS#1, SS#2) prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6). Mean data for sub-samples reported in Table D10

2 = Including half LOD values

3 = Excluding LOD values

Table D15 Concentrations of PCDDs and PCDFs in serum on a congener-specific basis (ng kg^{-1}, lipid wt basis)

Congener		Maori female				Maori male				Non-Maori female[1]				Non-Maori male[1]			
		Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island
2, 3, 7, 8 TCDD	15–24	*	1.1	1.1	1.1	*	*	1.0	< 1	1.0	1.2	1.0	1.2	1.4	1.0	0.7	1.1
	25–34	1.8	1.7	1.4	< 2	*	*	1.4	1.3	2.0	1.5	1.5	1.4	1.4	1.6	1.1	1.2
	35–49	2.7	1.9	2.2	2.3	*	2.6	2.1	1.6	2.3	2.2	2.1	2.0	1.9	1.7	1.4	1.9
	50–64	*	*	6.9	*	*	*	2.5	*	3.0	3.2	4.0	3.4	3.0	2.4	2.4	2.6
	65+	*	*	*	*	*	*	*	*	6.3	5.6	7.0	5.0	3.0	3.5	2.9	2.9
1, 2, 3, 7, 8 PeCDD	15–24	*	2.8	2.3	2.3	*	*	2.3	2.6	2.5	2.5	2.5	2.9	3.8	2.8	2.0	3.0
	25–34	3.2	4.1	3.2	4.0	*	*	3.3	4.0	4.2	4.1	3.2	3.1	3.7	4.4	2.8	3.4
	35–49	4.0	5.6	4.1	4.4	*	6.2	4.8	4.1	5.3	4.9	3.8	4.9	5.1	5.1	3.8	4.9
	50–64	*	*	7.1	*	*	*	5.4	*	5.8	6.5	5.6	5.6	6.2	6.2	4.9	6.1
	65+	*	*	*	*	*	*	*	*	9.1	9.3	7.1	7.6	6.4	7.7	5.2	6.2
1, 2, 3, 4, 7, 8 HxCDD	15–24	*	1.9	1.2	1.3	*	*	1.4	< 2	1.4	1.3	1.2	1.4	< 2	1.3	1.0	1.5
	25–34	1.9	2.3	nr	nr	*	*	1.9	2.5	2.2	2.6	1.9	1.3	2.1	2.5	1.6	1.9
	35–49	2.5	2.9	2.7	2.7	*	4.1	2.8	3.0	3.3	3.5	2.6	2.6	3.4	3.6	2.6	2.8
	50–64	*	*	3.9	*	*	*	2.9	*	3.5	4.9	3.4	3.2	3.8	4.3	2.9	3.4
	65+	*	*	*	*	*	*	*	*	5.9	5.7	5.3	4.2	3.5	5.0	3.0	3.7
1, 2, 3, 6, 7, 8 HxCDD	15–24	*	8.5	< 0.7	11.1	*	*	5.6	5.7	9.0	8.9	10.8	10.9	< 2	9.9	7.2	8.7
	25–34	20.1	20.2	11.1	12.5	*	*	13.1	16.2	20.2	17.9	12.5	13.6	19.7	18.0	13.2	14.9
	35–49	13.1	22.7	18.8	17.8	*	29.2	19.2	20.0	25.2	23.6	20.1	20.1	24.0	26.7	19.2	20.5
	50–64	*	*	32.8	*	*	*	25.5	*	24.9	35.3	25.2	23.5	31.2	28.4	24.5	25.3
	65+	*	*	*	*	*	*	*	*	36.8	39.3	36.3	36.1	30.7	39.6	24.3	29.4
1, 2, 3, 7, 8, 9 HxCDD	15–24	*	3.5	3.0	3.3	*	*	2.4	2.3	3.0	2.2	2.8	3.4	< 2	2.5	1.7	2.6
	25–34	3.7	4.5	3.5	3.9	*	*	2.5	2.7	4.3	4.5	3.3	3.4	3.1	3.4	2.0	3.0
	35–49	3.9	4.8	4.1	4.0	*	6.5	3.2	3.2	5.1	4.8	3.9	3.9	4.0	4.2	3.1	3.7
	50–64	*	*	6.4	*	*	*	3.2	*	5.5	6.7	5.3	4.9	4.5	4.5	4.1	4.6
	65+	*	*	*	*	*	*	*	*	8.3	7.8	6.8	6.7	4.6	6.1	4.2	4.9
1, 2, 3, 4, 6, 7, 8 HpCDD	15–24	*	27.0	20.4	27.1	*	*	20.2	< 50	21.0	< 30	22.3	29.3	21.3	25.4	14.2	20.0
	25–34	42.8	36.9	27.8	51.9	*	*	24.9	30.4	41.6	40.3	32.7	31.9	41.0	25.0	21.9	28.6
	35–49	54.7	36.3	38.2	56.3	*	48.1	35.1	32.1	48.4	40.5	34.2	37.4	40.5	44.6	32.1	33.0
	50–64	*	*	59.9	*	*	*	34.7	*	55.2	55.6	53.3	50.0	46.9	47.7	34.1	42.9
	65+	*	*	*	*	*	*	*	*	85.9	65.9	59.9	56.8	38.6	57.5	30.9	42.6

Table D15 (cont.) Concentrations of PCDDs and PCDFs in serum on a congener-specific basis (ng kg^{-1}, lipid wt basis)

Congener		Maori female				Maori male				Non-Maori female[1]				Non-Maori male[1]			
		Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island
OCDD	15–24	*	242	191	339	*	*	170	178	203	254	207	366	189	299	143	196
	25–34	387	391	280	912	*	*	231	386	400	363	326	366	319	217	209	246
	35–49	689	439	417	961	*	431	308	292	455	420	361	399	373	359	285	325
	50–64	*	*	383	*	*	*	287	*	439	399	497	447	420	406	316	391
	65+	*	*	*	*	*	*	*	*	628	527	484	537	304	561	278	382
2, 3, 7, 8 TCDF	15–24	*	< 1	< 0.4	< 0.8	*	*	< 0.6	< 1	< 0.5	< 0.8	< 0.3	< 0.3	< 0.8	< 0.7	< 0.3	0.4
	25–34	< 0.4	< 0.4	< 0.3	< 2	*	*	< 0.4	< 1	0.2	0.3	0.2	< 0.3	< 0.3	< 0.3	< 0.3	< 0.4
	35–49	< 0.8	< 1	< 0.4	< 0.7	*	0.7	< 0.3	< 0.6	< 0.4	0.3	0.2	0.3	< 0.2	0.2	0.2	< 0.3
	50–64	*	*	< 1	*	*	*	< 0.8	*	0.3	0.4	0.4	0.3	< 0.3	0.7	< 0.3	0.3
	65+	*	*	*	*	*	*	*	*	0.4	0.2	0.2	0.3	< 0.4	0.4	0.3	0.3
1, 2, 3, 7, 8 PeCDF	15–24	*	< 2	< 0.4	< 1	*	*	< 0.7	< 1	< 0.6	< 1	< 0.3	< 0.3	< 0.9	< 0.9	< 0.3	< 0.4
	25–34	< 0.4	< 0.4	< 0.3	< 3	*	*	< 0.8	< 1	0.2	< 0.3	< 0.3	< 0.4	< 0.3	< 0.4	< 0.3	< 0.5
	35–49	< 0.7	< 1	< 0.5	< 0.7	*	0.7	< 0.4	< 0.6	0.3	< 0.4	< 0.5	< 0.4	< 0.3	< 0.3	< 0.3	< 0.2
	50–64	*	*	< 1	*	*	*	< 0.9	*	0.2	0.2	0.3	0.3	< 0.3	< 0.5	0.3	0.2
	65+	*	*	*	*	*	*	*	*	< 0.7	nr	< 0.4	0.3	< 0.5	< 0.3	0.2	0.2
2, 3, 4, 7, 8 PeCDF	15–24	*	2.1	2.1	2.5	*	*	2.6	2.7	2.4	1.9	2.2	2.4	3.1	2.3	1.8	2.5
	25–34	2.6	2.8	2.2	2.6	*	*	3.0	4.0	3.4	2.8	2.6	3.1	3.8	3.0	2.6	3.4
	35–49	3.4	3.6	3.5	3.5	*	4.1	4.1	4.0	4.6	3.8	3.6	3.7	4.5	5.0	3.8	4.0
	50–64	*	*	6.2	*	*	*	4.5	*	5.1	4.9	4.8	5.2	5.7	5.0	4.9	5.1
	65+	*	*	*	*	*	*	*	*	8.3	6.8	6.7	6.5	4.4	5.6	4.9	5.6
1, 2, 3, 4, 7, 8 HxCDF	15–24	*	1.3	1.1	1.5	*	*	1.5	1.7	1.3	1.1	1.0	1.6	1.6	1.5	0.9	1.5
	25–34	1.6	1.6	1.6	2.1	*	*	1.5	2.3	2.0	1.6	1.4	1.8	1.9	1.9	1.2	1.7
	35–49	1.8	2.5	2.1	2.1	*	2.9	2.3	1.7	2.2	2.3	1.8	2.0	2.3	2.4	2.0	2.2
	50–64	*	*	3.6	*	*	*	3.0	*	2.6	3.2	2.7	2.9	2.3	2.9	2.1	2.8
	65+	*	*	*	*	*	*	*	*	4.2	4.3	3.5	3.6	2.2	3.1	2.4	2.7
1, 2, 3, 6, 7, 8 HxCDF	15–24	*	1.6	1.4	1.7	*	*	1.7	2.1	1.5	1.1	1.4	1.8	1.8	1.6	1.1	1.8
	25–34	2.1	2.0	1.8	2.6	*	*	2.0	2.9	2.3	2.2	1.7	2.0	2.5	2.2	1.6	2.4
	35–49	2.3	2.7	2.4	2.6	*	3.6	2.7	2.5	2.7	2.8	2.2	2.4	2.6	2.9	2.2	2.6
	50–64	*	*	3.9	*	*	*	3.1	*	3.0	3.5	3.0	3.2	2.9	3.2	2.7	3.7
	65+	*	*	*	*	*	*	*	*	4.6	4.4	3.8	4.0	2.5	3.7	3.0	3.4

Table D15 (cont.) Concentrations of PCDDs and PCDFs in serum on a congener-specific basis (ng kg^{-1}, lipid wt basis)

Congener		Maori female				Maori male				Non-Maori female[1]				Non-Maori male[1]			
		Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island
2, 3, 4, 6, 7, 8 HxCDF	15–24	*	< 2	0.4	0.8	*	*	0.8	< 2	0.7	< 0.9	0.3	0.5	1.0	0.7	0.4	0.6
	25–34	0.7	0.6	0.6	1.2	*	*	0.7	< 1	0.7	0.6	0.5	0.7	1.1	0.7	0.8	0.8
	35–49	0.7	0.6	0.6	0.8	*	1.4	0.8	0.8	0.8	0.7	0.6	0.7	0.8	1.1	0.7	0.9
	50–64	*	*	1.0	*	*	*	0.9	*	0.9	1.0	1.0	1.0	0.7	0.9	0.9	1.3
	65+	*	*	*	*	*	*	*	*	1.1	1.0	1.0	1.0	0.7	0.9	0.8	0.9
1, 2, 3, 7, 8, 9 HxCDF	15–24	*	< 1	< 0.5	< 0.6	*	*	< 0.8	< 2	< 0.7	< 0.9	< 0.3	< 0.3	< 1	< 0.6	< 0.3	< 0.5
	25–34	< 0.5	< 0.5	< 0.3	< 2	*	*	< 0.5	< 1	< 0.4	< 0.3	< 0.4	< 0.4	< 0.4	< 0.3	< 0.3	< 0.6
	35–49	< 1	< 1	< 0.4	< 0.7	*	< 0.8	< 0.4	< 0.7	< 0.4	< 0.3	< 0.3	< 0.3	< 0.2	< 0.3	< 0.3	< 0.2
	50–64	*	*	< 1	*	*	*	< 1	*	< 0.3	< 0.3	< 0.3	< 0.4	< 0.3	< 0.4	< 0.4	< 0.3
	65+	*	*	*	*	*	*	*	*	< 0.3	< 0.2	< 0.4	< 0.3	< 0.6	< 0.4	< 0.3	< 0.3
1, 2, 3, 4, 6, 7, 8 HpCDF	15–24	*	< 40	< 10	< 20	*	*	< 20	< 30	< 20	< 20	< 7	7.2	< 20	< 10	< 7	< 10
	25–34	< 7	< 7	< 9	< 40	*	*	< 10	< 20	5.3	4.1	5.0	5.8	9.4	< 9	< 5	5.8
	35–49	21.7	< 20	< 7	15.7	*	11.5	< 10	< 20	6.4	5.1	4.1	5.0	4.8	9.7	5.2	4.8
	50–64	*	*	< 30	*	*	*	< 20	*	< 5	4.7	5.0	3.9	5.0	4.8	4.0	6.2
	65+	*	*	*	*	*	*	*	*	5.5	4.3	< 9	4.4	< 10	7.1	< 7	5.2
1, 2, 3, 4, 7, 8, 9 HpCDF	15–24	*	< 2	< 0.6	< 0.9	*	*	< 1	< 2	< 1	< 1	< 0.4	0.5	< 1	< 0.8	< 0.4	< 0.6
	25–34	0.3	0.4	< 0.5	< 3	*	*	0.3	< 1	0.4	< 0.3	0.3	0.3	0.5	< 0.5	< 0.3	0.3
	35–49	1.2	< 0.9	< 0.4	1.1	*	1.2	< 0.7	< 0.9	0.4	0.3	0.3	0.3	0.3	0.5	0.3	0.2
	50–64	*	*	< 2	*	*	*	< 1	*	< 0.3	< 0.4	0.4	< 0.4	0.4	0.3	0.3	0.4
	65+	*	*	*	*	*	*	*	*	0.3	0.2	< 0.5	< 0.6	< 0.7	0.4	< 0.4	0.2
OCDF	15–24	*	< 5	< 2	< 50	*	*	< 2	< 4	< 2	< 50	< 1	< 70	< 2	< 100	< 1	< 2
	25–34	< 20	< 30	< 2	< 200	*	*	< 2	< 70	< 30	< 20	< 10	< 20	< 20	< 2	< 10	< 2
	35–49	< 200	< 40	< 20	< 200	*	< 40	< 1	< 2	< 20	< 20	< 20	< 10	< 20	< 30	< 10	< 10
	50–64	*	*	< 4	*	*	*	< 2	*	< 1	< 1	< 30	< 7	< 20	< 20	< 10	< 20
	65+	*	*	*	*	*	*	*	*	< 20	< 10	< 1	< 1	< 1	< 70	< 1	< 10

Table D15 (cont.) Concentrations of PCDDs and PCDFs in serum on a congener specific basis (ng kg^{-1}, lipid wt basis)

Congener		Maori female				Maori male				Non-Maori female[1]				Non-Maori male[1]			
		Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island
Sum of 2,3,7,8-PCDD/Fs (inc)[2]	15–24	*	319	232	426	*	*	221	246	259	325	257	465	240	406	178	246
	25–34	482	487	339	1,120	*	*	295	502	504	456	399	447	420	286	265	314
	35–49	897	553	510	1,170	*	574	392	376	572	525	448	491	478	482	367	414
	50–64	*	*	534	*	*	*	386	*	552	530	624	557	543	528	409	503
	65+	*	*	*	*	*	*	*	*	815	687	627	674	408	737	365	499
Sum of 2,3,7,8-PCDD/Fs (exc)[3]	15–24	*	292	224	392	*	*	210	195	247	274	253	429	223	348	174	240
	25–34	468	468	333	989	*	*	286	452	489	446	389	433	409	280	257	309
	35–49	797	523	496	1,070	*	554	385	365	559	515	440	482	467	467	361	406
	50–64	*	*	515	*	*	*	373	*	549	529	609	554	533	517	401	495
	65+	*	*	*	*	*	*	*	*	805	682	621	673	401	702	360	491
PCDD/F TEQ (inc)[2]	15–24	*	7.39	5.53	7.10	*	*	6.35	6.49	6.80	6.54	6.67	7.71	7.95	7.15	5.05	7.37
	25–34	9.87	10.8	7.95	9.48	*	*	8.78	10.7	11.6	10.5	8.53	8.76	10.6	10.7	7.42	9.09
	35–49	11.8	13.5	11.6	12.4	*	16.4	12.5	11.3	14.3	13.3	11.2	12.4	13.5	14.0	10.5	12.5
	50–64	*	*	23.2	*	*	*	14.6	*	16.1	18.3	16.7	16.1	17.2	16.2	13.9	15.9
	65+	*	*	*	*	*	*	*	*	26.7	25.3	23.7	22.1	16.6	20.6	14.8	17.1
PCDD/F TEQ (exc)[3]	15–24	*	6.92	5.38	6.92	*	*	6.16	5.15	6.62	6.14	6.59	7.67	7.42	6.98	4.98	7.28
	25–34	9.78	10.7	7.87	8.14	*	*	8.64	10.3	11.6	10.4	8.46	8.69	10.6	10.6	7.36	8.99
	35–49	11.7	13.3	11.5	12.3	*	16.4	12.4	11.2	14.3	13.3	11.1	12.4	13.5	14.0	10.4	12.5
	50–64	*	*	22.9	*	*	*	14.4	*	16.0	18.3	16.7	16.0	17.1	16.2	13.8	15.8
	65+	*	*	*	*	*	*	*	*	26.7	25.3	23.6	22.1	16.4	20.6	14.7	17.1

1 = Some data for certain age groups and geographic regions are means of unique sub-samples. Data for individual sub-samples are reported in Tables D11-D14
2 = Including half LOD values
3 = Excluding LOD values
* = Insufficient sample collected for analysis
nr = Result cannot be reported because one or more of the quality assurance or quality control parameters did not meet the specified QA/QC criteria

Appendix E Concentrations of PCBs in the serum of New Zealanders

This appendix reports the concentrations of PCBs in the serum of New Zealanders.

Results are provided for 42 PCB congeners. Data for the sum of congeners are reported both excluding LOD values and including half LOD values. PCB TEQ levels are reported both excluding LOD values and including half LOD values using the 1997 WHO TEFs (Van den Berg, *et al.,* 1998). Median and mean concentrations reported in this appendix (under the heading of 'national summary') are unweighted concentrations. That is, they do not take into account the number of individual samples that were combined to prepare each pooled sample, as described in Section B1.9, Appendix B.

PCB data are reported in the following tables:

Table E1	Concentrations in serum from Maori aged 15–24 years
Table E2	Concentrations in serum from non-Maori aged 15–24 years
Table E3	Concentrations in serum from Maori aged 25–34 years
Table E4	Concentrations in serum from non-Maori aged 25–34 years
Table E5	Concentrations in serum from Maori aged 35–49 years
Table E6	Concentrations in serum from non-Maori aged 35–49 years
Table E7	Concentrations in serum from Maori aged 50–64 years
Table E8	Concentrations in serum from non-Maori aged 50–64 years
Table E9	Concentrations in serum from Maori aged 65+ years
Table E10	Concentrations in serum from non-Maori aged 65+ years
Table E11	Concentrations in serum sub-samples from non-Maori aged 25–34 years
Table E12	Concentrations in serum sub-samples from non-Maori aged 35–49 years
Table E13	Concentrations in serum sub-samples from non-Maori aged 50–64 years
Table E14	Concentrations in serum sub-samples from non-Maori aged 65+ years
Table E15	Concentrations in serum on a congener-specific basis

Table E1 Concentrations of PCBs in serum from Maori aged 15–24 years (μg kg^{-1}, lipid wt basis)

	Maori female				Maori male				National summary for Maori aged 15–24 years				
Congener	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Number of positives	Minimum	Maximum [3]	Median [4]	Mean [5]
PCB #77	*	< 0.2	< 0.05	< 0.1	*	*	< 0.09	< 0.2	0	< 0.05	< 0.2	-	-
PCB #81	*	< 0.01	< 0.003	< 0.008	*	*	< 0.006	< 0.01	0	< 0.003	< 0.01	-	-
PCB #126	*	0.012	0.016	0.014	*	*	0.013	0.013	5	0.012	0.016	0.013	0.014
PCB #169	*	0.0076	0.0077	0.0089	*	*	0.0097	0.013	5	0.0076	0.013	0.0089	0.0094
PCB #18	*	< 10	< 10	< 10	*	*	< 10	< 10	0	< 10	< 10	-	-
PCB #28	*	< 20	< 20	< 20	*	*	< 20	< 20	0	< 20	< 20	-	-
PCB #52	*	< 10	< 10	< 20	*	*	< 20	< 20	0	< 10	< 20	-	-
PCB #49	*	< 8	< 10	< 20	*	*	< 10	< 10	0	< 8	< 20	-	-
PCB #44	*	< 10	< 10	< 20	*	*	< 20	< 10	0	< 10	< 20	-	-
PCB #74	*	< 6	< 5	< 6	*	*	< 6	< 6	0	< 5	< 6	-	-
PCB #66	*	< 6	< 5	< 6	*	*	< 6	< 6	0	< 5	< 6	-	-
PCB #101	*	< 6	< 5	< 6	*	*	< 5	< 6	0	< 5	< 6	-	-
PCB #99	*	< 6	< 5	< 6	*	*	< 5	< 6	0	< 5	< 6	-	-
PCB #87	*	< 6	< 5	< 6	*	*	< 5	< 6	0	< 5	< 6	-	-
PCB #110	*	< 6	< 5	< 6	*	*	< 5	< 6	0	< 5	< 6	-	-
PCB #118	*	< 6	< 5	< 6	*	*	< 5	< 5	0	< 5	< 6	-	-
PCB #105	*	< 6	< 5	< 6	*	*	< 5	< 5	0	< 5	< 6	-	-
PCB #151	*	< 6	< 5	< 7	*	*	< 6	< 6	0	< 5	< 7	-	-
PCB #149	*	< 6	< 5	< 7	*	*	< 6	< 6	0	< 5	< 7	-	-
PCB #146	*	< 6	< 6	< 7	*	*	< 6	< 6	0	< 6	< 7	-	-
PCB #153	*	6.1	6.8	6.6	*	*	8.9	9.9	5	6.1	9.9	6.8	7.7
PCB #138 + PCB #158	*	< 6	5.4	< 7	*	*	5.9	7.2	3	< 6	7.2	-	-
PCB #128	*	< 6	< 6	< 8	*	*	< 9	< 7	0	< 6	< 9	-	-
PCB #167	*	< 6	< 6	< 8	*	*	< 10	< 7	0	< 6	< 10	-	-
PCB #156	*	< 6	< 6	< 7	*	*	< 7	< 6	0	< 6	< 7	-	-
PCB #157	*	< 6	< 6	< 7	*	*	< 7	< 6	0	< 6	< 7	-	-
PCB #178	*	< 7	< 6	< 8	*	*	< 8	< 6	0	< 6	< 8	-	-
PCB #187	*	< 9	< 6	< 9	*	*	< 10	< 7	0	< 6	< 10	-	-
PCB #183	*	< 9	< 6	< 9	*	*	< 10	< 7	0	< 6	< 10	-	-
PCB #177	*	< 7	< 7	< 9	*	*	< 9	< 7	0	< 7	< 9	-	-
PCB #172	*	< 7	< 7	< 9	*	*	< 9	< 7	0	< 7	< 9	-	-
PCB #180	*	< 7	< 7	< 9	*	*	6.8	8.0	2	< 7	8.0	-	-
PCB #170	*	< 6	< 7	< 20	*	*	< 7	< 7	0	< 6	< 20	-	-
PCB #189	*	< 7	< 8	< 8	*	*	< 8	< 8	0	< 7	< 8	-	-
PCB #201	*	< 7	< 8	< 20	*	*	< 10	< 8	0	< 7	< 20	-	-
PCB #196 + PCB #203	*	< 7	< 10	< 10	*	*	< 10	< 10	0	< 7	< 10	-	-
PCB #195	*	< 8	< 9	< 10	*	*	< 10	< 10	0	< 8	< 10	-	-
PCB #194	*	< 8	< 9	< 10	*	*	< 10	< 10	0	< 8	< 10	-	-
PCB #206	*	< 10	< 10	< 10	*	*	< 10	< 10	0	< 10	< 10	-	-
PCB #209	*	< 10	< 20	< 20	*	*	< 10	< 20	0	< 10	< 20	-	-
Sum of PCBs (inc)[1]	*	138	149	196	*	*	166	167		138	196	166	163
Sum of PCBs (exc)[2]	*	6.12	12.2	6.62	*	*	21.6	25.1		6.12	25.1	12.2	14.3
PCB TEQ (inc)[1]	*	0.0051	0.0054	0.0062	*	*	0.0059	0.0056		0.0051	0.0062	0.0056	0.0056
PCB TEQ (exc)[2]	*	0.0013	0.0016	0.0015	*	*	0.0014	0.0015		0.0013	0.0016	0.0015	0.0015

1 = Including half LOD values
2 = Excluding LOD values
3 = Excludes any LOD value which is greater than a maximum measured value for that congener
4 = Median concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 4 positive determinations). LODs are included in the median calculation
5 = Mean concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 4 positive determinations). For any individual congener, calculation of the mean includes half LOD values
* = Insufficient sample collected for analysis

Table E2 Concentrations of PCBs in serum from non-Maori aged 15–24 years (μg kg^{-1}, lipid wt basis)

	Non-Maori female				Non-Maori male				National summary for non-Maori aged 15–24 years				
Congener	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Number of positives	Minimum	Maximum	Median [3]	Mean [4]
PCB #77	< 0.08	< 0.1	< 0.04	< 0.05	< 0.1	< 0.09	< 0.04	< 0.05	0	< 0.04	< 0.1	-	-
PCB #81	< 0.005	< 0.01	< 0.002	< 0.003	< 0.007	< 0.007	< 0.002	< 0.003	0	< 0.002	< 0.01	-	-
PCB #126	0.015	0.011	0.015	0.015	0.018	0.017	0.011	0.015	8	0.011	0.018	0.015	0.015
PCB #169	0.0088	0.0086	0.0091	0.0098	0.017	0.014	0.0096	0.013	8	0.0086	0.017	0.0097	0.011
PCB #18	< 10	< 20	< 10	< 10	< 20	< 10	< 8	< 20	0	< 8	< 20	-	-
PCB #28	< 20	< 30	< 20	< 20	< 30	< 20	< 10	< 30	0	< 10	< 30	-	-
PCB #52	< 20	< 20	< 10	< 20	< 20	< 10	< 7	< 30	0	< 7	< 30	-	-
PCB #49	< 10	< 10	< 9	< 10	< 10	< 7	< 5	< 20	0	< 5	< 20	-	-
PCB #44	< 20	< 20	< 10	< 20	< 20	< 9	< 6	< 30	0	< 6	< 30	-	-
PCB #74	< 8	< 8	< 5	< 6	< 6	< 6	< 4	< 8	0	< 4	< 8	-	-
PCB #66	< 8	< 8	< 5	< 6	< 6	< 6	< 4	< 8	0	< 4	< 8	-	-
PCB #101	< 6	< 7	< 6	< 5	< 7	< 5	< 4	< 8	0	< 4	< 8	-	-
PCB #99	< 6	< 7	< 5	< 5	< 6	< 5	< 4	< 7	0	< 4	< 7	-	-
PCB #87	< 6	< 8	< 5	< 5	< 6	< 5	< 4	< 9	0	< 4	< 9	-	-
PCB #110	< 6	< 8	< 5	< 5	< 6	< 5	< 4	< 9	0	< 4	< 9	-	-
PCB #118	< 6	< 7	< 5	< 5	< 6	< 5	< 4	< 8	0	< 4	< 8	-	-
PCB #105	< 6	< 7	< 5	< 5	< 6	< 5	< 4	< 8	0	< 4	< 8	-	-
PCB #151	< 7	< 7	< 5	< 5	< 6	< 5	< 4	< 9	0	< 4	< 9	-	-
PCB #149	< 7	< 7	< 5	< 5	< 6	< 5	< 4	< 9	0	< 4	< 9	-	-
PCB #146	< 8	< 7	< 5	< 7	< 6	< 5	< 5	< 9	0	< 5	< 9	-	-
PCB #153	8.6	9.5	7.2	7.8	12.3	12.7	10.7	11.2	8	7.2	12.7	10.1	10.0
PCB #138 + PCB #158	< 7	6.4	5.5	< 6	8.8	8.5	7.2	7.1	6	< 6	8.8	6.8	6.3
PCB #128	< 10	< 8	< 6	< 8	< 7	< 5	< 5	< 10	0	< 5	< 10	-	-
PCB #167	< 10	< 7	< 6	< 6	< 7	< 5	< 5	< 10	0	< 5	< 10	-	-
PCB #156	< 7	< 7	< 5	< 6	< 7	< 5	< 5	< 10	0	< 5	< 10	-	-
PCB #157	< 8	< 7	< 6	< 6	< 7	< 5	< 5	< 10	0	< 5	< 10	-	-
PCB #178	< 8	< 8	< 6	< 7	< 7	< 5	< 5	< 10	0	< 5	< 10	-	-
PCB #187	< 10	< 9	< 6	< 7	< 8	< 5	< 5	< 20	0	< 5	< 20	-	-
PCB #183	< 10	< 9	< 6	< 7	< 8	< 5	< 5	< 20	0	< 5	< 20	-	-
PCB #177	< 10	< 8	< 5	< 7	< 8	< 5	< 6	< 10	0	< 5	< 10	-	-
PCB #172	< 10	< 8	< 5	< 7	< 8	< 5	< 6	< 10	0	< 5	< 10	-	-
PCB #180	6.6	7.6	5.5	7.1	9.2	10.8	9.3	9.6	8	5.5	10.8	8.4	8.2
PCB #170	< 8	< 7	< 6	< 6	< 8	< 5	< 6	< 10	0	< 5	< 10	-	-
PCB #189	< 9	< 8	< 7	< 8	< 9	< 6	< 7	< 10	0	< 6	< 10	-	-
PCB #201	< 10	< 8	< 9	< 9	< 9	< 8	< 7	< 10	0	< 7	< 10	-	-
PCB #196 + PCB #203	< 10	< 10	< 9	< 9	< 10	< 8	< 9	< 20	0	< 8	< 20	-	-
PCB #195	< 10	< 10	< 9	< 10	< 10	< 8	< 9	< 20	0	< 8	< 20	-	-
PCB #194	< 10	< 10	< 9	< 10	< 10	< 8	< 9	< 20	0	< 8	< 20	-	-
PCB #206	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 20	0	< 10	< 20	-	-
PCB #209	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 20	0	< 10	< 20	-	-
Sum of PCBs (inc)[1]	185	182	140	157	180	145	127	255		127	255	169	171
Sum of PCBs (exc)[2]	15.2	23.5	18.2	14.9	30.3	32.0	27.2	27.9		14.9	32.0	25.4	23.7
PCB TEQ (inc)[1]	0.0066	0.0059	0.0052	0.0055	0.0063	0.0052	0.0047	0.0083		0.0047	0.0083	0.0057	0.0060
PCB TEQ (exc)[2]	0.0016	0.0012	0.0016	0.0016	0.0019	0.0018	0.0012	0.0016		0.0012	0.0019	0.0016	0.0016

1 = Including half LOD values
2 = Excluding LOD values
3 = Median concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are included in the median calculation
4 = Mean concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 6 positive determinations). For any individual congener, calculation of the mean includes half LOD values

Table E3 Concentrations of PCBs in serum from Maori aged 25–34 years (μg kg^{-1}, lipid wt basis)

	Maori female				Maori male				National summary for Maori aged 25–34 years				
Congener	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Number of positives	Minimum	Maximum [3]	Median [4]	Mean [5]
PCB #77	< 0.06	< 0.06	< 0.05	< 0.2	*	*	< 0.05	< 0.2	0	< 0.05	< 0.2	-	-
PCB #81	< 0.004	< 0.004	< 0.003	< 0.02	*	*	< 0.005	< 0.01	0	< 0.003	< 0.02	-	-
PCB #126	0.021	0.020	0.019	0.020	*	*	0.018	0.013	6	0.013	0.021	0.019	0.018
PCB #169	0.012	0.014	0.012	0.013	*	*	0.018	0.021	6	0.012	0.021	0.014	0.015
PCB #18	< 10	< 10	< 10	< 10	*	*	< 8	< 10	0	< 8	< 10	-	-
PCB #28	< 20	< 20	< 20	< 20	*	*	< 10	< 20	0	< 10	< 20	-	-
PCB #52	< 10	< 9	< 10	< 9	*	*	< 7	< 20	0	< 7	< 20	-	-
PCB #49	< 9	< 7	< 7	< 7	*	*	< 5	< 10	0	< 5	< 10	-	-
PCB #44	< 10	< 9	< 9	< 9	*	*	< 6	< 10	0	< 6	< 10	-	-
PCB #74	< 5	< 5	< 6	< 5	*	*	< 4	< 6	0	< 4	< 6	-	-
PCB #66	< 5	< 5	< 6	< 5	*	*	< 4	< 6	0	< 4	< 6	-	-
PCB #101	< 5	< 5	< 6	< 5	*	*	< 4	< 6	0	< 4	< 6	-	-
PCB #99	< 5	< 5	< 6	< 5	*	*	< 4	< 6	0	< 4	< 6	-	-
PCB #87	< 5	< 5	< 6	< 5	*	*	< 4	< 6	0	< 4	< 6	-	-
PCB #110	< 5	< 5	< 6	< 5	*	*	< 4	< 6	0	< 4	< 6	-	-
PCB #118	< 5	< 5	< 6	< 5	*	*	< 4	< 5	0	< 4	< 6	-	-
PCB #105	< 5	< 5	< 5	< 5	*	*	< 4	< 5	0	< 4	< 5	-	-
PCB #151	< 6	< 5	< 6	< 5	*	*	< 4	< 6	0	< 4	< 6	-	-
PCB #149	< 6	< 5	< 6	< 5	*	*	< 4	< 6	0	< 4	< 6	-	-
PCB #146	< 6	< 6	< 6	< 5	*	*	< 4	< 6	0	< 4	< 6	-	-
PCB #153	13.4	15.8	11.5	10.1	*	*	15.7	19.4	6	10.1	19.4	14.6	14.3
PCB #138 + PCB #158	9.0	11.0	8.3	7.3	*	*	10.2	12.9	6	7.3	12.9	9.6	9.8
PCB #128	< 8	< 8	< 7	< 6	*	*	< 4	< 7	0	< 4	< 8	-	-
PCB #167	< 9	< 7	< 7	< 6	*	*	< 4	< 7	0	< 4	< 9	-	-
PCB #156	< 6	< 6	< 7	< 6	*	*	< 4	< 6	0	< 4	< 7	-	-
PCB #157	< 6	< 6	< 7	< 6	*	*	< 4	< 7	0	< 4	< 7	-	-
PCB #178	< 7	< 6	< 7	< 5	*	*	< 4	< 7	0	< 4	< 7	-	-
PCB #187	< 9	< 8	< 7	< 6	*	*	< 4	< 8	0	< 4	< 9	-	-
PCB #183	< 9	< 8	< 7	< 6	*	*	< 4	< 8	0	< 4	< 9	-	-
PCB #177	< 8	< 8	< 8	< 5	*	*	< 4	< 7	0	< 4	< 8	-	-
PCB #172	< 8	< 8	< 8	< 5	*	*	< 4	< 7	0	< 4	< 8	-	-
PCB #180	10.0	11.5	8.9	8.5	*	*	14.2	16.7	6	8.5	16.7	10.8	11.6
PCB #170	< 7	5.4	< 8	< 20	*	*	6.7	6.5	3	< 7	6.7	-	-
PCB #189	< 8	< 10	< 9	< 9	*	*	< 6	< 7	0	< 6	< 10	-	-
PCB #201	< 10	< 10	< 9	< 40	*	*	< 30	< 8	0	< 8	< 40	-	-
PCB #196 + PCB #203	< 20	< 10	< 9	< 40	*	*	< 9	< 9	0	< 9	< 40	-	-
PCB #195	< 10	< 10	< 10	< 10	*	*	< 8	< 10	0	< 8	< 10	-	-
PCB #194	< 10	< 10	< 10	< 10	*	*	< 8	< 10	0	< 8	< 10	-	-
PCB #206	< 10	< 20	< 10	< 10	*	*	< 9	< 10	0	< 9	< 20	-	-
PCB #209	< 10	< 20	< 10	< 10	*	*	< 10	< 20	0	< 10	< 20	-	-
Sum of PCBs (inc)[1]	173	176	162	178	*	*	144	192		144	192	175	171
Sum of PCBs (exc)[2]	32.4	43.7	28.7	25.9	*	*	46.8	55.5		25.9	55.5	38.1	38.9
PCB TEQ (inc)[1]	0.0064	0.0063	0.0064	0.0060	*	*	0.0048	0.0055		0.0048	0.0064	0.0061	0.0059
PCB TEQ (exc)[2]	0.0022	0.0021	0.0020	0.0021	*	*	0.0019	0.0015		0.0015	0.0022	0.0020	0.0020

1 = Including half LOD values
2 = Excluding LOD values
3 = Excludes any LOD value which is greater than a maximum measured value for that congener
4 = Median concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 4 positive determinations). LODs are included in the median calculation
5 = Mean concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 4 positive determinations). For any individual congener, calculation of the mean includes half LOD values
* = Insufficient sample collected for analysis

Table E4 Concentrations of PCBs in serum from non-Maori aged 25–34 years (µg kg^{-1}, lipid wt basis)

	Non-Maori female				Non-Maori male				National summary for non-Maori aged 25–34 years				
Congener	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island (n=3) [3]	South Island (n=3) [3]	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island (n=2) [3]	South Island (n=2) [3]	Number of positives	Minimum	Maximum [4]	Median [5]	Mean [6]
PCB #77	< 0.04	< 0.05	< 0.05	< 0.05	< 0.05	< 0.04	< 0.03	< 0.05	0	< 0.03	< 0.05	-	-
PCB #81	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.002	< 0.003	0	< 0.002	< 0.003	-	-
PCB #126	0.029	0.023	0.019	0.017	0.023	0.018	0.012	0.016	8	0.012	0.029	0.019	0.020
PCB #169	0.016	0.015	0.013	0.012	0.021	0.024	0.016	0.017	8	0.012	0.024	0.016	0.017
PCB #18	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	0	< 10	< 10	-	-
PCB #28	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	0	< 20	< 20	-	-
PCB #52	< 10	< 10	< 20	< 10	< 20	< 9	< 10	< 20	0	< 9	< 20	-	-
PCB #49	< 7	< 8	< 10	< 10	< 10	< 6	< 9	< 10	0	< 6	< 10	-	-
PCB #44	< 9	< 10	< 20	< 10	< 20	< 8	< 10	< 20	0	< 8	< 20	-	-
PCB #74	< 5	< 5	< 6	< 6	< 6	< 5	< 4	< 5	0	< 4	< 6	-	-
PCB #66	< 5	< 5	< 6	< 6	< 6	< 5	< 4	< 5	0	< 4	< 6	-	-
PCB #101	< 5	< 6	< 6	< 5	< 5	< 5	< 5	< 6	0	< 5	< 6	-	-
PCB #99	< 5	< 6	< 6	< 5	< 5	< 5	< 4	< 5	0	< 4	< 6	-	-
PCB #87	< 5	< 6	< 6	< 6	< 5	< 5	< 4	< 5	0	< 4	< 6	-	-
PCB #110	< 5	< 6	< 6	< 6	< 5	< 5	< 4	< 5	0	< 4	< 6	-	-
PCB #118	< 5	< 6	< 6	< 5	< 5	< 5	< 4	< 5	0	< 4	< 6	-	-
PCB #105	< 5	< 6	< 5	< 5	< 5	< 5	< 4	< 5	0	< 4	< 6	-	-
PCB #151	< 5	< 6	< 6	< 6	< 6	< 5	< 5	< 5	0	< 5	< 6	-	-
PCB #149	< 5	< 6	< 6	< 6	< 6	< 5	< 5	< 5	0	< 5	< 6	-	-
PCB #146	< 6	< 6	< 6	< 6	< 7	< 5	< 5	< 6	0	< 5	< 7	-	-
PCB #153	19.5	14.8	13.2	15.3	21.2	25.2	17.8	15.9	8	13.2	25.2	16.8	17.9
PCB #138 + PCB #158	13.5	10.2	8.7	9.8	11.8	15.6	11.2	10.7	8	8.7	15.6	10.9	11.4
PCB #128	< 6	< 6	< 7	< 6	< 6	< 6	< 5	< 7	0	< 5	< 7	-	-
PCB #167	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 7	0	< 6	< 7	-	-
PCB #156	< 6	< 6	< 6	< 5	< 6	< 6	< 5	< 6	0	< 5	< 6	-	-
PCB #157	< 6	< 6	< 6	< 5	< 6	< 6	< 5	< 6	0	< 5	< 6	-	-
PCB #178	< 6	< 6	< 6	< 6	< 7	< 5	< 5	< 6	0	< 5	< 7	-	-
PCB #187	< 7	< 6	< 7	< 7	< 8	6.3	3.4	< 8	2	< 6	6.3	-	-
PCB #183	< 7	< 6	< 7	< 7	< 8	< 5	< 6	< 8	0	< 5	< 8	-	-
PCB #177	< 7	< 6	< 7	< 6	< 8	< 6	< 6	< 6	0	< 6	< 8	-	-
PCB #172	< 7	< 6	< 7	< 6	< 8	< 6	< 6	< 6	0	< 6	< 8	-	-
PCB #180	14.2	12.0	10.7	11.5	17.5	27.1	16.9	14.1	8	10.7	27.1	14.1	15.5
PCB #170	5.8	5.5	< 6	< 6	7.1	12.9	6.9	6.3	6	< 6	12.9	6.1	6.3
PCB #189	< 9	< 7	< 8	< 6	< 8	nr	< 6	< 7	0	< 6	< 9	-	-
PCB #201	< 8	< 9	< 8	< 6	< 8	< 40	< 7	< 9	0	< 6	< 40	-	-
PCB #196 + PCB #203	< 9	< 8	< 10	< 7	< 10	< 40	< 9	< 9	0	< 7	< 40	-	-
PCB #195	< 10	< 9	< 9	< 8	< 10	< 10	< 7	< 9	0	< 7	< 10	-	-
PCB #194	< 10	< 9	< 9	< 8	< 10	5.3	< 7	< 9	1	< 7	5.3	-	-
PCB #206	< 10	< 10	< 10	< 9	< 10	< 10	< 9	< 10	0	< 9	< 10	-	-
PCB #209	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	0	< 10	< 10	-	-
Sum of PCBs (inc)[1]	173	163	173	161	194	225	160	178		160	225	173	179
Sum of PCBs (exc)[2]	53.0	42.5	32.7	36.5	57.6	92.4	54.6	46.9		32.7	92.4	50.0	52.0
PCB TEQ (inc)[1]	0.0071	0.0063	0.0060	0.0054	0.0064	0.0055	0.0045	0.0055		0.0045	0.0071	0.0058	0.0058
PCB TEQ (exc)[2]	0.0031	0.0025	0.0021	0.0019	0.0025	0.0020	0.0014	0.0018		0.0014	0.0031	0.0020	0.0022

1 = Including half LOD values
2 = Excluding LOD values
3 = Mean of two (n=2) or three (n=3) unique sub-samples prepared for this stratum (see Table E11 and Appendix A, Section A6)
4 = Excludes any LOD value which is greater than a maximum measured value for that congener
5 = Median concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are included in the median calculation
6 = Mean concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 6 positive determinations). For any individual congener, calculation of the mean includes half LOD values
nr = Result cannot be reported because one or more of the quality assurance or quality control parameters did not meet the specified QA/QC criteria

Table E5 Concentrations of PCBs in serum from Maori aged 35–49 years (μg kg^{-1}, lipid wt basis)

	Maori female				Maori male				National summary for Maori aged 35–49 years				
Congener	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Number of positives	Minimum	Maximum [3]	Median [4]	Mean [5]
PCB #77	< 0.1	< 0.1	< 0.06	< 0.1	*	< 0.1	< 0.05	< 0.1	0	< 0.05	< 0.1	-	-
PCB #81	< 0.008	< 0.008	< 0.004	< 0.006	*	< 0.006	< 0.003	< 0.006	0	< 0.003	< 0.008	-	-
PCB #126	0.022	0.022	0.022	0.026	*	0.030	0.021	0.021	7	0.021	0.030	0.022	0.023
PCB #169	0.017	0.018	0.017	0.017	*	0.032	0.026	0.027	7	0.017	0.032	0.018	0.022
PCB #18	< 10	< 20	< 10	< 10	*	< 10	< 9	< 9	0	< 9	< 20	-	-
PCB #28	< 20	< 30	< 20	< 20	*	< 20	< 10	< 20	0	< 10	< 30	-	-
PCB #52	< 20	< 20	< 10	< 8	*	< 10	< 7	< 10	0	< 7	< 20	-	-
PCB #49	< 10	< 20	< 8	< 6	*	< 8	< 5	< 8	0	< 5	< 20	-	-
PCB #44	< 20	< 20	< 10	< 8	*	< 10	< 7	< 10	0	< 7	< 20	-	-
PCB #74	< 6	7.1	< 6	< 5	*	< 5	< 5	< 4	1	< 4	7.1	-	-
PCB #66	< 6	< 8	< 6	< 5	*	< 5	< 5	< 4	0	< 4	< 8	-	-
PCB #101	< 5	< 8	< 6	< 5	*	< 5	< 4	< 4	0	< 4	< 8	-	-
PCB #99	< 5	< 8	< 6	< 5	*	< 5	< 4	< 4	0	< 4	< 8	-	-
PCB #87	< 5	< 10	< 6	< 5	*	< 5	< 4	< 4	0	< 4	< 10	-	-
PCB #110	< 5	< 10	< 6	< 5	*	< 5	< 4	< 4	0	< 4	< 10	-	-
PCB #118	< 5	6.2	< 6	< 5	*	< 4	< 5	< 4	1	< 4	6.2	-	-
PCB #105	< 5	< 6	< 5	< 5	*	< 4	< 4	< 4	0	< 4	< 6	-	-
PCB #151	< 6	< 10	< 6	< 5	*	< 5	< 5	< 4	0	< 4	< 10	-	-
PCB #149	< 6	< 10	< 6	< 5	*	< 5	< 5	< 4	0	< 4	< 10	-	-
PCB #146	< 6	< 7	< 6	< 6	*	< 5	< 5	< 5	0	< 5	< 7	-	-
PCB #153	20.9	36.4	19.1	20.8	*	28.1	32.9	27.0	7	19.1	36.4	27.0	26.5
PCB #138 + PCB #158	13.2	23.0	13.0	13.4	*	18.5	22.5	17.1	7	13.0	23.0	17.1	17.2
PCB #128	< 6	< 10	< 6	< 7	*	< 5	< 5	< 6	0	< 5	< 10	-	-
PCB #167	< 6	< 8	< 6	< 8	*	< 5	< 6	< 6	0	< 5	< 8	-	-
PCB #156	< 6	< 6	< 6	< 6	*	< 5	< 6	< 6	0	< 5	< 6	-	-
PCB #157	< 6	< 5	< 6	< 6	*	< 5	< 6	< 6	0	< 5	< 6	-	-
PCB #178	< 6	< 7	< 6	< 6	*	< 5	< 6	< 6	0	< 5	< 7	-	-
PCB #187	< 7	6.9	< 6	< 7	*	6.6	7.5	6.5	4	< 6	7.5	-	-
PCB #183	< 7	< 8	< 6	< 7	*	< 5	< 6	< 7	0	< 5	< 8	-	-
PCB #177	< 8	< 6	< 6	< 8	*	< 5	< 8	< 7	0	< 5	< 8	-	-
PCB #172	< 8	< 6	< 6	< 8	*	< 5	< 8	< 7	0	< 5	< 8	-	-
PCB #180	15.2	27.9	14.4	14.8	*	26.1	27.1	25.8	7	14.4	27.9	25.8	21.6
PCB #170	6.4	9.9	6.2	6.2	*	15.9	10.5	10.2	7	6.2	15.9	9.9	9.3
PCB #189	< 8	< 5	< 6	< 10	*	< 6	< 8	< 10	0	< 5	< 10	-	-
PCB #201	< 8	< 8	< 20	< 10	*	< 6	< 8	< 8	0	< 6	< 20	-	-
PCB #196 + PCB #203	< 10	< 10	< 7	< 20	*	< 6	< 10	< 9	0	< 6	< 20	-	-
PCB #195	< 10	< 7	< 8	< 10	*	< 7	< 9	< 10	0	< 7	< 10	-	-
PCB #194	< 10	< 7	< 8	< 10	*	4.0	4.4	< 10	2	< 7	4.4	-	-
PCB #206	< 10	< 7	< 7	< 10	*	< 8	< 10	< 10	0	< 7	< 10	-	-
PCB #209	< 20	< 8	< 9	< 20	*	< 7	< 10	< 10	0	< 7	< 20	-	-
Sum of PCBs (inc)[1]	190	268	176	183	*	192	205	203		176	268	192	202
Sum of PCBs (exc)[2]	55.7	117	52.7	55.2	*	99.3	105	86.6		52.7	117	86.6	81.7
PCB TEQ (inc)[1]	0.0061	0.0064	0.0061	0.0068	*	0.0064	0.0064	0.0062		0.0061	0.0068	0.0064	0.0064
PCB TEQ (exc)[2]	0.0024	0.0030	0.0024	0.0027	*	0.0033	0.0024	0.0023		0.0023	0.0033	0.0024	0.0026

1 = Including half LOD values
2 = Excluding LOD values
3 = Excludes any LOD value which is greater than a maximum measured value for that congener
4 = Median concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 5 positive determinations). LODs are included in the median calculation
5 = Mean concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 5 positive determinations). For any individual congener, calculation of the mean includes half LOD values
* = Insufficient sample collected for analysis

Table E6 Concentrations of PCBs in serum from non-Maori aged 35–49 years (µg kg^{-1}, lipid wt basis)

	Non-Maori female				Non-Maori male				National summary for non-Maori aged 35–49 years				
Congener	Northland/ Auckland (n=2) [3]	Waikato/ Bay of Plenty	Lower North Island (n=2) [3]	South Island (n=3) [3]	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island (n=2) [3]	South Island (n=3) [3]	Number of positives	Minimum	Maximum [4]	Median [5]	Mean [6]
PCB #77	< 0.05	< 0.04	< 0.04	< 0.05	< 0.03	< 0.04	< 0.03	< 0.04	0	< 0.03	< 0.05	-	-
PCB #81	< 0.004	< 0.003	< 0.003	< 0.003	< 0.002	< 0.002	< 0.002	< 0.002	0	< 0.002	< 0.004	-	-
PCB #126	0.028	0.021	0.025	0.023	0.030	0.021	0.016	0.021	8	0.016	0.030	0.022	0.023
PCB #169	0.021	0.018	0.020	0.018	0.030	0.032	0.023	0.026	8	0.018	0.032	0.022	0.023
PCB #18	< 20	< 10	< 20	< 10	< 10	< 10	< 10	< 10	0	< 10	< 20	-	-
PCB #28	< 30	< 20	< 30	< 20	< 20	< 20	< 20	< 20	0	< 20	< 30	-	-
PCB #52	< 20	< 10	< 20	< 10	< 7	< 10	< 20	< 10	0	< 7	< 20	-	-
PCB #49	< 10	< 10	< 10	< 10	< 5	< 9	< 10	< 8	0	< 5	< 10	-	-
PCB #44	< 20	< 10	< 20	< 10	< 7	< 10	< 20	< 10	0	< 7	< 20	-	-
PCB #74	4.9	< 6	< 7	3.5	< 4	< 5	4.1	< 4	3	< 4	4.9	-	-
PCB #66	< 10	< 6	< 7	< 5	< 4	< 5	< 7	< 4	0	< 4	< 10	-	-
PCB #101	< 10	< 6	< 9	< 5	< 4	< 5	< 6	< 4	0	< 4	< 10	-	-
PCB #99	< 10	< 6	< 8	< 5	< 4	< 5	< 6	< 4	0	< 4	< 10	-	-
PCB #87	< 10	< 6	< 10	< 5	< 4	< 5	< 6	< 4	0	< 4	< 10	-	-
PCB #110	< 10	< 6	< 10	< 5	< 4	< 5	< 6	< 4	0	< 4	< 10	-	-
PCB #118	4.6	< 5	< 7	< 5	4.3	< 5	3.3	< 5	3	< 5	4.6	-	-
PCB #105	< 10	< 5	< 7	< 5	< 4	< 4	< 6	< 4	0	< 4	< 10	-	-
PCB #151	< 20	< 6	< 10	< 6	< 4	< 5	< 9	< 5	0	< 4	< 20	-	-
PCB #149	< 20	< 6	< 10	< 6	< 4	< 5	< 9	< 5	0	< 4	< 20	-	-
PCB #146	< 10	< 6	< 7	< 6	< 5	< 5	3.2	< 5	1	< 5	3.2	-	-
PCB #153	25.7	23.2	20.7	19.4	32.2	31.9	30.6	24.6	8	19.4	32.2	25.1	26.0
PCB #138 + PCB #158	16.1	15.3	13.9	12.6	18.6	18.8	18.1	15.8	8	12.6	18.8	15.9	16.1
PCB #128	< 20	< 6	< 10	< 6	< 4	< 6	< 7	< 5	0	< 4	< 20	-	-
PCB #167	< 10	< 6	< 8	< 6	< 5	< 7	< 6	< 5	0	< 5	< 10	-	-
PCB #156	< 9	< 5	< 6	< 7	< 5	< 6	3.6	< 5	1	< 5	3.6	-	-
PCB #157	< 8	< 6	< 6	< 7	< 5	< 6	< 7	< 5	0	< 5	< 8	-	-
PCB #178	< 10	< 7	< 8	< 6	< 4	< 6	< 9	< 5	0	< 4	< 10	-	-
PCB #187	4.4	< 9	4.3	< 7	7.5	7.6	7.1	5.2	6	< 7	7.6	4.8	5.5
PCB #183	< 10	< 9	< 9	< 7	< 4	< 7	< 10	< 6	0	< 4	< 10	-	-
PCB #177	< 9	< 6	< 6	< 8	< 5	< 7	< 7	< 5	0	< 5	< 9	-	-
PCB #172	< 9	< 6	< 6	< 8	< 5	< 7	< 7	< 5	0	< 5	< 9	-	-
PCB #180	20.6	19.9	16.6	17.1	26.8	32.2	27.3	24.7	8	16.6	32.2	22.6	23.1
PCB #170	9.5	7.9	7.5	7.2	10.7	14.9	9.3	10.2	8	7.2	14.9	9.4	9.6
PCB #189	< 6	< 6	< 6	< 7	< 7	< 7	< 5	< 6	0	< 5	< 7	-	-
PCB #201	< 10	< 7	< 20	< 20	< 6	4.8	3.5	< 6	2	< 6	4.8	-	-
PCB #196 + PCB #203	< 20	< 8	< 10	< 20	< 7	4.4	3.6	< 7	2	< 7	4.4	-	-
PCB #195	< 10	< 9	< 10	< 10	< 8	< 9	< 6	< 8	0	< 6	< 10	-	-
PCB #194	< 10	< 9	< 10	< 10	5.0	6.9	5.1	4.7	4	< 9	6.9	-	-
PCB #206	< 10	< 10	< 9	< 10	< 10	< 10	< 5	< 10	0	< 5	< 10	-	-
PCB #209	< 10	< 10	< 10	< 10	< 10	< 20	< 5	< 10	0	< 5	< 20	-	-
Sum of PCBs (inc)[1]	286	191	230	194	193	225	222	182		182	286	208	216
Sum of PCBs (exc)[2]	81.9	66.3	61.3	58.0	105	122	111	83.3		58.0	122	82.6	86.0
PCB TEQ (inc)[1]	0.0086	0.0059	0.0066	0.0069	0.0067	0.0064	0.0063	0.0055		0.0055	0.0086	0.0065	0.0066
PCB TEQ (exc)[2]	0.0033	0.0023	0.0027	0.0024	0.0037	0.0024	0.0031	0.0024		0.0023	0.0037	0.0025	0.0028

1 = Including half LOD values
2 = Excluding LOD values
3 = Mean of two (n=2) or three (n=3) unique sub-samples prepared for this stratum (see Table E12 and Appendix A, Section A6)
4 = Excludes any LOD value which is greater than a maximum measured value for that congener
5 = Median concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are included in the median calculation
6 = Mean concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 6 positive determinations). For any individual congener, calculation of the mean includes half LOD values

Table E7 Concentrations of PCBs in serum from Maori aged 50–64 years (μg kg^{-1}, lipid wt basis)

	Maori female				Maori male				National summary for Maori aged 50–64 years				
Congener	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Number of positives	Minimum	Maximum [3]	Median [4]	Mean [5]
PCB #77	*	*	< 0.1	*	*	*	< 0.1	*	0	< 0.1	< 0.1	-	-
PCB #81	*	*	< 0.009	*	*	*	< 0.006	*	0	< 0.006	< 0.009	-	-
PCB #126	*	*	0.061	*	*	*	0.033	*	2	0.033	0.061	0.047	0.047
PCB #169	*	*	0.035	*	*	*	0.031	*	2	0.031	0.035	0.033	0.033
PCB #18	*	*	< 10	*	*	*	< 8	*	0	< 8	< 10	-	-
PCB #28	*	*	< 20	*	*	*	< 10	*	0	< 10	< 20	-	-
PCB #52	*	*	< 10	*	*	*	< 6	*	0	< 6	< 10	-	-
PCB #49	*	*	< 10	*	*	*	< 5	*	0	< 5	< 10	-	-
PCB #44	*	*	< 10	*	*	*	< 6	*	0	< 6	< 10	-	-
PCB #74	*	*	6.5	*	*	*	4.7	*	2	4.7	6.5	5.6	5.6
PCB #66	*	*	< 5	*	*	*	< 5	*	0	< 5	< 5	-	-
PCB #101	*	*	< 6	*	*	*	< 4	*	0	< 4	< 6	-	-
PCB #99	*	*	< 6	*	*	*	< 4	*	0	< 4	< 6	-	-
PCB #87	*	*	< 8	*	*	*	< 4	*	0	< 4	< 8	-	-
PCB #110	*	*	< 8	*	*	*	< 4	*	0	< 4	< 8	-	-
PCB #118	*	*	8.6	*	*	*	5.1	*	2	5.1	8.6	6.9	6.9
PCB #105	*	*	< 6	*	*	*	< 4	*	0	< 4	< 6	-	-
PCB #151	*	*	< 6	*	*	*	< 4	*	0	< 4	< 6	-	-
PCB #149	*	*	< 6	*	*	*	< 4	*	0	< 4	< 6	-	-
PCB #146	*	*	5.5	*	*	*	6.1	*	2	5.5	6.1	5.8	5.8
PCB #153	*	*	45.0	*	*	*	46.8	*	2	45.0	46.8	45.9	45.9
PCB #138 + PCB #158	*	*	31.4	*	*	*	31.5	*	2	31.4	31.5	31.5	31.5
PCB #128	*	*	< 7	*	*	*	< 4	*	0	< 4	< 7	-	-
PCB #167	*	*	< 6	*	*	*	< 5	*	0	< 5	< 6	-	-
PCB #156	*	*	4.8	*	*	*	5.2	*	2	4.8	5.2	5.0	5.0
PCB #157	*	*	< 6	*	*	*	< 5	*	0	< 5	< 6	-	-
PCB #178	*	*	< 6	*	*	*	< 5	*	0	< 5	< 6	-	-
PCB #187	*	*	10.2	*	*	*	15.3	*	2	10.2	15.3	12.8	12.8
PCB #183	*	*	< 7	*	*	*	4.2	*	1	< 7	4.2	-	-
PCB #177	*	*	< 6	*	*	*	3.9	*	1	< 6	3.9	-	-
PCB #172	*	*	< 6	*	*	*	< 5	*	0	< 5	< 6	-	-
PCB #180	*	*	34.1	*	*	*	42.2	*	2	34.1	42.2	38.2	38.2
PCB #170	*	*	14.9	*	*	*	14.5	*	2	14.5	14.9	14.7	14.7
PCB #189	*	*	< 8	*	*	*	< 5	*	0	< 5	< 8	-	-
PCB #201	*	*	< 10	*	*	*	5.8	*	1	< 10	5.8	-	-
PCB #196 + PCB #203	*	*	< 9	*	*	*	5.0	*	1	< 9	5.0	-	-
PCB #195	*	*	< 9	*	*	*	< 6	*	0	< 6	< 9	-	-
PCB #194	*	*	5.4	*	*	*	6.6	*	2	5.4	6.6	6.0	6.0
PCB #206	*	*	< 10	*	*	*	< 6	*	0	< 6	< 10	-	-
PCB #209	*	*	< 10	*	*	*	< 8	*	0	< 8	< 10	-	-
Sum of PCBs (inc)[1]	*	*	277	*	*	*	256	*		256	277	266	266
Sum of PCBs (exc)[2]	*	*	166	*	*	*	197	*		166	197	182	182
PCB TEQ (inc)[1]	*	*	0.012	*	*	*	0.0083	*		0.0083	0.012	0.010	0.010
PCB TEQ (exc)[2]	*	*	0.0097	*	*	*	0.0067	*		0.0067	0.0097	0.0082	0.0082

1 = Including half LOD values
2 = Excluding LOD values
3 = Excludes any LOD value which is greater than a maximum measured value for that congener
4 = Median concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 2 positive determinations). LODs are included in the median calculation
5 = Mean concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 2 positive determinations). For any individual congener, calculation of the mean includes half LOD values
* = Insufficient sample collected for analysis

Table E8 Concentrations of PCBs in serum from non-Maori aged 50–64 years (μg kg^{-1}, lipid wt basis)

	Non-Maori female				Non-Maori male				National summary for non-Maori aged 50–64 years				
Congener	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island (n=2) [3]	South Island (n=2) [3]	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island (n=2) [3]	South Island (n=2) [3]	Number of positives	Minimum	Maximum [4]	Median [5]	Mean [6]
PCB #77	< 0.03	< 0.04	< 0.04	< 0.04	< 0.05	< 0.04	< 0.04	< 0.05	0	< 0.03	< 0.05	-	-
PCB #81	< 0.002	< 0.002	0.0029	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	1	< 0.002	0.0029	-	-
PCB #126	0.035	0.035	0.034	0.037	0.043	0.050	0.028	0.028	8	0.028	0.050	0.035	0.036
PCB #169	0.024	0.024	0.022	0.023	0.035	0.031	0.031	0.029	8	0.022	0.035	0.027	0.027
PCB #18	< 10	< 9	< 10	< 10	< 9	< 10	< 10	< 20	0	< 9	< 20	-	-
PCB #28	< 20	< 10	< 20	< 20	< 20	< 20	< 20	< 30	0	< 10	< 30	-	-
PCB #52	< 10	< 10	< 9	< 10	< 10	< 10	< 10	< 20	0	< 9	< 20	-	-
PCB #49	< 7	< 10	< 7	< 8	< 8	< 7	< 9	< 20	0	< 7	< 20	-	-
PCB #44	< 10	< 10	< 9	< 10	< 10	< 9	< 10	< 20	0	< 9	< 20	-	-
PCB #74	5.5	5.1	6.1	5.4	6.2	< 5	< 4	5.0	6	< 4	6.2	5.3	4.7
PCB #66	< 4	< 4	< 5	< 4	< 4	< 5	< 4	< 8	0	< 4	< 8	-	-
PCB #101	< 4	< 4	< 5	< 5	< 4	< 5	< 4	< 7	0	< 4	< 7	-	-
PCB #99	< 4	< 4	< 5	< 4	< 5	< 5	< 4	< 7	0	< 4	< 7	-	-
PCB #87	< 4	< 4	< 5	< 4	< 4	< 5	< 4	< 9	0	< 4	< 9	-	-
PCB #110	< 4	< 4	< 5	< 4	< 4	< 5	< 4	< 9	0	< 4	< 9	-	-
PCB #118	7.1	6.1	5.8	5.5	5.7	6.1	< 4	< 5	6	< 4	7.1	5.8	5.1
PCB #105	< 4	< 4	< 5	< 4	< 4	< 4	< 4	< 5	0	< 4	< 5	-	-
PCB #151	< 4	< 4	< 5	< 5	< 5	< 5	< 5	< 9	0	< 4	< 9	-	-
PCB #149	< 4	< 4	< 5	< 5	< 5	< 5	< 5	< 9	0	< 4	< 9	-	-
PCB #146	< 5	< 4	< 5	< 5	< 5	5.6	< 5	< 6	1	< 4	5.6	-	-
PCB #153	34.9	36.0	26.4	26.9	34.5	49.9	29.6	32.0	8	26.4	49.9	33.3	33.8
PCB #138 + PCB #158	21.9	21.1	17.5	17.7	20.3	36.2	18.4	19.7	8	17.5	36.2	20.0	21.6
PCB #128	< 5	< 6	< 5	< 5	< 6	< 5	< 5	< 7	0	< 5	< 7	-	-
PCB #167	< 5	< 6	< 5	< 5	< 6	< 5	< 5	< 5	0	< 5	< 6	-	-
PCB #156	< 5	< 4	< 5	< 6	4.8	5.5	< 5	3.5	3	< 4	5.5	-	-
PCB #157	< 5	< 4	< 5	< 4	< 6	< 5	< 5	< 5	0	< 4	< 6	-	-
PCB #178	< 5	< 5	< 5	< 5	< 6	< 5	< 5	< 6	0	< 5	< 6	-	-
PCB #187	7.3	7.6	5.5	5.3	7.3	12.0	6.4	7.8	8	5.3	12.0	7.3	7.4
PCB #183	< 6	< 7	< 6	< 5	< 7	5.3	< 6	< 6	1	< 5	5.3	-	-
PCB #177	< 7	< 5	< 5	< 5	< 7	4.4	< 5	< 6	1	< 5	4.4	-	-
PCB #172	< 7	< 5	< 5	< 5	< 7	< 5	< 5	< 6	0	< 5	< 7	-	-
PCB #180	26.7	30.4	20.0	21.4	29.1	44.6	28.3	31.7	8	20.0	44.6	28.7	29.0
PCB #170	11.5	11.9	8.6	9.4	13.7	18.6	11.4	11.9	8	8.6	18.6	11.7	12.1
PCB #189	< 8	< 6	< 5	< 5	< 8	< 5	< 6	< 6	0	< 5	< 8	-	-
PCB #201	< 7	< 7	< 20	< 10	< 7	5.9	< 20	4.4	2	< 7	5.9	-	-
PCB #196 + PCB #203	< 10	< 6	< 6	< 7	< 10	5.6	< 20	4.0	2	< 6	5.6	-	-
PCB #195	< 9	< 7	< 6	< 7	< 10	< 6	< 10	< 7	0	< 6	< 10	-	-
PCB #194	4.8	5.0	< 6	< 7	5.9	8.5	6.1	6.3	6	< 6	8.5	5.5	5.4
PCB #206	< 10	< 8	< 7	< 8	< 10	< 6	< 9	< 7	0	< 6	< 10	-	-
PCB #209	< 20	< 8	< 8	< 10	< 20	< 7	< 10	< 8	0	< 7	< 20	-	-
Sum of PCBs (inc)[1]	222	214	184	188	229	279	209	251		184	279	218	222
Sum of PCBs (exc)[2]	120	123	89.7	91.5	128	208	100	122		89.7	208	121	123
PCB TEQ (inc)[1]	0.0077	0.0070	0.0071	0.0076	0.0098	0.010	0.0062	0.0069		0.0062	0.010	0.0073	0.0078
PCB TEQ (exc)[2]	0.0044	0.0043	0.0042	0.0045	0.0076	0.0087	0.0031	0.0042		0.0031	0.0087	0.0044	0.0051

1 = Including half LOD values
2 = Excluding LOD values
3 = Mean of two unique sub-samples prepared for this stratum (see Table E13 and Appendix A, Section A6)
4 = Excludes any LOD value which is greater than a maximum measured value for that congener
5 = Median concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are included in the median calculation
6 = Mean concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 6 positive determinations). For any individual congener, calculation of the mean includes half LOD values

Table E9 Concentrations of PCBs in serum from Maori aged 65+ years (μg kg^{-1}, lipid wt basis)

	Maori female				Maori male				National summary for Maori aged 65+ years				
Congener	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Number of positives	Minimum	Maximum	Median	Mean
PCB #77	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #81	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #126	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #169	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #18	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #28	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #52	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #49	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #44	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #74	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #66	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #101	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #99	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #87	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #110	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #118	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #105	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #151	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #149	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #146	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #153	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #138 + PCB #158	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #128	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #167	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #156	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #157	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #178	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #187	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #183	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #177	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #172	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #180	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #170	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #189	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #201	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #196 + PCB #203	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #195	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #194	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #206	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB #209	*	*	*	*	*	*	*	*	-	-	-	-	-
Sum of PCBs (inc)	*	*	*	*	*	*	*	*	-	-	-	-	-
Sum of PCBs (exc)	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB TEQ (inc)	*	*	*	*	*	*	*	*	-	-	-	-	-
PCB TEQ (exc)	*	*	*	*	*	*	*	*	-	-	-	-	-

* = Insufficient sample collected for analysis

Table E10 Concentrations of PCBs in serum from non-Maori aged 65+ years (μg kg^{-1}, lipid wt basis)

	Non-Maori female				Non-Maori male				National summary for non-Maori aged 65+ years				
Congener	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island (n=2) [3]	South Island (n=2) [3]	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island (n=2) [3]	Number of positives	Minimum	Maximum [4]	Median [5]	Mean [6]
PCB #77	< 0.06	< 0.03	< 0.04	< 0.04	< 0.06	< 0.05	< 0.04	< 0.05	0	< 0.03	< 0.06	-	-
PCB #81	< 0.005	< 0.002	< 0.002	< 0.003	< 0.003	0.0027	< 0.003	0.0024	2	< 0.002	0.0027	-	-
PCB #126	0.065	0.057	0.053	0.043	0.028	0.057	0.031	0.034	8	0.028	0.065	0.048	0.046
PCB #169	0.035	0.026	0.030	0.026	0.028	0.038	0.032	0.032	8	0.026	0.038	0.031	0.031
PCB #18	< 9	< 9	< 10	< 8	< 10	< 9	< 9	< 20	0	< 8	< 20	-	-
PCB #28	< 10	< 10	< 20	< 10	< 20	< 10	< 10	< 30	0	< 10	< 30	-	-
PCB #52	< 7	< 10	< 10	< 8	< 20	< 10	< 10	< 20	0	< 7	< 20	-	-
PCB #49	< 5	< 9	< 7	< 6	< 10	< 7	< 8	< 10	0	< 5	< 10	-	-
PCB #44	< 7	< 10	< 9	< 7	< 20	< 9	< 10	< 20	0	< 7	< 20	-	-
PCB #74	8.8	6.0	10.9	8.4	5.7	6.3	5.3	6.6	8	5.3	10.9	6.4	7.2
PCB #66	< 4	< 5	< 5	< 4	< 6	< 4	< 4	< 9	0	< 4	< 9	-	-
PCB #101	< 4	< 4	< 4	< 4	< 5	< 4	< 4	< 9	0	< 4	< 9	-	-
PCB #99	< 4	< 4	< 4	< 4	< 5	< 4	< 4	< 9	0	< 4	< 9	-	-
PCB #87	< 4	< 4	< 4	< 4	< 5	< 4	< 5	< 10	0	< 4	< 10	-	-
PCB #110	< 4	< 4	< 4	< 4	< 5	< 4	< 5	< 10	0	< 4	< 10	-	-
PCB #118	10.0	8.4	9.2	7.3	5.6	6.2	5.9	3.9	8	3.9	10.0	6.8	7.1
PCB #105	< 4	< 4	< 4	< 4	< 5	< 4	< 4	< 8	0	< 4	< 8	-	-
PCB #151	< 4	< 5	< 5	< 4	< 6	< 4	< 4	< 10	0	< 4	< 10	-	-
PCB #149	< 4	< 5	< 5	< 4	< 6	< 4	< 4	< 10	0	< 4	< 10	-	-
PCB #146	5.3	< 5	3.6	< 4	5.3	6.1	< 4	< 8	4	< 4	6.1	-	-
PCB #153	44.0	35.8	37.0	30.1	44.6	46.3	38.2	32.2	8	30.1	46.3	37.6	38.5
PCB #138 + PCB #158	29.3	24.3	25.8	20.6	28.8	29.8	23.2	20.7	8	20.6	29.8	25.0	25.3
PCB #128	< 4	< 6	< 5	< 5	< 9	< 6	< 6	< 10	0	< 4	< 10	-	-
PCB #167	< 4	< 7	< 5	< 6	< 10	< 6	< 5	< 7	0	< 4	< 10	-	-
PCB #156	4.8	< 7	3.6	< 5	< 7	5.0	4.6	4.0	5	< 5	5.0	-	-
PCB #157	< 4	< 6	< 5	< 5	< 7	< 4	< 5	< 6	0	< 4	< 7	-	-
PCB #178	< 4	< 6	< 5	< 5	< 7	< 5	< 5	< 9	0	< 4	< 9	-	-
PCB #187	9.7	7.5	8.2	6.4	10.5	11.1	11.0	7.2	8	6.4	11.1	9.0	8.9
PCB #183	< 4	< 7	< 5	< 5	< 9	< 6	< 7	< 10	0	< 4	< 10	-	-
PCB #177	< 4	< 8	< 6	< 6	< 8	4.5	< 5	< 6	1	< 4	4.5	-	-
PCB #172	< 4	< 8	< 6	< 6	< 8	< 6	< 5	< 6	0	< 4	< 8	-	-
PCB #180	33.0	25.6	27.7	23.2	39.6	41.7	40.3	29.6	8	23.2	41.7	31.3	32.6
PCB #170	16.1	12.3	11.1	9.5	15.7	17.1	15.2	11.6	8	9.5	17.1	13.8	13.6
PCB #189	< 6	< 8	< 7	< 6	< 8	< 5	< 5	< 5	0	< 5	< 8	-	-
PCB #201	4.3	< 8	< 7	< 6	< 10	4.9	7.3	< 7	3	< 6	7.3	-	-
PCB #196 + PCB #203	4.3	< 10	< 7	< 7	< 8	4.5	6.0	< 7	3	< 7	6.0	-	-
PCB #195	< 8	< 10	< 8	< 8	< 9	< 6	< 7	< 7	0	< 6	< 10	-	-
PCB #194	5.7	< 10	4.7	4.0	6.6	6.9	9.2	6.1	7	< 10	9.2	5.9	6.0
PCB #206	< 9	< 10	< 9	< 8	< 10	< 7	< 9	< 7	0	< 7	< 10	-	-
PCB #209	< 10	< 20	< 9	< 9	< 10	< 8	< 9	< 8	0	< 8	< 20	-	-
Sum of PCBs (inc)[1]	243	235	227	192	280	259	245	260		192	280	244	243
Sum of PCBs (exc)[2]	175	120	139	107	162	190	166	119		107	190	151	148
PCB TEQ (inc)[1]	0.012	0.011	0.010	0.0083	0.0076	0.011	0.0080	0.0082		0.0076	0.012	0.0092	0.0094
PCB TEQ (exc)[2]	0.010	0.0067	0.0077	0.0054	0.0037	0.0092	0.0063	0.0051		0.0037	0.010	0.0065	0.0068

1 = Including half LOD values
2 = Excluding LOD values
3 = Mean of two unique sub-samples prepared for this stratum (see Table E14 and Appendix A, Section A6)
4 = Excludes any LOD value which is greater than a maximum measured value for that congener
5 = Median concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are included in the median calculation
6 = Mean concentration reported only if a PCB congener detected on more than 66% of occasions (minimum of 6 positive determinations). For any individual congener, calculation of the mean includes half LOD values

Table E11 Concentrations of PCBs in serum sub-samples from non-Maori aged 25–34 years (μg kg^{-1}, lipid wt basis)[1]

	Female, Lower North Island			Female, South Island			Male, Lower North Island		Male, South Island	
Congener	SS#1	SS#2	SS#3	SS#1	SS#2	SS#3	SS#1	SS#2	SS#1	SS#2
PCB #77	< 0.04	< 0.05	< 0.05	< 0.055	< 0.04	< 0.06	< 0.04	< 0.03	< 0.04	< 0.05
PCB #81	< 0.002	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.002	< 0.002	< 0.003	< 0.003
PCB #126	0.017	0.022	0.018	0.019	0.013	0.020	0.013	0.012	0.013	0.019
PCB #169	0.014	0.014	0.011	0.014	0.0098	0.013	0.017	0.015	0.015	0.019
PCB #18	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 8	< 10	< 10
PCB #28	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 10	< 20	< 20
PCB #52	< 30	< 20	< 10	< 20	< 10	< 10	< 20	< 9	< 20	< 20
PCB #49	< 20	< 10	< 8	< 10	< 8	< 10	< 10	< 6	< 10	< 10
PCB #44	< 20	< 10	< 10	< 20	< 10	< 10	< 10	< 9	< 10	< 20
PCB #74	< 6	< 5	< 6	< 7	< 5	< 6	< 5	< 4	< 5	< 6
PCB #66	< 6	< 5	< 6	< 7	< 5	< 6	< 5	< 4	< 5	< 6
PCB #101	< 6	< 6	< 6	< 6	< 5	< 5	< 5	< 4	< 6	< 6
PCB #99	< 6	< 5	< 6	< 6	< 5	< 5	< 5	< 4	< 5	< 5
PCB #87	< 6	< 5	< 6	< 7	< 5	< 5	< 5	< 4	< 5	< 5
PCB #110	< 6	< 5	< 6	< 7	< 5	< 5	< 5	< 4	< 5	< 5
PCB #118	< 6	< 5	< 6	< 5	< 5	< 5	< 5	< 4	< 5	< 5
PCB #105	< 6	< 5	< 6	< 5	< 5	< 5	< 4	< 4	< 5	< 5
PCB #151	< 6	< 6	< 6	< 8	< 5	< 6	< 5	< 4	< 5	< 5
PCB #149	< 6	< 6	< 6	< 8	< 5	< 6	< 5	< 4	< 5	< 5
PCB #146	< 7	< 6	< 6	< 6	< 5	< 6	< 5	< 5	< 5	< 7
PCB #153	13.9	13.1	12.6	16.1	14.3	15.4	18.2	17.3	17.4	14.4
PCB #138 + PCB #158	9.5	8.6	8.1	9.7	10.1	9.5	11.5	10.8	11.6	9.7
PCB #128	< 8	< 6	< 6	< 6	< 5	< 6	< 5	< 6	< 7	< 7
PCB #167	< 7	< 6	< 6	< 5	< 6	< 6	< 5	< 6	< 8	< 6
PCB #156	< 6	< 6	< 6	< 5	< 5	< 6	< 5	< 5	< 5	< 6
PCB #157	< 7	< 6	< 6	< 5	< 5	< 6	< 5	< 5	< 6	< 6
PCB #178	< 7	< 6	< 6	< 5	< 6	< 6	< 5	< 5	< 5	< 7
PCB #187	< 9	< 6	< 6	< 6	< 8	< 7	< 6	4	< 7	< 8
PCB #183	< 9	< 6	< 6	< 6	< 8	< 7	< 6	< 6	< 7	< 8
PCB #177	< 8	< 6	< 7	< 5	< 5	< 8	< 6	< 6	< 5	< 8
PCB #172	< 8	< 6	< 7	< 5	< 5	< 8	< 6	< 6	< 5	< 8
PCB #180	10.9	10.2	11.0	12.2	10.2	12.0	17.0	16.7	15.8	12.3
PCB #170	< 6	< 6	< 6	< 5	< 6	< 6	7.3	6.4	7.1	5.4
PCB #189	< 9	< 7	< 6	< 5	< 6	< 8	< 6	< 6	< 6	< 8
PCB #201	< 10	< 7	< 7	< 5	< 6	< 8	< 6	< 7	< 8	< 10
PCB #196 + PCB #203	< 10	< 10	< 7	< 6	< 7	< 9	< 9	< 9	< 8	< 10
PCB #195	< 10	< 8	< 7	< 5	< 8	< 10	< 7	< 7	< 8	< 10
PCB #194	< 10	< 8	< 7	< 5	< 8	< 10	< 7	< 7	< 8	< 10
PCB #206	< 20	< 10	< 8	< 5	< 10	< 10	< 9	< 8	< 10	< 10
PCB #209	< 20	< 10	< 9	< 5	< 10	< 20	< 20	< 9	< 10	< 10
Sum of PCBs (inc)[2]	205	163	152	159	148	177	172	148	174	181
Sum of PCBs (exc)[3]	34.3	31.9	31.7	38.0	34.6	36.9	54.0	55.2	51.9	41.8
PCB TEQ (inc)[2]	0.0062	0.0060	0.0058	0.0052	0.0047	0.0061	0.0047	0.0043	0.0050	0.0060
PCB TEQ (exc)[3]	0.0019	0.0024	0.0019	0.0020	0.0014	0.0021	0.0015	0.0013	0.0015	0.0021

1 = These data are the results of the analyses of unique sub-samples (SS#1, SS#2, SS#3) prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6). Mean data for sub-samples reported in Table E4

2 = Including half LOD values

3 = Excluding LOD values

Table E12 Concentrations of PCBs in serum sub-samples from non-Maori aged 35–49 years (μg kg^{-1}, lipid wt basis)[1]

	Female, Northland/Auckland		Female, Lower North Island		Female, South Island			Male, Lower North Island		Male, South Island		
Congener	SS#1	SS#2	SS#1	SS#2	SS#1	SS#2	SS#3	SS#1	SS#2	SS#1	SS#2	SS#3
PCB #77	< 0.05	< 0.05	< 0.04	< 0.04	< 0.05	< 0.05	< 0.04	< 0.03	< 0.03	< 0.03	< 0.04	< 0.04
PCB #81	< 0.003	< 0.004	< 0.002	< 0.003	< 0.003	< 0.003	< 0.004	< 0.002	< 0.003	< 0.002	< 0.003	< 0.002
PCB #126	0.034	0.022	0.031	0.019	0.020	0.029	0.019	0.017	0.016	0.017	0.020	0.026
PCB #169	0.023	0.020	0.022	0.017	0.018	0.018	0.019	0.023	0.023	0.021	0.027	0.029
PCB #18	< 30	< 10	< 20	< 10	< 10	< 9	< 10	< 10	< 10	< 10	< 10	< 9
PCB #28	< 50	< 20	< 40	< 20	< 20	< 10	< 20	< 20	< 20	< 20	< 20	< 10
PCB #52	< 30	< 8	< 30	< 10	< 10	< 10	< 20	< 20	< 20	< 8	< 10	< 10
PCB #49	< 20	< 6	< 20	< 8	< 10	< 10	< 10	< 10	< 10	< 6	< 9	< 10
PCB #44	< 30	< 8	< 30	< 10	< 10	< 10	< 20	< 10	< 20	< 8	< 10	< 10
PCB #74	7.3	< 5	< 9	< 6	< 5	5.1	< 6	6.1	< 4	< 5	< 4	< 4
PCB #66	< 20	< 5	< 9	< 6	< 5	< 5	< 6	< 9	< 4	< 5	< 4	< 4
PCB #101	< 20	< 5	< 10	< 6	< 5	< 4	< 5	< 8	< 4	< 5	< 4	< 4
PCB #99	< 20	< 5	< 10	< 6	< 5	< 4	< 5	< 8	< 4	< 5	< 4	< 4
PCB #87	< 20	< 5	< 20	< 6	< 5	< 4	< 5	< 9	< 4	< 5	< 5	< 4
PCB #110	< 20	< 5	< 20	< 6	< 5	< 4	< 5	< 9	< 4	< 5	< 5	< 4
PCB #118	6.7	< 5	< 8	< 6	< 5	< 4	< 6	4.6	< 4	< 5	< 5	< 4
PCB #105	< 20	< 5	< 9	< 6	< 5	< 4	< 6	< 7	< 4	< 5	< 5	< 4
PCB #151	< 30	< 5	< 10	< 6	< 5	< 5	< 7	< 10	< 5	< 5	< 6	< 4
PCB #149	< 30	< 5	< 10	< 6	< 5	< 5	< 7	< 10	< 5	< 5	< 6	< 4
PCB #146	< 20	< 5	< 8	< 6	< 6	< 6	< 7	3.8	< 5	< 5	< 5	< 5
PCB #153	30.6	20.7	21.7	19.6	18.0	21.9	18.4	37.9	23.2	20.7	23.3	29.7
PCB #138 + PCB #158	19.7	12.4	15.2	12.6	11.8	14.4	11.6	22.1	14.1	13.3	13.7	20.4
PCB #128	< 40	< 5	< 20	< 6	< 7	< 6	< 7	< 9	< 5	< 5	< 5	< 6
PCB #167	< 20	< 5	< 10	< 6	< 7	< 5	< 7	< 6	< 7	< 5	< 5	< 5
PCB #156	< 10	< 5	< 6	< 6	< 10	< 5	< 6	4.0	< 6	< 5	< 5	< 5
PCB #157	< 10	< 5	< 6	< 6	< 9	< 5	< 6	< 9	< 5	< 5	< 5	< 5
PCB #178	< 20	< 5	< 9	< 6	< 6	< 6	< 7	< 10	< 8	< 5	< 5	< 5
PCB #187	6.4	< 5	5.2	< 7	< 7	< 7	< 8	8.6	5.6	< 5	5.0	8.0
PCB #183	< 20	< 5	< 10	< 7	< 7	< 7	< 8	< 10	< 9	< 5	< 6	< 7
PCB #177	< 10	< 5	< 7	< 6	< 8	< 8	< 7	< 8	< 6	< 5	< 5	< 6
PCB #172	< 10	< 5	< 7	< 6	< 8	< 8	< 7	< 8	< 6	< 5	< 5	< 6
PCB #180	24.2	16.9	16.9	16.3	16.7	17.5	17.1	31.8	22.8	19.1	23.6	31.5
PCB #170	10.7	8.2	8.1	6.9	7.9	7.1	6.5	10.0	8.6	8.0	9.2	13.4
PCB #189	< 7	< 6	< 5	< 6	< 8	< 7	< 6	< 4	< 5	< 5	< 5	< 7
PCB #201	< 20	< 8	< 10	< 30	< 8	< 7	< 30	4.1	< 6	< 5	< 6	< 7
PCB #196 + PCB #203	< 20	< 7	< 20	< 10	< 10	< 8	< 40	3.8	< 7	< 6	< 6	< 9
PCB #195	< 20	< 8	< 10	< 8	< 10	< 10	< 10	< 5	< 6	< 6	< 7	< 10
PCB #194	< 20	< 8	< 10	< 8	< 10	< 10	< 10	5.9	4.3	< 6	4.6	6.3
PCB #206	< 10	< 9	< 10	< 7	< 10	< 10	< 10	< 4	< 6	< 8	< 8	< 10
PCB #209	< 10	< 10	< 10	< 9	< 20	< 10	< 10	< 3	< 7	< 9	< 10	< 10
Sum of PCBs (inc)[2]	413	160	271	188	188	180	214	256	189	154	176	217
Sum of PCBs (exc)[3]	106	58.2	67.2	55.4	54.4	66.0	53.6	143	78.6	61.1	79.4	109
PCB TEQ (inc)[2]	0.012	0.0056	0.0074	0.0058	0.0080	0.0066	0.0061	0.0073	0.0053	0.0049	0.0054	0.0062
PCB TEQ (exc)[3]	0.0043	0.0024	0.0033	0.0020	0.0022	0.0031	0.0021	0.0044	0.0018	0.0019	0.0023	0.0029

1 = These data are the results of the analyses of different sub-samples (SS#1, SS#2, SS#3) prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6). Mean data for sub-samples reported in Table E6

2 = Including half LOD values

3 = Excluding LOD values

Table E13 Concentrations of PCBs in serum sub-samples from non-Maori aged 50–64 years (µg kg^{-1}, lipid wt basis)[1]

	Female, Lower North Island		Female, South Island		Male, Lower North Island		Male, South Island	
Congener	SS#1	SS#2	SS#1	SS#2	SS#1	SS#2	SS#1	SS#2
PCB #77	< 0.04	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04	< 0.06	< 0.04
PCB #81	< 0.003	0.0043	< 0.003	< 0.003	< 0.003	< 0.003	< 0.004	< 0.003
PCB #126	0.037	0.030	0.030	0.044	0.027	0.029	0.030	0.026
PCB #169	0.025	0.020	0.021	0.026	0.034	0.028	0.031	0.027
PCB #18	< 10	< 9	< 10	< 10	< 10	< 9	< 10	< 30
PCB #28	< 20	< 10	< 20	< 20	< 20	< 10	< 20	< 40
PCB #52	< 10	< 9	< 9	< 10	< 10	< 10	< 10	< 30
PCB #49	< 7	< 6	< 6	< 9	< 8	< 10	< 8	< 20
PCB #44	< 10	< 8	< 8	< 10	< 10	< 10	< 10	< 30
PCB #74	5.4	6.8	5.3	5.4	< 5	< 4	4.4	5.5
PCB #66	< 5	< 4	< 5	< 4	< 5	< 4	< 5	< 10
PCB #101	< 6	< 4	< 5	< 5	< 5	< 4	< 4	< 10
PCB #99	< 5	< 4	< 5	< 4	< 5	< 4	< 4	< 9
PCB #87	< 5	< 4	< 5	< 4	< 5	< 4	< 4	< 10
PCB #110	< 5	< 4	< 5	< 4	< 5	< 4	< 4	< 10
PCB #118	5.6	5.9	4.8	6.2	< 5	< 4	< 4	< 6
PCB #105	< 5	< 4	< 5	< 4	< 5	< 4	< 4	< 7
PCB #151	< 6	< 4	< 5	< 4	< 5	< 5	< 4	< 10
PCB #149	< 6	< 4	< 5	< 4	< 5	< 5	< 4	< 10
PCB #146	< 5	< 4	< 5	< 4	< 5	< 5	< 5	< 7
PCB #153	25.7	27.0	23.4	30.3	29.9	29.2	33.2	30.8
PCB #138 + PCB #158	17.5	17.4	15.4	19.9	18.4	18.3	21.7	17.7
PCB #128	< 6	< 4	< 5	< 4	< 5	< 5	< 5	< 9
PCB #167	< 6	< 4	< 5	< 5	< 5	< 5	< 5	< 5
PCB #156	< 5	< 4	< 5	< 7	< 5	< 5	4.4	< 5
PCB #157	< 5	< 4	< 5	< 4	< 5	< 5	< 5	< 5
PCB #178	< 5	< 5	< 5	< 4	< 6	< 5	< 5	< 7
PCB #187	5.5	5.4	4.8	5.8	6.6	6.1	8.7	6.9
PCB #183	< 6	< 6	< 5	< 5	< 8	< 5	< 5	< 8
PCB #177	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 7
PCB #172	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 7
PCB #180	19.9	20.1	19.1	23.7	30.3	26.3	34.1	29.3
PCB #170	8.3	8.8	8.1	10.7	11.7	11.1	13.7	10.1
PCB #189	< 6	< 4	< 5	< 6	< 6	< 5	< 6	< 5
PCB #201	< 30	< 5	< 20	< 6	< 7	< 20	5.7	< 6
PCB #196 + PCB #203	< 7	< 5	< 6	< 8	< 8	< 30	4.8	< 6
PCB #195	< 7	< 6	< 6	< 7	< 10	< 7	< 7	< 7
PCB #194	< 7	< 6	< 6	< 7	7.0	5.2	7.1	5.5
PCB #206	< 7	< 7	< 6	< 10	< 10	< 8	< 8	< 7
PCB #209	< 8	< 8	< 7	< 10	< 10	< 10	< 7	< 8
Sum of PCBs (inc)[2]	195	173	174	201	208	210	220	282
Sum of PCBs (exc)[3]	88.0	91.5	81.0	102	104	96.3	138	106
PCB TEQ (inc)[2]	0.0078	0.0064	0.0066	0.0086	0.0063	0.0062	0.0074	0.0064
PCB TEQ (exc)[3]	0.0046	0.0038	0.0037	0.0052	0.0030	0.0032	0.0055	0.0029

1 = These data are the results of the analyses of different sub-samples (SS#1, SS#2) prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6). Mean data for sub-samples reported in Table E8

2 = Including half LOD values

3 = Excluding LOD values

Table E14 Concentrations of PCBs in serum sub-samples from non-Maori aged 65+ years (µg kg^{-1}, lipid wt basis)[1]

	Female, Lower North Island		Female, South Island		Male, South Island	
Congener	SS#1	SS#2	SS#1	SS#2	SS#1	SS#2
PCB #77	< 0.04	< 0.03	< 0.05	< 0.03	< 0.04	< 0.05
PCB #81	< 0.003	< 0.002	< 0.003	< 0.002	< 0.003	0.0031
PCB #126	0.051	0.056	0.045	0.042	0.028	0.040
PCB #169	0.031	0.029	0.027	0.024	0.030	0.034
PCB #18	< 9	< 10	< 8	< 8	< 10	< 20
PCB #28	< 10	< 20	< 10	< 10	< 20	< 30
PCB #52	< 7	< 10	< 6	< 9	< 20	< 20
PCB #49	< 5	< 9	< 5	< 7	< 10	< 10
PCB #44	< 7	< 10	< 6	< 9	< 20	< 20
PCB #74	12.1	9.7	8.5	8.3	4.7	8.6
PCB #66	< 5	< 4	< 4	< 4	< 5	< 10
PCB #101	< 4	< 4	< 4	< 4	< 5	< 10
PCB #99	< 4	< 4	< 4	< 4	< 5	< 10
PCB #87	< 4	< 4	< 4	< 4	< 5	< 20
PCB #110	< 4	< 4	< 4	< 4	< 5	< 20
PCB #118	8.8	9.6	6.5	8.1	< 4	5.8
PCB #105	< 4	< 4	< 4	< 4	< 5	< 10
PCB #151	< 5	< 4	< 4	< 4	< 5	< 20
PCB #149	< 5	< 4	< 4	< 4	< 5	< 20
PCB #146	< 5	4.7	< 4	< 4	< 6	< 10
PCB #153	36.3	37.6	27.8	32.4	29.2	35.5
PCB #138 + PCB #158	25.2	26.3	19.2	21.9	18.5	23.1
PCB #128	< 5	< 5	< 4	< 6	< 6	< 20
PCB #167	< 6	< 5	< 5	< 7	< 8	< 6
PCB #156	< 6	4.4	< 5	< 5	< 7	4.7
PCB #157	< 6	< 5	< 5	< 5	< 6	< 6
PCB #178	< 5	< 5	< 5	< 5	< 6	< 10
PCB #187	8.2	8.2	6.1	6.6	6.6	7.9
PCB #183	< 6	< 5	< 5	< 6	< 9	< 10
PCB #177	< 7	< 5	< 7	< 6	< 7	< 6
PCB #172	< 7	< 5	< 7	< 6	< 7	< 6
PCB #180	27.8	27.5	22.9	23.5	27.3	32.0
PCB #170	10.8	11.4	9.0	9.9	10.7	12.6
PCB #189	< 8	< 5	< 7	< 6	< 6	< 4
PCB #201	< 8	< 6	< 7	< 6	< 7	< 7
PCB #196 + PCB #203	< 9	< 6	< 8	< 6	< 7	< 7
PCB #195	< 9	< 6	< 7	< 8	< 7	< 7
PCB #194	4.8	4.6	4.1	< 8	5.7	6.5
PCB #206	< 10	< 8	< 9	< 8	< 7	< 7
PCB #209	< 10	< 7	< 10	< 9	< 8	< 8
Sum of PCBs (inc)[2]	226	227	185	200	217	308
Sum of PCBs (exc)[3]	134	144	104	111	103	137
PCB TEQ (inc)[2]	0.0098	0.011	0.0084	0.0082	0.0069	0.0095
PCB TEQ (exc)[3]	0.0063	0.0091	0.0055	0.0053	0.0031	0.0073

1 = These data are the results of the analyses of different sub-samples (SS#1, SS#2) prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6). Mean data for sub-samples reported in Table E10

2 = Including half LOD values

3 = Excluding LOD values

Table E15 Concentrations of PCBs in serum on a congener-specific basis (μg kg^{-1}, lipid wt basis)

Congener		Maori female				Maori male				Non-Maori female[1]				Non-Maori male[1]			
		Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island
PCB #77	15–24	*	< 0.2	< 0.05	< 0.1	*	*	< 0.09	< 0.2	< 0.08	< 0.1	< 0.04	< 0.05	< 0.1	< 0.09	< 0.04	< 0.05
	25–34	< 0.06	< 0.06	< 0.05	< 0.2	*	*	< 0.05	< 0.2	< 0.04	< 0.05	< 0.05	< 0.05	< 0.05	< 0.04	< 0.03	< 0.05
	35–49	< 0.1	< 0.1	< 0.06	< 0.1	*	< 0.1	< 0.05	< 0.1	< 0.05	< 0.04	< 0.04	< 0.05	< 0.03	< 0.04	< 0.03	< 0.04
	50–64	*	*	< 0.1	*	*	*	< 0.1	*	< 0.03	< 0.04	< 0.04	< 0.04	< 0.05	< 0.04	< 0.04	< 0.05
	65+	*	*	*	*	*	*	*	*	< 0.06	< 0.03	< 0.04	< 0.04	< 0.06	< 0.05	< 0.04	< 0.05
PCB #81	15–24	*	< 0.01	< 0.003	< 0.008	*	*	< 0.006	< 0.01	< 0.005	< 0.01	< 0.002	< 0.003	< 0.007	< 0.007	< 0.002	< 0.003
	25–34	< 0.004	< 0.004	< 0.003	< 0.02	*	*	< 0.005	< 0.01	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.002	< 0.003
	35–49	< 0.008	< 0.008	< 0.004	< 0.006	*	< 0.006	< 0.003	< 0.006	< 0.004	< 0.003	< 0.003	< 0.003	< 0.002	< 0.002	< 0.002	< 0.002
	50–64	*	*	< 0.009	*	*	*	< 0.006	*	< 0.002	< 0.002	0.0029	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
	65+	*	*	*	*	*	*	*	*	< 0.005	< 0.002	< 0.002	< 0.003	< 0.003	0.0027	< 0.003	0.0024
PCB #126	15–24	*	0.012	0.016	0.014	*	*	0.013	0.013	0.015	0.011	0.015	0.015	0.018	0.017	0.011	0.015
	25–34	0.021	0.020	0.019	0.020	*	*	0.018	0.013	0.029	0.023	0.019	0.017	0.023	0.018	0.012	0.016
	35–49	0.022	0.022	0.022	0.026	*	0.030	0.021	0.021	0.028	0.021	0.025	0.023	0.030	0.021	0.016	0.021
	50–64	*	*	0.061	*	*	*	0.033	*	0.035	0.035	0.034	0.037	0.043	0.050	0.028	0.028
	65+	*	*	*	*	*	*	*	*	0.065	0.057	0.053	0.043	0.028	0.057	0.031	0.034
PCB #169	15–24	*	0.0076	0.0077	0.0089	*	*	0.0097	0.013	0.0088	0.0086	0.0091	0.010	0.017	0.014	0.010	0.013
	25–34	0.012	0.014	0.012	0.013	*	*	0.018	0.021	0.016	0.015	0.013	0.012	0.021	0.024	0.016	0.017
	35–49	0.017	0.018	0.017	0.017	*	0.032	0.026	0.027	0.021	0.018	0.020	0.018	0.030	0.032	0.023	0.026
	50–64	*	*	0.035	*	*	*	0.031	*	0.024	0.024	0.022	0.023	0.035	0.031	0.031	0.029
	65+	*	*	*	*	*	*	*	*	0.035	0.026	0.030	0.026	0.028	0.038	0.032	0.032
PCB #18	15–24	*	< 10	< 10	< 10	*	*	< 10	< 10	< 10	< 20	< 10	< 10	< 20	< 10	< 8	< 20
	25–34	< 10	< 10	< 10	< 10	*	*	< 8	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
	35–49	< 10	< 20	< 10	< 10	*	< 10	< 9	< 9	< 20	< 10	< 20	< 10	< 10	< 10	< 10	< 10
	50–64	*	*	< 10	*	*	*	< 8	*	< 10	< 9	< 10	< 10	< 9	< 10	< 10	< 20
	65+	*	*	*	*	*	*	*	*	< 9	< 9	< 10	< 8	< 10	< 9	< 9	< 20
PCB #28	15–24	*	< 20	< 20	< 20	*	*	< 20	< 20	< 20	< 30	< 20	< 20	< 30	< 20	< 10	< 30
	25–34	< 20	< 20	< 20	< 20	*	*	< 10	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
	35–49	< 20	< 30	< 20	< 20	*	< 20	< 10	< 20	< 30	< 20	< 30	< 20	< 20	< 20	< 20	< 20
	50–64	*	*	< 20	*	*	*	< 10	*	< 20	< 10	< 20	< 20	< 20	< 20	< 20	< 30
	65+	*	*	*	*	*	*	*	*	< 10	< 10	< 20	< 10	< 20	< 10	< 10	< 30
PCB #52	15–24	*	< 10	< 10	< 20	*	*	< 20	< 20	< 20	< 20	< 10	< 20	< 20	< 10	< 7	< 30
	25–34	< 10	< 9	< 10	< 9	*	*	< 7	< 20	< 10	< 10	< 20	< 10	< 20	< 9	< 10	< 20
	35–49	< 20	< 20	< 10	< 8	*	< 10	< 7	< 10	< 20	< 10	< 20	< 10	< 7	< 10	< 20	< 10
	50–64	*	*	< 10	*	*	*	< 6	*	< 10	< 10	< 9	< 10	< 10	< 10	< 10	< 20
	65+	*	*	*	*	*	*	*	*	< 7	< 10	< 10	< 8	< 20	< 10	< 10	< 20
PCB #49	15–24	*	< 8	< 10	< 20	*	*	< 10	< 10	< 10	< 10	< 9	< 10	< 10	< 7	< 5	< 20
	25–34	< 9	< 7	< 7	< 7	*	*	< 5	< 10	< 7	< 8	< 10	< 10	< 10	< 6	< 9	< 10
	35–49	< 10	< 20	< 8	< 6	*	< 8	< 5	< 8	< 10	< 10	< 10	< 10	< 5	< 9	< 10	< 8
	50–64	*	*	< 10	*	*	*	< 5	*	< 7	< 10	< 7	< 8	< 8	< 7	< 9	< 20
	65+	*	*	*	*	*	*	*	*	< 5	< 9	< 7	< 6	< 10	< 7	< 8	< 10
PCB #44	15–24	*	< 10	< 10	< 20	*	*	< 20	< 10	< 20	< 20	< 10	< 20	< 20	< 9	< 6	< 30
	25–34	< 10	< 9	< 9	< 9	*	*	< 6	< 10	< 9	< 10	< 20	< 10	< 20	< 8	< 10	< 20
	35–49	< 20	< 20	< 10	< 8	*	< 10	< 7	< 10	< 20	< 10	< 20	< 10	< 7	< 10	< 20	< 10
	50–64	*	*	< 10	*	*	*	< 6	*	< 10	< 10	< 9	< 10	< 10	< 9	< 10	< 20
	65+	*	*	*	*	*	*	*	*	< 7	< 10	< 9	< 7	< 20	< 9	< 10	< 20

Table E15 (cont.) Concentrations of PCBs in serum on a congener-specific basis (μg kg^{-1}, lipid wt basis)

Congener		Maori female				Maori male				Non-Maori female[1]				Non-Maori male[1]			
		Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island
PCB #74	15–24	*	< 6	< 5	< 6	*	*	< 6	< 6	< 8	< 8	< 5	< 6	< 6	< 6	< 4	< 8
	25–34	< 5	< 5	< 6	< 5	*	*	< 4	< 6	< 5	< 5	< 6	< 6	< 6	< 5	< 4	< 5
	35–49	< 6	7.1	< 6	< 5	*	< 5	< 5	< 4	4.9	< 6	< 7	3.5	< 4	< 5	4.1	< 4
	50–64	*	*	6.5	*	*	*	4.7	*	5.5	5.1	6.1	5.4	6.2	< 5	< 4	5.0
	65+	*	*	*	*	*	*	*	*	8.8	6.0	10.9	8.4	5.7	6.3	5.3	6.6
PCB #66	15–24	*	< 6	< 5	< 6	*	*	< 6	< 6	< 8	< 8	< 5	< 6	< 6	< 6	< 4	< 8
	25–34	< 5	< 5	< 6	< 5	*	*	< 4	< 6	< 5	< 5	< 6	< 6	< 6	< 5	< 4	< 5
	35–49	< 6	< 8	< 6	< 5	*	< 5	< 5	< 4	< 10	< 6	< 7	< 5	< 4	< 5	< 7	< 4
	50–64	*	*	< 5	*	*	*	< 5	*	< 4	< 4	< 5	< 4	< 4	< 5	< 4	< 8
	65+	*	*	*	*	*	*	*	*	< 4	< 5	< 5	< 4	< 6	< 4	< 4	< 9
PCB #101	15–24	*	< 6	< 5	< 6	*	*	< 5	< 6	< 6	< 7	< 6	< 5	< 7	< 5	< 4	< 8
	25–34	< 5	< 5	< 6	< 5	*	*	< 4	< 6	< 5	< 6	< 6	< 5	< 5	< 5	< 5	< 6
	35–49	< 5	< 8	< 6	< 5	*	< 5	< 4	< 4	< 10	< 6	< 9	< 5	< 4	< 5	< 6	< 4
	50–64	*	*	< 6	*	*	*	< 4	*	< 4	< 4	< 5	< 5	< 4	< 5	< 4	< 7
	65+	*	*	*	*	*	*	*	*	< 4	< 4	< 4	< 4	< 5	< 4	< 4	< 9
PCB #99	15–24	*	< 6	< 5	< 6	*	*	< 5	< 6	< 6	< 7	< 5	< 5	< 6	< 5	< 4	< 7
	25–34	< 5	< 5	< 6	< 5	*	*	< 4	< 6	< 5	< 6	< 6	< 5	< 5	< 5	< 4	< 5
	35–49	< 5	< 8	< 6	< 5	*	< 5	< 4	< 4	< 10	< 6	< 8	< 5	< 4	< 5	< 6	< 4
	50–64	*	*	< 6	*	*	*	< 4	*	< 4	< 4	< 5	< 4	< 5	< 5	< 4	< 7
	65+	*	*	*	*	*	*	*	*	< 4	< 4	< 4	< 4	< 5	< 4	< 4	< 9
PCB #87	15–24	*	< 6	< 5	< 6	*	*	< 5	< 6	< 6	< 8	< 5	< 5	< 6	< 5	< 4	< 9
	25–34	< 5	< 5	< 6	< 5	*	*	< 4	< 6	< 5	< 6	< 6	< 6	< 5	< 5	< 4	< 5
	35–49	< 5	< 10	< 6	< 5	*	< 5	< 4	< 4	< 10	< 6	< 10	< 5	< 4	< 5	< 6	< 4
	50–64	*	*	< 8	*	*	*	< 4	*	< 4	< 4	< 5	< 4	< 4	< 5	< 4	< 9
	65+	*	*	*	*	*	*	*	*	< 4	< 4	< 4	< 4	< 5	< 4	< 5	< 10
PCB #110	15–24	*	< 6	< 5	< 6	*	*	< 5	< 6	< 6	< 8	< 5	< 5	< 6	< 5	< 4	< 9
	25–34	< 5	< 5	< 6	< 5	*	*	< 4	< 6	< 5	< 6	< 6	< 6	< 5	< 5	< 4	< 5
	35–49	< 5	< 10	< 6	< 5	*	< 5	< 4	< 4	< 10	< 6	< 10	< 5	< 4	< 5	< 6	< 4
	50–64	*	*	< 8	*	*	*	< 4	*	< 4	< 4	< 5	< 4	< 4	< 5	< 4	< 9
	65+	*	*	*	*	*	*	*	*	< 4	< 4	< 4	< 4	< 5	< 4	< 5	< 10
PCB #118	15–24	*	< 6	< 5	< 6	*	*	< 5	< 5	< 6	< 7	< 5	< 5	< 6	< 5	< 4	< 8
	25–34	< 5	< 5	< 6	< 5	*	*	< 4	< 5	< 5	< 6	< 6	< 5	< 5	< 5	< 4	< 5
	35–49	< 5	6.2	< 6	< 5	*	< 4	< 5	< 4	4.6	< 5	< 7	< 5	4.3	< 5	3.3	< 5
	50–64	*	*	8.6	*	*	*	5.1	*	7.1	6.1	5.8	5.5	5.7	6.1	< 4	< 5
	65+	*	*	*	*	*	*	*	*	10.0	8.4	9.2	7.3	5.6	6.2	5.9	3.9
PCB #105	15–24	*	< 6	< 5	< 6	*	*	< 5	< 5	< 6	< 7	< 5	< 5	< 6	< 5	< 4	< 8
	25–34	< 5	< 5	< 5	< 5	*	*	< 4	< 5	< 5	< 6	< 5	< 5	< 5	< 5	< 4	< 5
	35–49	< 5	< 6	< 5	< 5	*	< 4	< 4	< 4	< 10	< 5	< 7	< 5	< 4	< 4	< 6	< 4
	50–64	*	*	< 6	*	*	*	< 4	*	< 4	< 4	< 5	< 4	< 4	< 4	< 4	< 5
	65+	*	*	*	*	*	*	*	*	< 4	< 4	< 4	< 4	< 5	< 4	< 4	< 8
PCB #151	15–24	*	< 6	< 5	< 7	*	*	< 6	< 6	< 7	< 7	< 5	< 5	< 6	< 5	< 4	< 9
	25–34	< 6	< 5	< 6	< 5	*	*	< 4	< 6	< 5	< 6	< 6	< 6	< 6	< 5	< 5	< 5
	35–49	< 6	< 10	< 6	< 5	*	< 5	< 5	< 4	< 20	< 6	< 10	< 6	< 4	< 5	< 9	< 5
	50–64	*	*	< 6	*	*	*	< 4	*	< 4	< 4	< 5	< 5	< 5	< 5	< 5	< 9
	65+	*	*	*	*	*	*	*	*	< 4	< 5	< 5	< 4	< 6	< 4	< 4	< 10

Table E15 (cont.) Concentrations of PCBs in serum on a congener-specific basis (μg kg^{-1}, lipid wt basis)

Congener		Maori female				Maori male				Non-Maori female[1]				Non-Maori male[1]			
		Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island
PCB #149	15–24	*	< 6	< 5	< 7	*	*	< 6	< 6	< 7	< 7	< 5	< 5	< 6	< 5	< 4	< 9
	25–34	< 6	< 5	< 6	< 5	*	*	< 4	< 6	< 5	< 6	< 6	< 6	< 6	< 5	< 5	< 5
	35–49	< 6	< 10	< 6	< 5	*	< 5	< 5	< 4	< 20	< 6	< 10	< 6	< 4	< 5	< 9	< 5
	50–64	*	*	< 6	*	*	*	< 4	*	< 4	< 4	< 5	< 5	< 5	< 5	< 5	< 9
	65+	*	*	*	*	*	*	*	*	< 4	< 5	< 5	< 4	< 6	< 4	< 4	< 10
PCB #146	15–24	*	< 6	< 6	< 7	*	*	< 6	< 6	< 8	< 7	< 5	< 7	< 6	< 5	< 5	< 9
	25–34	< 6	< 6	< 6	< 5	*	*	< 4	< 6	< 6	< 6	< 6	< 6	< 7	< 5	< 5	< 6
	35–49	< 6	< 7	< 6	< 6	*	< 5	< 5	< 5	< 10	< 6	< 7	< 6	< 5	< 5	3.2	< 5
	50–64	*	*	5.5	*	*	*	6.1	*	< 5	< 4	< 5	< 5	< 5	5.6	< 5	< 6
	65+	*	*	*	*	*	*	*	*	5.3	< 5	3.6	< 4	5.3	6.1	< 4	< 8
PCB #153	15–24	*	6.1	6.8	6.6	*	*	8.9	9.9	8.6	9.5	7.2	7.8	12.3	12.7	10.7	11.2
	25–34	13.4	15.8	11.5	10.1	*	*	15.7	19.4	19.5	14.8	13.2	15.3	21.2	25.2	17.8	15.9
	35–49	20.9	36.4	19.1	20.8	*	28.1	32.9	27.0	25.7	23.2	20.7	19.4	32.2	31.9	30.6	24.6
	50–64	*	*	45.0	*	*	*	46.8	*	34.9	36.0	26.4	26.9	34.5	49.9	29.6	32.0
	65+	*	*	*	*	*	*	*	*	44.0	35.8	37.0	30.1	44.6	46.3	38.2	32.2
PCB #138 + PCB #158	15–24	*	< 6	5.4	< 7	*	*	5.9	7.2	< 7	6.4	5.5	< 6	8.8	8.5	7.2	7.1
	25–34	9.0	11.0	8.3	7.3	*	*	10.2	12.9	13.5	10.2	8.7	9.8	11.8	15.6	11.2	10.7
	35–49	13.2	23.0	13.0	13.4	*	18.5	22.5	17.1	16.1	15.3	13.9	12.6	18.6	18.8	18.1	15.8
	50–64	*	*	31.4	*	*	*	31.5	*	21.9	21.1	17.5	17.7	20.3	36.2	18.4	19.7
	65+	*	*	*	*	*	*	*	*	29.3	24.3	25.8	20.6	28.8	29.8	23.2	20.7
PCB #128	15–24	*	< 6	< 6	< 8	*	*	< 9	< 7	< 10	< 8	< 6	< 8	< 7	< 5	< 5	< 10
	25–34	< 8	< 8	< 7	< 6	*	*	< 4	< 7	< 6	< 6	< 7	< 6	< 6	< 6	< 5	< 7
	35–49	< 6	< 10	< 6	< 7	*	< 5	< 5	< 6	< 20	< 6	< 10	< 6	< 4	< 6	< 7	< 5
	50–64	*	*	< 7	*	*	*	< 4	*	< 5	< 6	< 5	< 5	< 6	< 5	< 5	< 7
	65+	*	*	*	*	*	*	*	*	< 4	< 6	< 5	< 5	< 9	< 6	< 6	< 10
PCB #167	15–24	*	< 6	< 6	< 8	*	*	< 10	< 7	< 10	< 7	< 6	< 6	< 7	< 5	< 5	< 10
	25–34	< 9	< 7	< 7	< 6	*	*	< 4	< 7	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 7
	35–49	< 6	< 8	< 6	< 8	*	< 5	< 6	< 6	< 10	< 6	< 8	< 6	< 5	< 7	< 6	< 5
	50–64	*	*	< 6	*	*	*	< 5	*	< 5	< 6	< 5	< 5	< 6	< 5	< 5	< 5
	65+	*	*	*	*	*	*	*	*	< 4	< 7	< 5	< 6	< 10	< 6	< 5	< 7
PCB #156	15–24	*	< 6	< 6	< 7	*	*	< 7	< 6	< 7	< 7	< 5	< 6	< 7	< 5	< 5	< 10
	25–34	< 6	< 6	< 7	< 6	*	*	< 4	< 6	< 6	< 6	< 6	< 5	< 6	< 6	< 5	< 6
	35–49	< 6	< 6	< 6	< 6	*	< 5	< 6	< 6	< 9	< 5	< 6	< 7	< 5	< 6	3.6	< 5
	50–64	*	*	4.8	*	*	*	5.2	*	< 5	< 4	< 5	< 6	4.8	5.5	< 5	3.5
	65+	*	*	*	*	*	*	*	*	4.8	< 7	3.6	< 5	< 7	5.0	4.6	4.0
PCB #157	15–24	*	< 6	< 6	< 7	*	*	< 7	< 6	< 8	< 7	< 6	< 6	< 7	< 5	< 5	< 10
	25–34	< 6	< 6	< 7	< 6	*	*	< 4	< 7	< 6	< 6	< 6	< 5	< 6	< 6	< 5	< 6
	35–49	< 6	< 5	< 6	< 6	*	< 5	< 6	< 6	< 8	< 6	< 6	< 7	< 5	< 6	< 7	< 5
	50–64	*	*	< 6	*	*	*	< 5	*	< 5	< 4	< 5	< 4	< 6	< 5	< 5	< 5
	65+	*	*	*	*	*	*	*	*	< 4	< 6	< 5	< 5	< 7	< 4	< 5	< 6
PCB #178	15–24	*	< 7	< 6	< 8	*	*	< 8	< 6	< 8	< 8	< 6	< 7	< 7	< 5	< 5	< 10
	25–34	< 7	< 6	< 7	< 5	*	*	< 4	< 7	< 6	< 6	< 6	< 6	< 7	< 5	< 5	< 6
	35–49	< 6	< 7	< 6	< 6	*	< 5	< 6	< 6	< 10	< 7	< 8	< 6	< 4	< 6	< 9	< 5
	50–64	*	*	< 6	*	*	*	< 5	*	< 5	< 5	< 5	< 5	< 6	< 5	< 5	< 6
	65+	*	*	*	*	*	*	*	*	< 4	< 6	< 5	< 5	< 7	< 5	< 5	< 9

Table E15 (cont.) Concentrations of PCBs in serum on a congener-specific basis (μg kg^{-1}, lipid wt basis)

Congener		Maori female				Maori male				Non-Maori female[1]				Non-Maori male[1]			
		Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island
PCB #187	15–24	*	< 9	< 6	< 9	*	*	< 10	< 7	< 10	< 9	< 6	< 7	< 8	< 5	< 5	< 20
	25–34	< 9	< 8	< 7	< 6	*	*	< 4	< 8	< 7	< 6	< 7	< 7	< 8	6.3	3.4	< 8
	35–49	< 7	6.9	< 6	< 7	*	6.6	7.5	6.5	4.4	< 9	4.3	< 7	7.5	7.6	7.1	5.2
	50–64	*	*	10.2	*	*	*	15.3	*	7.3	7.6	5.5	5.3	7.3	12.0	6.4	7.8
	65+	*	*	*	*	*	*	*	*	9.7	7.5	8.2	6.4	10.5	11.1	11.0	7.2
PCB #183	15–24	*	< 9	< 6	< 9	*	*	< 10	< 7	< 10	< 9	< 6	< 7	< 8	< 5	< 5	< 20
	25–34	< 9	< 8	< 7	< 6	*	*	< 4	< 8	< 7	< 6	< 7	< 7	< 8	< 5	< 6	< 8
	35–49	< 7	< 8	< 6	< 7	*	< 5	< 6	< 7	< 10	< 9	< 9	< 7	< 4	< 7	< 10	< 6
	50–64	*	*	< 7	*	*	*	4.2	*	< 6	< 7	< 6	< 5	< 7	5.3	< 6	< 6
	65+	*	*	*	*	*	*	*	*	< 4	< 7	< 5	< 5	< 9	< 6	< 7	< 10
PCB #177	15–24	*	< 7	< 7	< 9	*	*	< 9	< 7	< 10	< 8	< 5	< 7	< 8	< 5	< 6	< 10
	25–34	< 8	< 8	< 8	< 5	*	*	< 4	< 7	< 7	< 6	< 7	< 6	< 8	< 6	< 6	< 6
	35–49	< 8	< 6	< 6	< 8	*	< 5	< 8	< 7	< 9	< 6	< 6	< 8	< 5	< 7	< 7	< 5
	50–64	*	*	< 6	*	*	*	3.9	*	< 7	< 5	< 5	< 5	< 7	4.4	< 5	< 6
	65+	*	*	*	*	*	*	*	*	< 4	< 8	< 6	< 6	< 8	4.5	< 5	< 6
PCB #172	15–24	*	< 7	< 7	< 9	*	*	< 9	< 7	< 10	< 8	< 5	< 7	< 8	< 5	< 6	< 10
	25–34	< 8	< 8	< 8	< 5	*	*	< 4	< 7	< 7	< 6	< 7	< 6	< 8	< 6	< 6	< 6
	35–49	< 8	< 6	< 6	< 8	*	< 5	< 8	< 7	< 9	< 6	< 6	< 8	< 5	< 7	< 7	< 5
	50–64	*	*	< 6	*	*	*	< 5	*	< 7	< 5	< 5	< 5	< 7	< 5	< 5	< 6
	65+	*	*	*	*	*	*	*	*	< 4	< 8	< 6	< 6	< 8	< 6	< 5	< 6
PCB #180	15–24	*	< 7	< 7	< 9	*	*	6.8	8.0	6.6	7.6	5.5	7.1	9.2	10.8	9.3	9.6
	25–34	10.0	11.5	8.9	8.5	*	*	14.2	16.7	14.2	12.0	10.7	11.5	17.5	27.1	16.9	14.1
	35–49	15.2	27.9	14.4	14.8	*	26.1	27.1	25.8	20.6	19.9	16.6	17.1	26.8	32.2	27.3	24.7
	50–64	*	*	34.1	*	*	*	42.2	*	26.7	30.4	20.0	21.4	29.1	44.6	28.3	31.7
	65+	*	*	*	*	*	*	*	*	33.0	25.6	27.7	23.2	39.6	41.7	40.3	29.6
PCB #170	15–24	*	< 6	< 7	< 20	*	*	< 7	< 7	< 8	< 7	< 6	< 6	< 8	< 5	< 6	< 10
	25–34	< 7	5.4	< 8	< 20	*	*	6.7	6.5	5.8	5.5	< 6	< 6	7.1	12.9	6.9	6.3
	35–49	6.4	9.9	6.2	6.2	*	15.9	10.5	10.2	9.5	7.9	7.5	7.2	10.7	14.9	9.3	10.2
	50–64	*	*	14.9	*	*	*	14.5	*	11.5	11.9	8.6	9.4	13.7	18.6	11.4	11.9
	65+	*	*	*	*	*	*	*	*	16.1	12.3	11.1	9.5	15.7	17.1	15.2	11.6
PCB #189	15–24	*	< 7	< 8	< 8	*	*	< 8	< 8	< 9	< 8	< 7	< 8	< 9	< 6	< 7	< 10
	25–34	< 8	< 10	< 9	< 9	*	*	< 6	< 7	< 9	< 7	< 8	< 6	< 8	nr	< 6	< 7
	35–49	< 8	< 5	< 6	< 10	*	< 6	< 8	< 10	< 6	< 6	< 6	< 7	< 7	< 7	< 5	< 6
	50–64	*	*	< 8	*	*	*	< 5	*	< 8	< 6	< 5	< 5	< 8	< 5	< 6	< 6
	65+	*	*	*	*	*	*	*	*	< 6	< 8	< 7	< 6	< 8	< 5	< 5	< 5
PCB #201	15–24	*	< 7	< 8	< 20	*	*	< 10	< 8	< 10	< 8	< 9	< 9	< 9	< 8	< 7	< 10
	25–34	< 10	< 10	< 9	< 40	*	*	< 30	< 8	< 8	< 9	< 8	< 6	< 8	< 40	< 7	< 9
	35–49	< 8	< 8	< 20	< 10	*	< 6	< 8	< 8	< 10	< 7	< 20	< 20	< 6	4.8	3.5	< 6
	50–64	*	*	< 10	*	*	*	5.8	*	< 7	< 7	< 20	< 10	< 7	5.9	< 20	4.4
	65+	*	*	*	*	*	*	*	*	4.3	< 8	< 7	< 6	< 10	4.9	7.3	< 7
PCB #196 + PCB #203	15–24	*	< 7	< 10	< 10	*	*	< 10	< 10	< 10	< 10	< 9	< 9	< 10	< 8	< 9	< 20
	25–34	< 20	< 10	< 9	< 40	*	*	< 9	< 9	< 9	< 8	< 10	< 7	< 10	< 40	< 9	< 9
	35–49	< 10	< 10	< 7	< 20	*	< 6	< 10	< 9	< 20	< 8	< 10	< 20	< 7	4.4	3.6	< 7
	50–64	*	*	< 9	*	*	*	5	*	< 10	< 6	< 6	< 7	< 10	5.6	< 20	4.0
	65+	*	*	*	*	*	*	*	*	4.3	< 10	< 7	< 7	< 8	4.5	6.0	< 7

Table E15 (cont.) Concentrations of PCBs in serum on a congener-specific basis (µg kg^{-1}, lipid wt basis)

Congener		Maori female				Maori male				Non-Maori female[1]				Non-Maori male[1]			
		Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island	Northland/ Auckland	Waikato/ Bay of Plenty	Lower North Island	South Island
PCB #195	15–24	*	< 8	< 9	< 10	*	*	< 10	< 10	< 10	< 10	< 9	< 10	< 10	< 8	< 9	< 20
	25–34	< 10	< 10	< 10	< 10	*	*	< 8	< 10	< 10	< 9	< 9	< 8	< 10	< 10	< 7	< 9
	35–49	< 10	< 7	< 8	< 10	*	< 7	< 9	< 10	< 10	< 9	< 10	< 10	< 8	< 9	< 6	< 8
	50–64	*	*	< 9	*	*	*	< 6	*	< 9	< 7	< 6	< 7	< 10	< 6	< 10	< 7
	65+	*	*	*	*	*	*	*	*	< 8	< 10	< 8	< 8	< 9	< 6	< 7	< 7
PCB #194	15–24	*	< 8	< 9	< 10	*	*	< 10	< 10	< 10	< 10	< 9	< 10	< 10	< 8	< 9	< 20
	25–34	< 10	< 10	< 10	< 10	*	*	< 8	< 10	< 10	< 9	< 9	< 8	< 10	5.3	< 7	< 9
	35–49	< 10	< 7	< 8	< 10	*	4.0	4.4	< 10	< 10	< 9	< 10	< 10	5.0	6.9	5.1	4.7
	50–64	*	*	5.4	*	*	*	6.6	*	4.8	5.0	< 6	< 7	5.9	8.5	6.1	6.3
	65+	*	*	*	*	*	*	*	*	5.7	< 10	4.7	4.0	6.6	6.9	9.2	6.1
PCB #206	15–24	*	< 10	< 10	< 10	*	*	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 20
	25–34	< 10	< 20	< 10	< 10	*	*	< 9	< 10	< 10	< 10	< 10	< 9	< 10	< 10	< 9	< 10
	35–49	< 10	< 7	< 7	< 10	*	< 8	< 10	< 10	< 10	< 10	< 9	< 10	< 10	< 10	< 5	< 10
	50–64	*	*	< 10	*	*	*	< 6	*	< 10	< 8	< 7	< 8	< 10	< 6	< 9	< 7
	65+	*	*	*	*	*	*	*	*	< 9	< 10	< 9	< 8	< 10	< 7	< 9	< 7
PCB #209	15–24	*	< 10	< 20	< 20	*	*	< 10	< 20	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 20
	25–34	< 10	< 20	< 10	< 10	*	*	< 10	< 20	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
	35–49	< 20	< 8	< 9	< 20	*	< 7	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 20	< 5	< 10
	50–64	*	*	< 10	*	*	*	< 8	*	< 20	< 8	< 8	< 10	< 20	< 7	< 10	< 8
	65+	*	*	*	*	*	*	*	*	< 10	< 20	< 9	< 9	< 10	< 8	< 9	< 8
Sum of PCBs (inc)[2]	15–24	*	138	149	196	*	*	166	167	185	182	140	157	180	145	127	255
	25–34	173	176	162	178	*	*	144	192	173	163	173	161	194	225	160	178
	35–49	190	268	176	183	*	192	205	203	286	191	230	194	193	225	222	182
	50–64	*	*	277	*	*	*	256	*	222	214	184	188	229	279	209	251
	65+	*	*	*	*	*	*	*	*	243	235	227	192	280	259	245	260
Sum of PCBs (exc)[3]	15–24	*	6.12	12.2	6.62	*	*	21.6	25.1	15.2	23.5	18.2	14.9	30.3	32.0	27.2	27.9
	25–34	32.4	43.7	28.7	25.9	*	*	46.8	55.5	53.0	42.5	32.7	36.5	57.6	92.4	54.6	46.9
	35–49	55.7	117	52.7	55.2	*	99.3	105	86.6	81.9	66.3	61.3	58.0	105	122	111	83.3
	50–64	*	*	166	*	*	*	197	*	120	123	89.7	91.5	128	208	100	122
	65+	*	*	*	*	*	*	*	*	175	120	139	107	162	190	166	119
PCB TEQ (inc)[2]	15–24	*	0.0051	0.0054	0.0062	*	*	0.0059	0.0056	0.0066	0.0059	0.0052	0.0055	0.0063	0.0052	0.0047	0.0083
	25–34	0.0064	0.0063	0.0064	0.0060	*	*	0.0048	0.0055	0.0071	0.0063	0.0060	0.0054	0.0064	0.0055	0.0045	0.0055
	35–49	0.0061	0.0064	0.0061	0.0068	*	0.0064	0.0064	0.0062	0.0086	0.0059	0.0066	0.0069	0.0067	0.0064	0.0063	0.0055
	50–64	*	*	0.012	*	*	*	0.0083	*	0.0077	0.0070	0.0071	0.0076	0.0098	0.010	0.0062	0.0069
	65+	*	*	*	*	*	*	*	*	0.012	0.011	0.010	0.0083	0.0076	0.011	0.0080	0.0082
PCB TEQ (exc)[3]	15–24	*	0.0013	0.0016	0.0015	*	*	0.0014	0.0015	0.0016	0.0012	0.0016	0.0016	0.0019	0.0018	0.0012	0.0016
	25–34	0.0022	0.0021	0.0020	0.0021	*	*	0.0019	0.0015	0.0031	0.0025	0.0021	0.0019	0.0025	0.0020	0.0014	0.0018
	35–49	0.0024	0.0030	0.0024	0.0027	*	0.0033	0.0024	0.0023	0.0033	0.0023	0.0027	0.0024	0.0037	0.0024	0.0031	0.0024
	50–64	*	*	0.0097	*	*	*	0.0067	*	0.0044	0.0043	0.0042	0.0045	0.0076	0.0087	0.0031	0.0042
	65+	*	*	*	*	*	*	*	*	0.010	0.0067	0.0077	0.0054	0.0037	0.0092	0.0063	0.0051

1 = Some data for certain age groups and geographic regions are means of unique sub-samples. Data for individual sub-samples are reported in Tables E11-E14
2 = Including half LOD values
3 = Excluding LOD values
* = Insufficient sample collected for analysis
nr = Result cannot be reported because one or more of the quality assurance or quality control parameters did not meet the specified QA/QC criteria

Appendix F Concentrations of organochlorine pesticides in the serum of New Zealanders

This appendix reports the concentrations of selected organochlorine pesticides and pesticide degradation products in the serum of New Zealanders.

Median and mean concentrations reported in this appendix (under the heading of 'national summary') are unweighted concentrations. That is, they do not take into account the number of individual samples that were combined to prepare each pooled sample, as described in Section B1.9, Appendix B.

Organochlorine pesticide data are reported in the following tables:

Table F1	Concentrations in serum from Maori aged 15–24 years
Table F2	Concentrations in serum from non-Maori aged 15–24 years
Table F3	Concentrations in serum from Maori aged 25–34 years
Table F4	Concentrations in serum from non-Maori aged 25–34 years
Table F5	Concentrations in serum from Maori aged 35–49 years
Table F6	Concentrations in serum from non-Maori aged 35–49 years
Table F7	Concentrations in serum from Maori aged 50–64 years
Table F8	Concentrations in serum from non-Maori aged 50–64 years
Table F9	Concentrations in serum from Maori aged 65+ years
Table F10	Concentrations in serum from non-Maori aged 65+ years
Table F11	Concentrations in serum sub-samples from non-Maori aged 25–34 years
Table F12	Concentrations in serum sub-samples from non-Maori aged 35–49 years
Table F13	Concentrations in serum sub-samples from non-Maori aged 50–64 years
Table F14	Concentrations in serum sub-samples from non-Maori aged 65+ years
Table F15	Concentrations in serum on a pesticide-specific basis

Table F1 Concentrations of organochlorine pesticides in serum from Maori aged 15–24 years (µg kg^{-1}, lipid wt basis)

	Maori female				Maori male				National summary for Maori aged 15–24 years				
Pesticide	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island**	**South Island**	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island**	**South Island**	**Number of positives**	**Minimum**	**Maximum[1]**	**Median[2]**	**Mean[3]**
β-HCH	*	< 10	< 10	< 9	*	*	< 7	< 10	0	< 7	< 10	-	-
γ-HCH	*	< 10	< 20	< 10	*	*	< 7	< 10	0	< 7	< 20	-	-
HCB	*	< 30	< 30	< 30	*	*	< 20	< 20	0	< 20	< 30	-	-
Aldrin	*	< 5	< 4	< 5	*	*	< 4	< 5	0	< 4	< 5	-	-
Dieldrin	*	< 8	9.4	10.1	*	*	10.6	8.6	4	< 8	10.6	9.4	9.7
Endrin	*	< 8	< 7	< 8	*	*	< 7	< 8	0	< 7	< 8	-	-
Heptachlor epoxide	*	< 5	< 4	< 5	*	*	< 4	< 5	0	< 4	< 5	-	-
Oxychlordane	*	< 5	< 4	< 5	*	*	< 4	< 5	0	< 4	< 5	-	-
t-Nonachlor	*	< 8	< 7	< 8	*	*	< 7	< 8	0	< 7	< 8	-	-
pp-DDE	*	413	513	694	*	*	652	965	5	413	965	652	647
op-DDT	*	< 20	< 10	< 20	*	*	< 10	< 20	0	< 10	< 20	-	-
pp-DDT	*	< 20	< 20	< 20	*	*	< 20	< 20	0	< 20	< 20	-	-
Mirex	*	< 10	< 10	< 9	*	*	< 7	< 10	0	< 7	< 10	-	-

1 = Excludes any LOD value which is greater than a maximum measured value for that pesticide

2 = Median concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 4 positive determinations). LODs are included in the median calculation

3 = Mean concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 4 positive determinations). LODs are excluded from the mean calculation

* = Insufficient sample collected for analysis

Table F2 Concentrations of organochlorine pesticides in serum from non-Maori aged 15–24 years (µg kg^{-1}, lipid wt basis)

	Non-Maori female				Non-Maori male				National summary for non-Maori aged 15–24 years				
Pesticide	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island**	**South Island**	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island**	**South Island**	**Number of positives**	**Minimum**	**Maximum[1]**	**Median[2]**	**Mean[3]**
β-HCH	< 9	< 20	< 8	< 8	< 10	8.8	7.5	< 10	2	< 8	8.8	-	-
γ-HCH	< 9	< 20	< 8	< 8	< 8	< 8	< 10	< 10	0	< 8	< 20	-	-
HCB	< 30	< 40	< 20	< 20	< 30	< 20	< 30	< 30	0	< 20	< 40	-	-
Aldrin	< 5	< 5	< 5	< 5	< 5	< 5	< 4	< 5	0	< 4	< 5	-	-
Dieldrin	< 9	< 8	10.5	10.8	11.6	8.8	9.7	13.3	6	< 8	13.3	10.1	10.8
Endrin	< 9	< 9	< 8	< 8	< 8	< 8	nr	< 8	0	< 8	< 9	-	-
Heptachlor epoxide	< 5	< 5	< 5	< 5	< 5	< 5	< 4	< 5	0	< 4	< 5	-	-
Oxychlordane	< 5	< 5	< 5	< 5	< 5	< 5	< 4	< 5	0	< 4	< 5	-	-
t-Nonachlor	< 9	< 9	< 8	< 8	< 8	< 8	< 7	< 8	0	< 7	< 9	-	-
pp-DDE	432	522	585	605	535	548	718	859	8	432	859	566	600
op-DDT	< 20	< 20	< 20	< 10	< 20	< 10	< 10	< 20	0	< 10	< 20	-	-
pp-DDT	33.2	< 30	< 20	< 20	< 20	< 20	15.0	< 20	2	< 20	33.2	-	-
Mirex	< 9	< 10	< 7	< 5	< 6	< 5	< 9	< 10	0	< 5	< 10	-	-

1 = Excludes any LOD value which is greater than a maximum measured value for that pesticide

2 = Median concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are included in the median calculation

3 = Mean concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are excluded from the mean calculation

nr = Result cannot be reported because one or more of the quality assurance or quality control parameters did not meet the specified QA/QC criteria

Table F3 Concentrations of organochlorine pesticides in serum from Maori aged 25–34 years (µg kg^{-1}, lipid wt basis)

	Maori female				Maori male				National summary for Maori aged 25–34 years				
Pesticide	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island**	**South Island**	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island**	**South Island**	**Number of positives**	**Minimum**	**Maximum[1]**	**Median[2]**	**Mean[3]**
β-HCH	< 10	7.8	< 20	< 7	*	*	< 7	< 9	1	< 7	7.8	-	-
γ-HCH	< 10	< 7	< 20	< 10	*	*	< 10	< 10	0	< 7	< 20	-	-
HCB	< 30	< 20	< 50	< 20	*	*	< 20	< 20	0	< 20	< 50	-	-
Aldrin	< 5	< 4	< 6	< 4	*	*	< 4	< 4	0	< 4	< 6	-	-
Dieldrin	9.6	14.6	24.1	9.2	*	*	10.7	10.1	6	9.2	24.1	10.4	13.1
Endrin	< 8	< 7	nr	< 7	*	*	< 7	< 7	0	< 7	< 8	-	-
Heptachlor epoxide	< 5	< 4	< 6	< 4	*	*	< 4	< 4	0	< 4	< 6	-	-
Oxychlordane	< 5	< 4	< 6	< 4	*	*	< 4	< 4	0	< 4	< 6	-	-
t-Nonachlor	< 8	< 7	< 10	< 7	*	*	< 7	< 7	0	< 7	< 10	-	-
pp-DDE	504	667	864	799	*	*	905	1,340	6	504	1,340	832	847
op-DDT	< 20	< 10	< 20	< 20	*	*	< 10	< 10	0	< 10	< 20	-	-
pp-DDT	< 20	< 20	< 30	< 20	*	*	< 20	< 20	0	< 20	< 30	-	-
Mirex	< 8	< 4	< 10	< 6	*	*	< 5	< 7	0	< 4	< 10	-	-

1 = Excludes any LOD value which is greater than a maximum measured value for that pesticide

2 = Median concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 4 positive determinations). LODs are included in the median calculation

3 = Mean concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 4 positive determinations). LODs are excluded from the mean calculation

* = Insufficient sample collected for analysis

nr = Result cannot be reported because one or more of the quality assurance or quality control parameters did not meet the specified QA/QC criteria

Table F4 Concentrations of organochlorine pesticides in serum from non-Maori aged 25–34 years (µg kg^{-1}, lipid wt basis)

	Non-Maori female				Non-Maori male				National summary for non-Maori aged 25–34 years				
Pesticide	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island (n=3)[1]**	**South Island (n=3)[1]**	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island (n=2)[1]**	**South Island (n=2)[1]**	**Number of positives**	**Minimum**	**Maximum[2]**	**Median[3]**	**Mean[4]**
β-HCH	29.1	< 7	8.1	9.3	7.8	7.5	10.2	10.7	7	< 7	29.1	8.7	11.8
γ-HCH	< 7	< 8	< 20	< 10	< 8	< 8	< 8	< 9	0	< 7	< 20	-	-
HCB	< 20	< 20	< 50	< 30	< 20	< 20	< 20	< 20	0	< 20	< 50	-	-
Aldrin	< 4	< 4	< 8	< 4	< 4	< 4	< 3	< 4	0	< 3	< 8	-	-
Dieldrin	9.4	9.9	10.3	11.1	11.3	10.3	9.8	11.5	8	9.4	11.5	10.3	10.5
Endrin	< 7	< 7	< 8	< 7	< 7	< 7	< 6	< 7	0	< 6	< 8	-	-
Heptachlor epoxide	< 4	< 4	< 8	< 4	< 4	< 4	< 3	< 4	0	< 3	< 8	-	-
Oxychlordane	< 4	< 4	< 8	< 4	< 4	< 4	< 3	< 4	0	< 3	< 8	-	-
t-Nonachlor	< 7	< 7	< 10	< 7	< 7	< 7	< 6	< 7	0	< 6	< 10	-	-
pp-DDE	564	705	736	755	450	622	803	1,170	8	450	1,170	720	726
op-DDT	< 10	< 10	< 20	< 10	< 10	< 10	< 10	< 10	0	< 10	< 20	-	-
pp-DDT	< 20	< 20	< 30	< 30	< 20	< 20	< 20	23.9	1	< 20	23.9	-	-
Mirex	< 4	< 5	< 10	< 9	< 6	< 5	< 5	< 7	0	< 4	< 10	-	-

1 = Mean of two (n=2) or three (n=3) unique sub-samples prepared for this stratum (see Table F11 and Appendix A, Section A6)

2 = Excludes any LOD value which is greater than a maximum measured value for that pesticide

3 = Median concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are included in the median calculation

4 = Mean concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are excluded from the mean calculation

Table F5 Concentrations of organochlorine pesticides in serum from Maori aged 35–49 years (µg kg^{-1}, lipid wt basis)

	Maori female				Maori male				National summary for Maori aged 35–49 years				
Pesticide	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island**	**South Island**	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island**	**South Island**	**Number of positives**	**Minimum**	**Maximum[1]**	**Median[2]**	**Mean[3]**
β-HCH	< 8	nr	< 7	9.4	*	25.3	9.7	17.1	4	< 7	25.3	-	-
γ-HCH	< 9	nr	< 7	< 20	*	< 6	< 10	< 6	0	< 6	< 20	-	-
HCB	< 20	< 20	< 20	< 30	*	< 20	< 30	< 20	0	< 20	< 30	-	-
Aldrin	< 5	nr	< 4	< 4	*	< 3	< 4	< 4	0	< 3	< 5	-	-
Dieldrin	15.3	15.9	9.6	16.8	*	15.8	25.9	11.0	7	9.6	25.9	15.8	15.8
Endrin	< 8	nr	< 7	< 7	*	< 6	nr	< 6	0	< 6	< 8	-	-
Heptachlor epoxide	< 5	nr	< 4	< 4	*	< 3	< 4	< 4	0	< 3	< 5	-	-
Oxychlordane	< 5	nr	< 4	< 4	*	< 3	< 4	< 4	0	< 3	< 5	-	-
t-Nonachlor	< 8	nr	< 7	< 7	*	< 6	< 7	< 6	0	< 6	< 8	-	-
pp-DDE	547	1,810	1,270	1,740	*	902	1,590	1,280	7	547	1,810	1,280	1,310
op-DDT	< 10	nr	< 10	< 20	*	< 10	< 10	< 10	0	< 10	< 20	-	-
pp-DDT	< 20	< 60	< 20	27.1	*	< 20	20.5	< 20	2	< 20	27.1	-	-
Mirex	< 9	< 6	< 4	< 8	*	< 3	< 10	< 5	0	< 3	< 10	-	-

1 = Excludes any LOD value which is greater than a maximum measured value for that pesticide

2 = Median concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 5 positive determinations). LODs are included in the median calculation

3 = Mean concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 5 positive determinations). LODs are excluded from the mean calculation

* = Insufficient sample collected for analysis

nr = Result cannot be reported because one or more of the quality assurance or quality control parameters did not meet the specified QA/QC criteria

Table F6 Concentrations of organochlorine pesticides in serum from non-Maori aged 35–49 years (µg kg^{-1}, lipid wt basis)

	Non-Maori female				Non-Maori male				National summary for non-Maori aged 35–49 years				
Pesticide	**Northland/Auckland (n=2)[1]**	**Waikato/Bay of Plenty**	**Lower North Island (n=2)[1]**	**South Island (n=3)[1]**	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island (n=2)[1]**	**South Island (n=3)[1]**	**Number of positives**	**Minimum**	**Maximum[2]**	**Median[3]**	**Mean[4]**
β-HCH	73.1	10.4	12.2	9.5	38.4	10.4	44.7	34.1	8	9.5	73.1	23.2	29.1
γ-HCH	< 8	< 10	< 10	< 7	< 8	< 6	< 7	< 9	0	< 6	< 10	-	-
HCB	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	0	< 20	< 20	-	-
Aldrin	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	0	< 4	< 4	-	-
Dieldrin	14.9	9.4	11.3	11.0	11.2	8.5	14.3	11.7	8	8.5	14.9	11.3	11.5
Endrin	< 7	< 7	< 7	< 7	< 6	< 6	< 6	< 6	0	< 6	< 7	-	-
Heptachlor epoxide	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	0	< 4	< 4	-	-
Oxychlordane	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	0	< 4	< 4	-	-
t-Nonachlor	< 7	< 7	< 7	< 7	< 6	< 6	< 6	< 6	0	< 6	< 7	-	-
pp-DDE	756	809	839	1,040	1,030	709	1,380	1,330	8	709	1,380	935	987
op-DDT	< 10	< 10	< 10	< 10	< 20	< 10	< 10	< 10	0	< 10	< 20	-	-
pp-DDT	27.1	< 20	< 50	< 20	32.4	< 20	< 40	< 20	2	< 20	32.4	-	-
Mirex	< 10	< 7	< 8	< 4	< 6	< 4	< 10	< 6	0	< 4	< 10	-	-

1 = Mean of two (n=2) or three (n=3) unique sub-samples prepared for this stratum (see Table F12 and Appendix A, Section A6)

2 = Excludes any LOD value which is greater than a maximum measured value for that pesticide

3 = Median concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are included in the median calculation

4 = Mean concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are excluded from the mean calculation

Table F7 Concentrations of organochlorine pesticides in serum from Maori aged 50–64 years (µg kg^{-1}, lipid wt basis)

	Maori female				Maori male				National summary for Maori aged 50–64 years				
Pesticide	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island**	**South Island**	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island**	**South Island**	**Number of positives**	**Minimum**	**Maximum**	**Median[1]**	**Mean[2]**
β-HCH	*	*	17.5	*	*	*	12.6	*	2	12.6	17.5	15.1	15.1
γ-HCH	*	*	< 7	*	*	*	< 20	*	0	< 7	< 20	-	-
HCB	*	*	53.6	*	*	*	< 40	*	1	< 40	53.6	-	-
Aldrin	*	*	< 4	*	*	*	< 4	*	0	< 4	< 4	-	-
Dieldrin	*	*	17.1	*	*	*	26.3	*	2	17.1	26.3	21.7	21.7
Endrin	*	*	< 7	*	*	*	nr	*	0	< 7	< 7	-	-
Heptachlor epoxide	*	*	< 4	*	*	*	< 4	*	0	< 4	< 4	-	-
Oxychlordane	*	*	< 4	*	*	*	< 4	*	0	< 4	< 4	-	-
t-Nonachlor	*	*	< 7	*	*	*	< 7	*	0	< 7	< 7	-	-
pp-DDE	*	*	2,780	*	*	*	2,050	*	2	2,050	2,780	2,420	2,420
op-DDT	*	*	< 10	*	*	*	< 10	*	0	< 10	< 10	-	-
pp-DDT	*	*	44.1	*	*	*	24.6	*	2	24.6	44.1	34.4	34.4
Mirex	*	*	< 5	*	*	*	< 7	*	0	< 5	< 7	-	-

1 = Median concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 2 positive determinations). LODs are included in the median calculation

2 = Mean concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 2 positive determinations). LODs are excluded from the mean calculation

* = Insufficient sample collected for analysis

nr = Result cannot be reported because one or more of the quality assurance or quality control parameters did not meet the specified QA/QC criteria

Table F8 Concentrations of organochlorine pesticides in serum from non-Maori aged 50–64 years (µg kg^{-1}, lipid wt basis)

	Non-Maori female				Non-Maori male				National summary for non-Maori aged 50–64 years				
Pesticide	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island (n=2)[1]**	**South Island (n=2)[1]**	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island (n=2)[1]**	**South Island (n=2)[1]**	**Number of positives**	**Minimum**	**Maximum[2]**	**Median[3]**	**Mean[4]**
β-HCH	20.0	13.6	19.2	27.7	23.5	15.4	11.6	12.2	8	11.6	27.7	17.3	17.9
γ-HCH	< 9	< 6	91.1	< 8	< 6	< 6	< 8	< 6	1	< 6	91.1	-	-
HCB	< 20	< 20	< 20	52.8	< 20	< 20	< 20	< 20	1	< 20	52.8	-	-
Aldrin	< 4	< 4	< 4	< 3	< 4	< 3	< 4	< 4	0	< 3	< 4	-	-
Dieldrin	15.7	13.7	12.3	20.6	14.5	15.8	12.7	19.8	8	12.3	20.6	15.1	15.6
Endrin	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	0	< 6	< 6	-	-
Heptachlor epoxide	< 4	< 4	< 4	< 3	< 4	< 3	< 4	< 4	0	< 3	< 4	-	-
Oxychlordane	< 4	< 4	< 4	< 3	< 4	< 3	< 4	< 4	0	< 3	< 4	-	-
t-Nonachlor	7.6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	1	< 6	7.6	-	-
pp-DDE	1,100	919	1,530	1,520	605	876	1,210	1,540	8	605	1,540	1,160	1,160
op-DDT	< 10	< 10	< 20	< 10	< 10	< 10	< 10	< 10	0	< 10	< 20	-	-
pp-DDT	29.4	< 20	24.5	21.9	< 20	< 20	16.7	< 60	4	< 20	29.4	-	-
Mirex	< 7	< 6	< 6	< 5	< 4	< 3	< 5	< 7	0	< 3	< 7	-	-

1 = Mean of two unique sub-samples prepared for this stratum (see Table F13 and Appendix A, Section A6)

2 = Excludes any LOD value which is greater than a maximum measured value for that pesticide

3 = Median concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are included in the median calculation

4 = Mean concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are excluded from the mean calculation

Table F9 Concentrations of organochlorine pesticides in serum from Maori aged 65+ years (µg kg^{-1}, lipid wt basis)

	Maori female				Maori male				National summary for Maori aged 65+ years				
Pesticide	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island**	**South Island**	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island**	**South Island**	**Number of positives**	**Minimum**	**Maximum**	**Median**	**Mean**
β-HCH	*	*	*	*	*	*	*	*	-	-	-	-	-
γ-HCH	*	*	*	*	*	*	*	*	-	-	-	-	-
HCB	*	*	*	*	*	*	*	*	-	-	-	-	-
Aldrin	*	*	*	*	*	*	*	*	-	-	-	-	-
Dieldrin	*	*	*	*	*	*	*	*	-	-	-	-	-
Endrin	*	*	*	*	*	*	*	*	-	-	-	-	-
Heptachlor epoxide	*	*	*	*	*	*	*	*	-	-	-	-	-
Oxychlordane	*	*	*	*	*	*	*	*	-	-	-	-	-
t-Nonachlor	*	*	*	*	*	*	*	*	-	-	-	-	-
pp-DDE	*	*	*	*	*	*	*	*	-	-	-	-	-
op-DDT	*	*	*	*	*	*	*	*	-	-	-	-	-
pp-DDT	*	*	*	*	*	*	*	*	-	-	-	-	-
Mirex	*	*	*	*	*	*	*	*	-	-	-	-	-

* = Insufficient sample collected for analysis

Table F10 Concentrations of organochlorine pesticides in serum from non-Maori aged 65+ years (μg kg^{-1}, lipid wt basis)

	Non-Maori female				Non-Maori male				National summary for non-Maori aged 65+ years				
Pesticide	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island (n=2)[1]**	**South Island (n=2)[1]**	**Northland/Auckland**	**Waikato/Bay of Plenty**	**Lower North Island**	**South Island (n=2)[1]**	**Number of positives**	**Minimum**	**Maximum**	**Median[2]**	**Mean[3]**
β-HCH	31.2	22.8	29.1	29.9	24.2	15.9	14.5	19.4	8	14.5	31.2	23.5	23.4
γ-HCH	< 9	< 6	< 10	< 9	< 7	< 5	< 9	< 8	0	< 5	< 10	-	-
HCB	< 20	< 20	28.8	24.3	< 20	< 20	< 20	< 20	2	< 20	28.8	-	-
Aldrin	< 3	< 3	< 4	< 4	< 4	< 3	< 4	< 4	0	< 3	< 4	-	-
Dieldrin	25.1	23.3	28.4	21.5	18.1	27.6	17.7	19.1	8	17.7	28.4	22.4	22.6
Endrin	< 6	< 6	< 6	< 6	< 7	< 5	< 6	< 6	0	< 5	< 7	-	-
Heptachlor epoxide	< 3	< 3	< 4	< 4	< 4	< 3	< 4	< 4	0	< 3	< 4	-	-
Oxychlordane	< 3	< 3	< 4	< 4	< 4	< 3	< 4	< 4	0	< 3	< 4	-	-
t-Nonachlor	8.4	< 6	< 7	< 6	8.3	< 5	< 6	< 6	2	< 5	8.4	-	-
pp-DDE	1,090	1,880	2,740	2,100	950	1,220	1,310	1,650	8	950	2,740	1,480	1,620
op-DDT	< 10	< 10	< 20	< 20	< 10	< 10	< 10	< 10	0	< 10	< 20	-	-
pp-DDT	17.1	26.7	49.2	30.9	< 20	20.5	< 20	< 40	5	< 20	49.2	-	-
Mirex	< 6	< 5	< 7	< 7	< 7	< 3	< 8	< 6	0	< 3	< 8	-	-

1 = Mean of two unique sub-samples prepared for this stratum (see Table F14 and Appendix A, Section A6)

2 = Median concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are included in the median calculation

3 = Mean concentration reported only if a pesticide detected on more than 66% of occasions (minimum of 6 positive determinations). LODs are excluded from the mean calculation

Table F11 Concentrations of organochlorine pesticides in serum sub-samples from non-Maori aged 25–34 years (µg kg^{-1}, lipid wt basis)[1]

	Female, Lower North Island			Female, South Island			Male, Lower North Island		Male, South Island	
Pesticide	SS#1	SS#2	SS#3	SS#1	SS#2	SS#3	SS#1	SS#2	SS#1	SS#2
β-HCH	8.1	< 10	8.0	nr	9.3	< 10	12.0	8.4	10.9	10.5
γ-HCH	< 10	< 10	< 40	nr	< 10	< 10	< 6	< 10	< 10	< 7
HCB	< 30	< 30	< 80	< 30	< 20	< 20	< 20	< 20	< 20	< 20
Aldrin	< 5	< 5	< 10	nr	< 4	< 5	< 3	< 4	< 4	< 4
Dieldrin	< 8	8.4	12.2	14.0	9.8	9.4	10.4	9.2	12.3	10.6
Endrin	< 8	< 8	nr	nr	< 7	< 8	< 6	< 6	< 7	< 7
Heptachlor epoxide	< 5	< 5	< 10	nr	< 4	< 5	< 3	< 4	< 4	< 4
Oxychlordane	< 5	< 5	< 10	nr	< 4	< 5	< 3	< 4	< 4	< 4
t-Nonachlor	< 8	< 8	< 20	nr	< 7	< 8	< 6	< 6	< 7	< 7
pp-DDE	610	733	864	710	803	752	817	790	927	1,420
op-DDT	< 20	< 20	< 30	nr	< 10	< 20	< 10	< 10	< 10	< 10
pp-DDT	< 20	< 20	< 40	< 60	< 20	< 20	< 20	< 20	< 20	23.9
Mirex	< 9	< 10	< 20	< 9	< 8	< 10	< 3	< 7	< 10	< 4

1 = These data are the results of the analyses of unique sub-samples (SS#1, SS#2, SS#3) prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6).
Mean data for sub-samples reported in Table F4

nr = Result cannot be reported because one or more of the quality assurance or quality control parameters did not meet the specified QA/QC criteria

Table F12 Concentrations of organochlorine pesticides in serum sub-samples from non-Maori aged 35–49 years (µg kg^{-1}, lipid wt basis)[1]

	Female, Northland/Auckland		Female, Lower North Island		Female, South Island			Male, Lower North Island		Male, South Island		
Pesticide	SS#1	SS#2	SS#1	SS#2	SS#1	SS#2	SS#3	SS#1	SS#2	SS#1	SS#2	SS#3
β-HCH	nr	73.1	nr	12.2	7.9	10.9	9.7	nr	44.7	62.2	14.3	25.8
γ-HCH	nr	< 8	nr	< 10	< 7	< 6	< 7	nr	< 7	< 10	< 10	< 6
HCB	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
Aldrin	nr	< 4	nr	< 4	< 4	< 4	< 4	nr	< 4	< 4	< 4	< 4
Dieldrin	14.9	< 8	11.9	10.7	10.1	13	9.9	17.7	10.9	10.6	11.2	13.3
Endrin	nr	< 7	nr	< 7	< 7	< 6	< 7	nr	< 6	< 7	< 6	< 6
Heptachlor epoxide	nr	< 4	nr	< 4	< 4	< 4	< 4	nr	< 4	< 4	< 4	< 4
Oxychlordane	nr	< 4	nr	< 4	< 4	< 4	< 4	nr	< 4	< 4	< 4	< 4
t-Nonachlor	nr	< 7	nr	< 7	< 7	< 6	< 7	nr	< 6	< 7	< 6	< 6
pp-DDE	882	630	749	929	755	1,140	1,210	1,650	1,100	1,120	1,530	1,350
op-DDT	nr	< 10	nr	< 10	< 10	< 10	< 10	nr	< 10	< 10	< 10	< 10
pp-DDT	< 80	27.1	< 90	< 20	< 20	< 20	< 20	< 70	< 20	< 20	< 20	< 20
Mirex	< 20	< 6	< 10	< 5	< 4	< 4	< 4	< 20	< 6	< 7	< 6	< 4

1 = These data are the results of the analyses of different sub-samples (SS#1, SS#2, SS#3) prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6).
Mean data for sub-samples reported in Table F6

nr = Result cannot be reported because one or more of the quality assurance or quality control parameters did not meet the specified QA/QC criteria

Table F13 Concentrations of organochlorine pesticides in serum sub-samples from non-Maori aged 50–64 years (µg kg^{-1}, lipid wt basis)[1]

	Female, Lower North Island		Female, South Island		Male, Lower North Island		Male, South Island	
Pesticide	SS#1	SS#2	SS#1	SS#2	SS#1	SS#2	SS#1	SS#2
β-HCH	15.3	23.1	31.3	24.1	12.3	10.8	12.2	nr
γ-HCH	91.1	< 10	< 7	< 10	< 10	< 6	< 6	nr
HCB	< 20	< 20	< 20	52.8	< 20	< 20	< 20	< 20
Aldrin	< 4	< 4	< 4	< 3	< 4	< 3	< 4	nr
Dieldrin	11.4	13.1	18.0	23.1	13.5	11.9	14.6	24.9
Endrin	< 6	< 6	< 6	< 6	< 6	< 5	< 6	nr
Heptachlor epoxide	< 4	< 4	< 4	< 3	< 4	< 3	< 4	nr
Oxychlordane	< 4	< 4	< 4	< 3	< 4	< 3	< 4	nr
t-Nonachlor	< 6	< 6	< 6	< 6	< 6	< 5	< 6	nr
pp-DDE	1,420	1,630	1,350	1,690	1,160	1,260	1,500	1,580
op-DDT	< 20	< 20	< 10	< 10	< 10	< 10	< 10	nr
pp-DDT	17.6	31.5	21.9	21.9	< 20	16.7	< 20	< 100
Mirex	< 4	< 7	< 4	< 7	< 6	< 4	< 4	< 10

1 = These data are the results of the analyses of different sub-samples (SS#1, SS#2) prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6).
Mean data for sub-samples reported in Table F8

nr = Result cannot be reported because one or more of the quality assurance or quality control parameters did not meet the specified QA/QC criteria

Table F14 Concentrations of organochlorine pesticides in serum sub-samples from non-Maori aged 65+ years (µg kg^{-1}, lipid wt basis)[1]

	Female, Lower North Island		Female, South Island		Male, South Island	
Pesticide	SS#1	SS#2	SS#1	SS#2	SS#1	SS#2
β-HCH	27.3	30.8	26.9	32.8	19.4	nr
γ-HCH	< 20	< 6	< 10	< 6	< 8	nr
HCB	27.8	29.7	25.4	23.1	< 20	< 20
Aldrin	< 5	< 4	< 4	< 3	< 4	nr
Dieldrin	25.1	31.7	22.1	20.9	13.3	25.3
Endrin	nr	< 6	nr	< 6	< 6	nr
Heptachlor epoxide	< 5	< 4	< 4	< 3	< 4	nr
Oxychlordane	< 5	< 4	< 4	< 3	< 4	nr
t-Nonachlor	< 8	< 6	< 7	< 6	< 6	nr
pp-DDE	3,160	2,320	2,360	1,840	1,230	2,070
op-DDT	< 20	< 10	< 10	< 20	< 10	nr
pp-DDT	68.6	29.8	37.4	24.4	< 20	< 50
Mirex	< 10	< 4	< 10	< 4	< 5	< 8

1 = These data are the results of the analyses of different sub-samples (SS#1, SS#2) prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6).
Mean data for sub-samples reported in Table F10

nr = Result cannot be reported because one or more of the quality assurance or quality control parameters did not meet the specified QA/QC criteria

Table F15 Concentrations of organochlorine pesticides in serum on a pesticide-specific basis (μg kg^{-1}, lipid wt basis)

Pesticide		Maori female				Maori male				Non-Maori female[1]				Non-Maori male[1]			
		Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island
β-HCH	15–24	*	< 10	< 10	< 9	*	*	< 7	< 10	< 9	< 20	< 8	< 8	< 10	8.8	7.5	< 10
	25–34	< 10	7.8	< 20	< 7	*	*	< 7	< 9	29.1	< 7	8.1	9.3	7.8	7.5	10.2	10.7
	35–49	< 8	nr	< 7	9.4	*	25.3	9.7	17.1	73.1	10.4	12.2	9.5	38.4	10.4	44.7	34.1
	50–64	*	*	17.5	*	*	*	12.6	*	20.0	13.6	19.2	27.7	23.5	15.4	11.6	12.2
	65+	*	*	*	*	*	*	*	*	31.2	22.8	29.1	29.9	24.2	15.9	14.5	19.4
γ-HCH	15–24	*	< 10	< 20	< 10	*	*	< 7	< 10	< 9	< 20	< 8	< 8	< 8	< 8	< 10	< 10
	25–34	< 10	< 7	< 20	< 10	*	*	< 10	< 10	< 7	< 8	< 20	< 10	< 8	< 8	< 8	< 9
	35–49	< 9	nr	< 7	< 20	*	< 6	< 10	< 6	< 8	< 10	< 10	< 7	< 8	< 6	< 7	< 9
	50–64	*	*	< 7	*	*	*	< 20	*	< 9	< 6	91.1	< 8	< 6	< 6	< 8	< 6
	65+	*	*	*	*	*	*	*	*	< 9	< 6	< 10	< 9	< 7	< 5	< 9	< 8
HCB	15–24	*	< 30	< 30	< 30	*	*	< 20	< 20	< 30	< 40	< 20	< 20	< 30	< 20	< 30	< 30
	25–34	< 30	< 20	< 50	< 20	*	*	< 20	< 20	< 20	< 20	< 50	< 30	< 20	< 20	< 20	< 20
	35–49	< 20	< 20	< 20	< 30	*	< 20	< 30	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
	50–64	*	*	53.6	*	*	*	< 40	*	< 20	< 20	< 20	52.8	< 20	< 20	< 20	< 20
	65+	*	*	*	*	*	*	*	*	< 20	< 20	28.8	24.3	< 20	< 20	< 20	< 20
Aldrin	15–24	*	< 5	< 4	< 5	*	*	< 4	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 4	< 5
	25–34	< 5	< 4	< 6	< 4	*	*	< 4	< 4	< 4	< 4	< 8	< 4	< 4	< 4	< 3	< 4
	35–49	< 5	nr	< 4	< 4	*	< 3	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
	50–64	*	*	< 4	*	*	*	< 4	*	< 4	< 4	< 4	< 3	< 4	< 3	< 4	< 4
	65+	*	*	*	*	*	*	*	*	< 3	< 3	< 4	< 4	< 4	< 3	< 4	< 4
Dieldrin	15–24	*	< 8	9.4	10.1	*	*	10.6	8.6	< 9	< 8	10.5	10.8	11.6	8.8	9.7	13.3
	25–34	9.6	14.6	24.1	9.2	*	*	10.7	10.1	9.4	9.9	10.3	11.1	11.3	10.3	9.8	11.5
	35–49	15.3	15.9	9.6	16.8	*	15.8	25.9	11.0	14.9	9.4	11.3	11.0	11.2	8.5	14.3	11.7
	50–64	*	*	17.1	*	*	*	26.3	*	15.7	13.7	12.3	20.6	14.5	15.8	12.7	19.8
	65+	*	*	*	*	*	*	*	*	25.1	23.3	28.4	21.5	18.1	27.6	17.7	19.1
Endrin	15–24	*	< 8	< 7	< 8	*	*	< 7	< 8	< 9	< 9	< 8	< 8	< 8	< 8	nr	< 8
	25–34	< 8	< 7	nr	< 7	*	*	< 7	< 7	< 7	< 7	< 8	< 7	< 7	< 7	< 6	< 7
	35–49	< 8	nr	< 7	< 7	*	< 6	nr	< 6	< 7	< 7	< 7	< 7	< 6	< 6	< 6	< 6
	50–64	*	*	< 7	*	*	*	nr	*	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6
	65+	*	*	*	*	*	*	*	*	< 6	< 6	< 6	< 6	< 7	< 5	< 6	< 6
Heptachlor epoxide	15–24	*	< 5	< 4	< 5	*	*	< 4	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 4	< 5
	25–34	< 5	< 4	< 6	< 4	*	*	< 4	< 4	< 4	< 4	< 8	< 4	< 4	< 4	< 3	< 4
	35–49	< 5	nr	< 4	< 4	*	< 3	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
	50–64	*	*	< 4	*	*	*	< 4	*	< 4	< 4	< 4	< 3	< 4	< 3	< 4	< 4
	65+	*	*	*	*	*	*	*	*	< 3	< 3	< 4	< 4	< 4	< 3	< 4	< 4

Table F15 (cont.) Concentrations of organochlorine pesticides in serum on a pesticide-specific basis (µg kg^{-1}, lipid wt basis)

Pesticide		Maori female				Maori male				Non-Maori female[1]				Non-Maori male[1]			
		Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island	Northland/Auckland	Waikato/Bay of Plenty	Lower North Island	South Island
Oxychlordane	15–24	*	< 5	< 4	< 5	*	*	< 4	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 4	< 5
	25–34	< 5	< 4	< 6	< 4	*	*	< 4	< 4	< 4	< 4	< 8	< 4	< 4	< 4	< 3	< 4
	35–49	< 5	nr	< 4	< 4	*	< 3	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
	50–64	*	*	< 4	*	*	*	< 4	*	< 4	< 4	< 4	< 3	< 4	< 3	< 4	< 4
	65+	*	*	*	*	*	*	*	*	< 3	< 3	< 4	< 4	< 4	< 3	< 4	< 4
t-Nonachlor	15–24	*	< 8	< 7	< 8	*	*	< 7	< 8	< 9	< 9	< 8	< 8	< 8	< 8	< 7	< 8
	25–34	< 8	< 7	< 10	< 7	*	*	< 7	< 7	< 7	< 7	< 10	< 7	< 7	< 7	< 6	< 7
	35–49	< 8	nr	< 7	< 7	*	< 6	< 7	< 6	< 7	< 7	< 7	< 7	< 6	< 6	< 6	< 6
	50–64	*	*	< 7	*	*	*	< 7	*	7.6	< 6	< 6	< 6	< 6	< 6	< 6	< 6
	65+	*	*	*	*	*	*	*	*	8.4	< 6	< 7	< 6	8.3	< 5	< 6	< 6
pp-DDE	15–24	*	413	513	694	*	*	652	965	432	522	585	605	535	548	718	859
	25–34	504	667	864	799	*	*	905	1,340	564	705	736	755	450	622	803	1,170
	35–49	547	1,810	1,270	1,740	*	902	1,590	1,280	756	809	839	1,040	1,030	709	1,380	1,330
	50–64	*	*	2,780	*	*	*	2,050	*	1,100	919	1,530	1,520	605	876	1,210	1,540
	65+	*	*	*	*	*	*	*	*	1,090	1,880	2,740	2,100	950	1,220	1,310	1,650
op-DDT	15–24	*	< 20	< 10	< 20	*	*	< 10	< 20	< 20	< 20	< 20	< 10	< 20	< 10	< 10	< 20
	25–34	< 20	< 10	< 20	< 20	*	*	< 10	< 10	< 10	< 10	< 20	< 10	< 10	< 10	< 10	< 10
	35–49	< 10	nr	< 10	< 20	*	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 20	< 10	< 10	< 10
	50–64	*	*	< 10	*	*	*	< 10	*	< 10	< 10	< 20	< 10	< 10	< 10	< 10	< 10
	65+	*	*	*	*	*	*	*	*	< 10	< 10	< 20	< 20	< 10	< 10	< 10	< 10
pp-DDT	15–24	*	< 20	< 20	< 20	*	*	< 20	< 20	33.2	< 30	< 20	< 20	< 20	< 20	15.0	< 20
	25–34	< 20	< 20	< 30	< 20	*	*	< 20	< 20	< 20	< 20	< 30	< 30	< 20	< 20	< 20	23.9
	35–49	< 20	< 60	< 20	27.1	*	< 20	20.5	< 20	27.1	< 20	< 50	< 20	32.4	< 20	< 40	< 20
	50–64	*	*	44.1	*	*	*	24.6	*	29.4	< 20	24.5	21.9	< 20	< 20	16.7	< 60
	65+	*	*	*	*	*	*	*	*	17.1	26.7	49.2	30.9	< 20	20.5	< 20	< 40
Mirex	15–24	*	< 10	< 10	< 9	*	*	< 7	< 10	< 9	< 10	< 7	< 5	< 6	< 5	< 9	< 10
	25–34	< 8	< 4	< 10	< 6	*	*	< 5	< 7	< 4	< 5	< 10	< 9	< 6	< 5	< 5	< 7
	35–49	< 9	< 6	< 4	< 8	*	< 3	< 10	< 5	< 10	< 7	< 8	< 4	< 6	< 4	< 10	< 6
	50–64	*	*	< 5	*	*	*	< 7	*	< 7	< 6	< 6	< 5	< 4	< 3	< 5	< 7
	65+	*	*	*	*	*	*	*	*	< 6	< 5	< 7	< 7	< 7	< 3	< 8	< 6

1 = Some data for certain age groups and geographic regions are means of unique sub-samples. Data for individual sub-samples are reported in Tables F11-F14

* = Insufficient sample collected for analysis

nr = Result cannot be reported because one or more of the quality assurance or quality control parameters did not meet the specified QA/QC criteria

Appendix G Standard error estimates

This appendix reports the standard error estimates for the analysis of the serum sub-samples for organochlorines.

Table G1	Standard errors of PCDD/F analysis, non-Maori aged 25–34 years
Table G2	Standard errors of PCDD/F analysis, non-Maori aged 35–49 years
Table G3	Standard errors of PCDD/F analysis, non-Maori aged 50–64 years
Table G4	Standard errors of PCDD/F analysis, non-Maori aged 65+ years
Table G5	Standard errors of PCB analysis, non-Maori aged 25–34 years
Table G6	Standard errors of PCB analysis, non-Maori aged 35–49 years
Table G7	Standard errors of PCB analysis, non-Maori aged 50–64 years
Table G8	Standard errors of PCB analysis, non-Maori aged 65+ years
Table G9	Standard errors of organochlorine pesticide analysis, non-Maori aged 25–34 years
Table G10	Standard errors of organochlorine pesticide analysis, non-Maori aged 35–49 years
Table G11	Standard errors of organochlorine pesticide analysis, non-Maori aged 50–64 years
Table G12	Standard errors of organochlorine pesticide analysis, non-Maori aged 65+ years

Table G1 Standard errors of PCDD and PCDF analyisis of serum sub-samples from non-Maori aged 25–34 years (ng kg^{-1}, lipid weight basis)

	Female, Lower North Island		Female, South Island		Male, Lower North Island		Male, South Island	
Congener	Mean (n=3)[1]	Std Error	Mean (n=3)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error
2, 3, 7, 8 TCDD	1.5	0.12	1.4	0.17	1.1	0.050	1.2	0.25
1, 2, 3, 7, 8 PeCDD	3.2	0.23	3.1	0.17	2.8	0.25	3.4	0.45
1, 2, 3, 4, 7, 8 HxCDD	1.9	0.088	1.3	nc	1.6	0.050	1.9	0.30
1, 2, 3, 6, 7, 8 HxCDD	12.5	1.7	13.6	2.1	13.2	1.8	14.9	2.1
1, 2, 3, 7, 8, 9 HxCDD	3.3	0.35	3.4	0.32	2.0	0.050	3.0	0.40
1, 2, 3, 4, 6, 7, 8 HpCDD	32.7	4.4	31.9	5.6	21.9	1.8	28.6	5.2
OCDD	326	45.3	366	53.7	209	18.5	246	27.5
2, 3, 7, 8 TCDF	0.2	nc	< 0.3	nc	< 0.3	nc	< 0.4	nc
1, 2, 3, 7, 8 PeCDF	< 0.3	nc	< 0.4	nc	< 0.3	nc	< 0.5	nc
2, 3, 4, 7, 8 PeCDF	2.6	0.29	3.1	0.28	2.6	0.30	3.4	0.30
1, 2, 3, 4, 7, 8 HxCDF	1.4	0.088	1.8	0.13	1.2	0.10	1.7	0.20
1, 2, 3, 6, 7, 8 HxCDF	1.7	0.15	2.0	0.20	1.6	0.050	2.4	0.25
2, 3, 4, 6, 7, 8 HxCDF	0.5	0.033	0.7	0.10	0.8	0.25	0.8	0.15
1, 2, 3, 4, 6, 7, 8 HpCDF	5.0	nc	5.8	nc	< 5	nc	5.8	nc
1, 2, 3, 4, 7, 8, 9 HpCDF	0.3	nc	0.3	nc	< 0.3	nc	0.3	nc
OCDF	< 10	nc	< 20	nc	< 10	nc	< 2	nc
Sum of 2,3,7,8-PCDD/Fs (inc)[2]	399	57	447	68	265	22	314	36
Sum of 2,3,7,8-PCDD/Fs (exc)[3]	389	54	433	64	257	17	309	40
PCDD/F TEQ (inc)[2]	8.54	0.66	8.76	0.73	7.42	0.36	9.09	1.2
PCDD/F TEQ (exc)[3]	8.46	0.66	8.69	0.73	7.36	0.34	8.99	1.3

1 = Mean concentration calculated from the analysis of two (n=2) or three (n=3) unique sub-samples prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6)
2 = Including half LOD values
3 = Excluding LOD values
nc = Not calculated due to values for some sub-samples being below detection limits

Table G2 Standard errors of PCDD and PCDF analyisis of serum sub-samples from non-Maori aged 35–49 years (ng kg^{-1}, lipid weight basis)

	Female, Northland/Auckland		Female, Lower North Island		Female, South Island		Male, Lower North Island		Male, South Island	
Congener	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=3)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=3)[1]	Std Error
2, 3, 7, 8 TCDD	2.3	0.65	2.1	0.25	2.0	0.25	1.4	0.050	1.9	0.18
1, 2, 3, 7, 8 PeCDD	5.3	0.85	3.8	0.050	4.9	0.76	3.8	0	4.9	0.23
1, 2, 3, 4, 7, 8 HxCDD	3.3	0.55	2.6	0.10	2.6	0.22	2.6	0.20	2.8	0.24
1, 2, 3, 6, 7, 8 HxCDD	25.2	6.5	20.1	0.55	20.1	1.5	19.2	1.0	20.5	0.70
1, 2, 3, 7, 8, 9 HxCDD	5.1	1.7	3.9	0.30	3.9	0.26	3.1	0.15	3.7	0.15
1, 2, 3, 4, 6, 7, 8 HpCDD	48.4	15.9	34.2	1.7	37.4	3.7	32.1	1.6	33.0	2.5
OCDD	455	112	361	27.0	399	26.5	285	2.0	325	30.6
2, 3, 7, 8 TCDF	< 0.4	nc	0.2	nc	0.3	nc	0.2	nc	< 0.3	nc
1, 2, 3, 7, 8 PeCDF	0.3	nc	< 0.5	nc	< 0.4	nc	< 0.3	nc	< 0.2	nc
2, 3, 4, 7, 8 PeCDF	4.6	0.25	3.6	0.20	3.7	0.22	3.8	0.40	4.0	0.45
1, 2, 3, 4, 7, 8 HxCDF	2.2	0.35	1.8	0.10	2.0	0.15	2.0	0.15	2.2	0.12
1, 2, 3, 6, 7, 8 HxCDF	2.7	0.30	2.2	0.10	2.4	0.17	2.2	0.15	2.6	0.12
2, 3, 4, 6, 7, 8 HxCDF	0.8	0.10	0.6	0	0.7	0.033	0.7	0.10	0.9	0.033
1, 2, 3, 4, 6, 7, 8 HpCDF	6.4	nc	4.1	0.10	5.0	nc	5.2	0.050	4.8	0.44
1, 2, 3, 4, 7, 8, 9 HpCDF	0.4	0.10	0.3	0.050	0.3	nc	0.3	0.050	0.2	nc
OCDF	< 20	nc	< 20	nc	< 20	nc	< 10	nc	< 10	nc
Sum of 2,3,7,8-PCDD/Fs (inc)[2]	572	128	448	29	491	34	367	2.4	414	33
Sum of 2,3,7,8-PCDD/Fs (exc)[3]	559	144	440	28	482	32	361	1.8	406	35
PCDD/F TEQ (inc)[2]	14.3	2.8	11.2	0.38	12.4	1.1	10.5	0.34	12.5	0.67
PCDD/F TEQ (exc)[3]	14.3	2.8	11.1	0.39	12.4	1.1	10.4	0.35	12.5	0.66

1 = Mean concentration calculated from the analysis of two (n=2) or three (n=3) unique sub-samples prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6)
2 = Including half LOD values
3 = Excluding LOD values
nc = Not calculated due to values for some sub-samples being below detection limits

Table G3 Standard errors of PCDD and PCDF analyisis of serum sub-samples from non-Maori aged 50–64 years (ng kg^{-1}, lipid weight basis)

	Female, Lower North Island		Female, South Island		Male, Lower North Island		Male, South Island	
Congener	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error
2, 3, 7, 8 TCDD	4.0	0.90	3.4	0.45	2.4	0.10	2.6	0.25
1, 2, 3, 7, 8 PeCDD	5.6	0.75	5.6	0.40	4.9	0.10	6.1	0.50
1, 2, 3, 4, 7, 8 HxCDD	3.4	0.40	3.2	0.25	2.9	0.050	3.4	0
1, 2, 3, 6, 7, 8 HxCDD	25.2	1.0	23.5	2.3	24.5	2.9	25.3	0.50
1, 2, 3, 7, 8, 9 HxCDD	5.3	0.85	4.9	0.15	4.1	0.10	4.6	0.35
1, 2, 3, 4, 6, 7, 8 HpCDD	53.3	12.3	50.0	3.3	34.1	3.4	42.9	2.3
OCDD	497	161	447	1.0	316	46.5	391	40.5
2, 3, 7, 8 TCDF	0.4	0.050	0.3	0	< 0.3	nc	0.3	0.050
1, 2, 3, 7, 8 PeCDF	0.3	nc	0.3	0.050	0.3	nc	0.2	nc
2, 3, 4, 7, 8 PeCDF	4.8	0.60	5.2	0.70	4.9	0.35	5.1	0.65
1, 2, 3, 4, 7, 8 HxCDF	2.7	0.45	2.9	0.50	2.1	0.30	2.8	0.050
1, 2, 3, 6, 7, 8 HxCDF	3.0	0.45	3.2	0.60	2.7	0.30	3.7	0.40
2, 3, 4, 6, 7, 8 HxCDF	1.0	0.050	1.0	0.20	0.9	0	1.3	0.25
1, 2, 3, 4, 6, 7, 8 HpCDF	5.0	nc	3.9	0.30	4.0	nc	6.2	1.3
1, 2, 3, 4, 7, 8, 9 HpCDF	0.4	nc	< 0.4	nc	0.3	nc	0.4	0.050
OCDF	< 30	nc	< 7	nc	< 10	nc	< 20	nc
Sum of 2,3,7,8-PCDD/Fs (inc)[2]	624	193	557	5.3	409	59	503	51
Sum of 2,3,7,8-PCDD/Fs (exc)[3]	609	182	554	8.0	401	56	495	42
PCDD/F TEQ (inc)[2]	16.7	2.4	16.1	1.6	13.9	0.58	15.9	1.1
PCDD/F TEQ (exc)[3]	16.7	2.4	16.0	1.6	13.8	0.60	15.8	1.1

1 = Mean concentration calculated from the analysis of two unique sub-samples prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6)
2 = Including half LOD values
3 = Excluding LOD values
nc = Not calculated due to values for some sub-samples being below detection limits

Table G4 Standard errors of PCDD and PCDF analyisis of serum sub-samples from non-Maori aged 65+ years (ng kg^{-1}, lipid weight basis)

	Female, Lower North Island		Female, South Island		Male, South Island	
Congener	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error
2, 3, 7, 8 TCDD	7.0	0.25	5.0	0.70	2.9	0.25
1, 2, 3, 7, 8 PeCDD	7.1	0.35	7.6	1.4	6.2	0.050
1, 2, 3, 4, 7, 8 HxCDD	5.3	0.45	4.2	0.80	3.7	0.50
1, 2, 3, 6, 7, 8 HxCDD	36.3	2.5	36.1	8.8	29.4	4.5
1, 2, 3, 7, 8, 9 HxCDD	6.8	0.35	6.7	0.80	4.9	0.45
1, 2, 3, 4, 6, 7, 8 HpCDD	59.9	2.5	56.8	6.0	42.6	5.5
OCDD	484	13.0	537	74.5	382	8.0
2, 3, 7, 8 TCDF	0.2	nc	0.3	nc	0.3	0.050
1, 2, 3, 7, 8 PeCDF	< 0.4	nc	0.3	0.050	0.2	nc
2, 3, 4, 7, 8 PeCDF	6.7	0.25	6.5	0.050	5.6	0.40
1, 2, 3, 4, 7, 8 HxCDF	3.5	0.050	3.6	0	2.7	0.35
1, 2, 3, 6, 7, 8 HxCDF	3.8	0.10	4.0	0.10	3.4	0.50
2, 3, 4, 6, 7, 8 HxCDF	1.0	0	1.0	0.10	0.9	0.15
1, 2, 3, 4, 6, 7, 8 HpCDF	< 9	nc	4.4	0.55	5.2	0.70
1, 2, 3, 4, 7, 8, 9 HpCDF	< 0.5	nc	< 0.6	nc	0.2	0.050
OCDF	< 1	nc	< 1	nc	< 10	nc
Sum of 2,3,7,8-PCDD/Fs (inc)[2]	627	13	674	94	499	22
Sum of 2,3,7,8-PCDD/Fs (exc)[3]	621	13	673	94	490	22
PCDD/F TEQ (inc)[2]	23.7	0.24	22.1	3.2	17.1	1.2
PCDD/F TEQ (exc)[3]	23.6	0.25	22.1	3.2	17.1	1.2

1 = Mean concentration calculated from the analysis of two unique sub-samples prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6)
2 = Including half LOD values
3 = Excluding LOD values
nc = Not calculated due to values for some sub-samples being below detection limits

Table G5 Standard errors of PCB analyisis of serum sub-samples from non-Maori aged 25–34 years (μg kg^{-1}, lipid weight basis)

	Female, Lower North Island		Female, South Island		Male, Lower North Island		Male, South Island	
Congener	Mean (n=3)[1]	Std Error	Mean (n=3)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error
PCB #126	0.019	0.0015	0.017	0.0022	0.012	0.0010	0.016	0.0028
PCB #169	0.013	0.00099	0.012	0.0012	0.016	0.0011	0.017	0.0019
PCB #74	< 6	nc	< 6	nc	< 4	nc	< 5	nc
PCB #118	< 6	nc	< 5	nc	< 4	nc	< 5	nc
PCB #153	13.2	0.38	15.3	0.52	17.8	0.45	15.9	1.5
PCB #138 + PCB #158	8.7	0.41	9.8	0.18	11.2	0.35	10.7	0.95
PCB #187	< 7	nc	< 7	nc	3.4	nc	< 8	nc
PCB #180	10.7	0.25	11.5	0.64	16.9	0.15	14.1	1.8
PCB #170	< 6	nc	< 6	nc	6.9	0.45	6.3	0.85
PCB #194	< 9	nc	< 8	nc	< 7	nc	< 9	nc
Sum of PCBs (inc)[2]	173	16	161	8.3	160	12	178	3.5
Sum of PCBs (exc)[3]	32.7	0.83	36.5	1.0	54.6	0.60	46.9	5.0
PCB TEQ (inc)[2]	0.0060	0.00012	0.0054	0.00040	0.0045	0.00018	0.0055	0.00050
PCB TEQ (exc)[3]	0.0021	0.00016	0.0019	0.00023	0.0014	0.00010	0.0018	0.00030

1 = Mean concentration calculated from the analysis of two (n=2) or three (n=3) unique sub-samples prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6)
2 = Including half LOD values
3 = Excluding LOD values
nc = Not calculated due to values for some sub-samples being below detection limits

Table G6 Standard errors of PCB analyisis of serum sub-samples from non-Maori aged 35–49 years (μg kg^{-1}, lipid weight basis)

	Female, Northland/Auckland		Female, Lower North Island		Female, South Island		Male, Lower North Island		Male, South Island	
Congener	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=3)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=3)[1]	Std Error
PCB #126	0.028	0.0060	0.025	0.0060	0.023	0.0033	0.016	0.00035	0.021	0.0029
PCB #169	0.021	0.0014	0.020	0.0022	0.018	0.0002	0.023	0	0.026	0.0024
PCB #74	4.9	nc	< 7	nc	3.5	nc	4.1	nc	< 4	nc
PCB #118	4.6	nc	< 7	nc	< 5	nc	3.3	nc	< 5	nc
PCB #153	25.7	5.0	20.7	1.1	19.4	1.2	30.6	7.4	24.6	2.7
PCB #138 + PCB #158	16.1	3.7	13.9	1.3	12.6	0.90	18.1	4.0	15.8	2.3
PCB #187	4.4	nc	4.3	nc	< 7	nc	7.1	1.5	5.2	nc
PCB #180	20.6	3.7	16.6	0.30	17.1	0.23	27.3	4.5	24.7	3.6
PCB #170	9.5	1.3	7.5	0.60	7.2	0.41	9.3	0.70	10.2	1.6
PCB #194	< 10	nc	< 10	nc	< 10	nc	5.1	0.80	4.7	nc
Sum of PCBs (inc)[2]	286	127	230	42	194	10	222	33	182	18
Sum of PCBs (exc)[3]	81.9	24	61.3	5.9	58.0	4.0	111	32	83.3	14
PCB TEQ (inc)[2]	0.0086	0.0030	0.0066	0.00081	0.0069	0.00057	0.0063	0.0010	0.0055	0.00039
PCB TEQ (exc)[3]	0.0033	0.00096	0.0027	0.00062	0.0024	0.00033	0.0031	0.0013	0.0024	0.00031

1 = Mean concentration calculated from the analysis of two (n=2) or three (n=3) unique sub-samples prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6)
2 = Including half LOD values
3 = Excluding LOD values
nc = Not calculated due to values for some sub-samples being below detection limits

Table G7 Standard errors of PCB analyisis of serum sub-samples from non-Maori aged 50–64 years (µg kg^{-1}, lipid weight basis)

	Female, Lower North Island		Female, South Island		Male, Lower North Island		Male, South Island	
Congener	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error
PCB #126	0.034	0.0039	0.037	0.0070	0.028	0.00090	0.028	0.0018
PCB #169	0.022	0.0025	0.023	0.0029	0.031	0.0030	0.029	0.0022
PCB #74	6.1	0.70	5.4	0.050	< 4	nc	5.0	0.55
PCB #118	5.8	0.15	5.5	0.70	< 4	nc	< 5	nc
PCB #153	26.4	0.65	26.9	3.4	29.6	0.35	32.0	1.2
PCB #138 + PCB #158	17.5	0.050	17.7	2.3	18.4	0.050	19.7	2.0
PCB #187	5.5	0.050	5.3	0.50	6.4	0.25	7.8	0.90
PCB #180	20.0	0.10	21.4	2.3	28.3	2.0	31.7	2.4
PCB #170	8.6	0.25	9.4	1.3	11.4	0.30	11.9	1.8
PCB #194	< 6	nc	< 7	nc	6.1	0.90	6.3	0.80
Sum of PCBs (inc)[2]	184	11	188	14	209	1.2	251	31
Sum of PCBs (exc)[3]	89.7	1.7	91.5	11	100	3.9	122	16
PCB TEQ (inc)[2]	0.0071	0.00071	0.0076	0.0010	0.0062	0.000067	0.0069	0.00046
PCB TEQ (exc)[3]	0.0042	0.00041	0.0045	0.00077	0.0031	0.000060	0.0042	0.0013

1 = Mean concentration calculated from the analysis of two unique sub-samples prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6)
2 = Including half LOD values
3 = Excluding LOD values
nc = Not calculated due to values for some sub-samples being below detection limits

Table G8 Standard errors of PCB analyisis of serum sub-samples from non-Maori aged 65+ years (μg kg^{-1}, lipid weight basis)

	Female, Lower North Island		Female, South Island		Male, South Island	
Congener	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error
PCB #126	0.053	0.0025	0.043	0.0013	0.034	0.0061
PCB #169	0.030	0.0010	0.026	0.0014	0.032	0.0020
PCB #74	10.9	1.2	8.4	0.10	6.6	2.0
PCB #118	9.2	0.40	7.3	0.80	3.9	nc
PCB #153	37.0	0.65	30.1	2.3	32.2	3.1
PCB #138 + PCB #158	25.8	0.55	20.6	1.4	20.7	2.3
PCB #187	8.2	0	6.4	0.25	7.2	0.65
PCB #180	27.7	0.15	23.2	0.30	29.6	2.4
PCB #170	11.1	0.30	9.5	0.45	11.6	0.95
PCB #194	4.7	0.10	4.0	nc	6.1	0.40
Sum of PCBs (inc)[2]	227	0.20	192	7.3	260	45
Sum of PCBs (exc)[3]	139	5.0	107	3.3	119	17
PCB TEQ (inc)[2]	0.010	0.00046	0.0083	0.00012	0.0082	0.0013
PCB TEQ (exc)[3]	0.0077	0.0014	0.0054	0.00010	0.0051	0.0021

1 = Mean concentration calculated from the analysis of two unique sub-samples prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6)
2 = Including half LOD values
3 = Excluding LOD values
nc = Not calculated due to values for some sub-samples being below detection limits

Table G9 Standard errors of organochlorine pesticide analyisis of serum sub-samples from non-Maori aged 25–34 years (µg kg^{-1}, lipid weight basis)

	Female, Lower North Island		Female, South Island		Male, Lower North Island		Male, South Island	
Pesticide	Mean (n=3)[1]	Std Error	Mean (n=3)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error
β-HCH	8.1	nc	9.3	nc	10.2	1.8	10.7	0.20
HCB	< 50	nc	< 30	nc	< 20	nc	< 20	nc
Dieldrin	10.3	nc	11.1	1.5	9.8	0.60	11.5	0.85
pp-DDE	736	73.3	755	26.9	803	13.5	1,170	245
pp-DDT	< 30	nc	< 30	nc	< 20	nc	23.9	nc

1 = Mean concentration calculated from the analysis of two (n=2) or three (n=3) unique sub-samples prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6)
nc = Not calculated due to values for some sub-samples being below detection limits

Table G10 Standard errors of organochlorine pesticide analyisis of serum sub-samples from non-Maori aged 35–49 years (µg kg^{-1}, lipid weight basis)

	Female, Northland/Auckland		Female, Lower North Island		Female, South Island		Male, Lower North Island		Male, South Island	
Pesticide	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=3)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=3)[1]	Std Error
β-HCH	73.1	nc	12.2	nc	9.5	0.87	44.7	nc	34.1	14.4
HCB	< 20	nc	< 20	nc	< 20	nc	< 20	nc	< 20	nc
Dieldrin	14.9	nc	11.3	0.60	11.0	1.0	14.3	3.4	11.7	0.82
pp-DDE	756	126	839	89.8	1,030	143	1,380	273	1,330	118
pp-DDT	27.1	nc	< 50	nc	< 20	nc	< 40	nc	< 20	nc

1 = Mean concentration calculated from the analysis of two (n=2) or three (n=3) unique sub-samples prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6)
nc = Not calculated due to values for some sub-samples being below detection limits

Table G11 Standard errors of organochlorine pesticide analyisis of serum sub-samples from non-Maori aged 50–64 years (µg kg^{-1}, lipid weight basis)

	Female, Lower North Island		Female, South Island		Male, Lower North Island		Male, South Island	
Pesticide	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error
β-HCH	19.2	3.9	27.7	3.6	11.6	0.75	12.2	nc
HCB	< 20	nc	52.8	nc	< 20	nc	< 20	nc
Dieldrin	12.3	0.85	20.6	2.6	12.7	0.80	19.8	5.1
pp-DDE	1,530	108	1,520	169	1,210	52.7	1,540	40.5
pp-DDT	24.5	7.0	21.9	0	16.7	nc	< 60	nc

1 = Mean concentration calculated from the analysis of two unique sub-samples prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6)
nc = Not calculated due to values for some sub-samples being below detection limits

Table G12 Standard errors of organochlorine pesticide analyisis of serum sub-samples from non-Maori aged 65+ years (µg kg^{-1}, lipid weight basis)

	Female, Lower North Island		Female, South Island		Male, South Island	
Pesticide	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error	Mean (n=2)[1]	Std Error
β-HCH	29.1	1.8	29.9	3.0	19.4	nc
HCB	28.8	0.95	24.3	1.2	< 20	nc
Dieldrin	28.4	3.3	21.5	0.60	19.1	6.0
pp-DDE	2,740	419	2,100	263	1,650	419
pp-DDT	49.2	19.4	30.9	6.5	< 40	nc

1 = Mean concentration calculated from the analysis of two unique sub-samples prepared from within a stratum for the purposes of assessing inter-individual sample variance (see Appendix A, Section A6)
nc = Not calculated due to values for some sub-samples being below detection limits

Appendix H Comparison with international data

Limitations when making comparisons with international data

There are always limitations in comparing data from different studies. In this regard, the following points should be noted:

1. There are a number of factors to consider when comparing the serum contaminant levels found in the current study to overseas data. It is necessary, for example, to consider the age range of the subjects and whether they had been occupationally exposed. Therefore, overseas studies aimed at determining contaminant levels in comparable populations are the main focus of the comparison in this appendix. However, it was difficult to find overseas studies with exactly the same parameters as the current study. Particular care therefore needs to be taken, and the uncertainties recognised, when comparing the data from the current study with data compiled and summarised from the published literature.

2. Wherever possible, comparative data have been taken from studies carried out in the 1990s. This was because concentrations of PCDDs and PCDFs have fallen in industrialised environments during the last decade as a result of many government restrictions that had been enforced since the 1980s.

3. More recent studies typically report PCBs as individual congeners, whereas older studies typically reported them as 'total PCBs' or as Aroclor equivalents. This makes detailed comparison difficult.

4. A compounding factor in reporting data for PCDDs, PCDFs and PCBs is the inconsistency in the treatment of non-detectable congeners, either for the calculation of TEQ levels or for the summation of congeners. Some studies derive TEQ data (or congener sums) on the assumption that non-detected congeners were present at half the LOD; others assume they were present at the level of detection; and still others equate a non-detection level to a concentration level of zero.

5. In general, studies reporting levels of organochlorine contaminants in blood are less common than studies reporting levels of the same compounds in breast milk. Breast milk is a popular analytical matrix, as it is obtained by non-invasive techniques and the levels of organochlorines present in milk are significantly higher than in blood. However, studies involving breast milk are limited in that data are obtained only from women of childbearing age.

In spite of these limitations, a comparison with data from other countries remains useful to benchmark the concentrations of organochlorines determined in serum from the non-occupationally exposed New Zealand population into a broader international perspective.

H1 Introduction

To assist in the interpretation of the organochlorine concentration data found in the current study, it is useful to know how the serum concentrations compare with published background data on non-exposed populations from other countries. A difficulty in making such a comparison is that this is the only such study of its kind, to our knowledge, with no other studies having attempted to obtain a representative population-based sample for an entire country, at least for the PCDDs, PCDFs and PCBs. Nevertheless, this report has attempted to identify other published studies that provide data on non-exposed populations.

The comparative data discussed in this appendix are taken from published studies that report organochlorine concentrations in blood serum or plasma. The information assembled is not intended to represent a comprehensive review of all studies carried out, but rather to provide a summary of those that are considered to be most relevant. Generally, the studies selected were those most recently undertaken, and which provided sufficient information to demonstrate data quality. Whilst the current study is concerned with the non-occupationally exposed population, comparative data have been taken from studies of occupationally exposed populations where results for a comparison population drawn from a local area or community has been reported.

Organochlorine concentrations are presented as median and/or mean data. For the New Zealand data, these are weighted medians and means for consistency with the results presented in Section 5 of this report, and as discussed in Appendix B. Similarly, where possible, the comparative international data are reported on a lipid weight basis for consistency with the New Zealand data presented herein. However, for some of the organochlorine contaminants, most of the published concentration data were reported on a sample volume basis (i.e. blood serum or plasma basis). In these instances, the New Zealand data have been converted to a serum volume basis using the lipid content reported in Appendix C.

When comparing median and mean concentrations between countries, care should be taken in how this comparison is interpreted. For example, the figures presented in this appendix are plots of mean concentrations, and these are shown as horizontal bars; although a bar for one country may not overlap with a bar for another country, this does not mean that some of the individual sample concentrations that contribute to the mean do not overlap. There will be a range of concentrations about these means, and it may be that the concentrations of some of the individual samples for the different countries do coincide or overlap.

H2 PCDDs and PCDFs

Results of studies that have measured PCDD and PCDF concentrations in blood serum or plasma of non-exposed populations are summarised in Table H1. Depending on the data available, median and/or mean concentrations are reported. In general, the numbers of subjects in the overseas studies were small compared to the numbers in the current study. A comparison of the mean concentration of the New Zealand exposure data from the current study and an earlier 1992/93 study with mean concentrations from the overseas studies reported in Table H1 is illustrated in Figure H1.

All concentrations given in this section are reported as TEQ on a lipid-adjusted basis. Most publications, until recently, have expressed PCDD and PCDF data in terms of I-TEQ. However,

TEQ levels in the current study were calculated using the most recently accepted TEFs for the PCDDs and PCDFs, as agreed at a 1997 WHO consultation (Van den Berg *et al*., 1998). Therefore, to enable valid comparison of the New Zealand and overseas data, where necessary, TEQ data that were calculated using alternative TEF schemes have been recalculated using the 1997 WHO TEFs from the congener-specific data reported in the source publication.

Table H1 Concentrations of PCDDs and PCDFs in non-exposed populations from various countries

Country	No. of samples	Year of sampling	Concentration, ng TEQ kg^{-1} lipid[2]		Reference
			Median	Mean	
New Zealand	**60[1] (1834)**	**1996/97**	**12.4**	**12.8**	**This study**
New Zealand	28	1992/93	12.4	13.9	Hannah *et al*., 1994
New Zealand	9	1988		24.5	Smith *et al*., 1992
Finland	14	1989/90	53.8	56.8	Rosenberg *et al*., 1995
Finland	8	1993	61.6	68.6	Kontsas *et al*., 1998
Germany	744	1989 to 1998		42.7	Wittsiepe *et al*., 2000
Germany	9	1997/98		24.1	Wittsiepe *et al*., 2000
Germany	139	1996	17.8	18.8	Päpke, 1998
Germany	228	1989		52.2	Wittsiepe *et al*., 2000
Japan	94	1990 to 1996		22.3	Matsueda *et al*., 1999
Japan	50	nr		18.9	Iida *et al*., 1999
Spain	11	1993		16.2	Jiménez *et al*., 1996
Spain	10[1] (198)	1995		15.7	González *et al*., 1998
Spain	20	1997		31.3	Schuhmacher *et al*., 1999
Sweden	5	nr		24.4	Littorin *et al*., 1994
UK	1[1]	nr		17.3	Startin *et al*., 1994
USA (Michigan)	50	nr		31.0	Schecter, 1994
USA	16	nr	21.4		Tepper *et al*., 1997
USA	316	1995 to 1997		20.1	US EPA, 2000

1. Pooled samples. Where reported in the publication, the number in parentheses denotes the total number of individual samples included in the study.
2. TEQs were calculated using the 1997 WHO TEFs. Where necessary, TEQs were recalculated from the original data reported in the referenced publication. In recalculating TEQs, one half the LODs were taken for non-detected congeners, to provide comparability with the current serum study data.

nr = Not reported.

An early New Zealand study of PCDD and PCDF serum levels, undertaken to assess the 2,3,7,8-TCDD exposures of heavily exposed pesticide applicators who had long-term experience of using the herbicide 2,4,5-T, was reported by Smith *et al*. (1992). The mean serum PCDD and PCDF concentration of nine New Zealand men (average age 53 years, range 45–62 years) used as a control group was 24.5 ng TEQ kg^{-1} lipid. By comparison, the weighted mean PCDD and PCDF concentration for males aged 50–64 years in the current study was 15.4 ng TEQ kg^{-1} lipid (range 13.9–17.2 ng TEQ kg^{-1}). This suggests that there has been a slight downward shift in PCDD and PCDF concentrations in New Zealanders over the decade preceding the current study. However, given the small sample size of the Smith *et al*. (1992) study, it is difficult to draw this conclusion with certainty.

A separate study of New Zealanders, carried out in 1992/93, investigated the levels of PCDDs and PCDFs in a group of 28 non-occupationally exposed people in the Wellington region (Hannah *et al*., 1994), and provides data to suggest that concentrations in the New Zealand population have remained relatively constant over approximately the last five years. The 1992/93 study group comprised equal numbers of men and women ranging in age from 20 to 60 years. The mean PCDD and PCDF level from that study was 13.9 ng TEQ kg^{-1} lipid, which is comparable to the mean serum concentration determined in the current study of 12.8 ng TEQ kg^{-1} lipid. A limitation to the interpretation of this comparison is that the 1992/93 study used a convenience sample, rather than a true population-based sample.

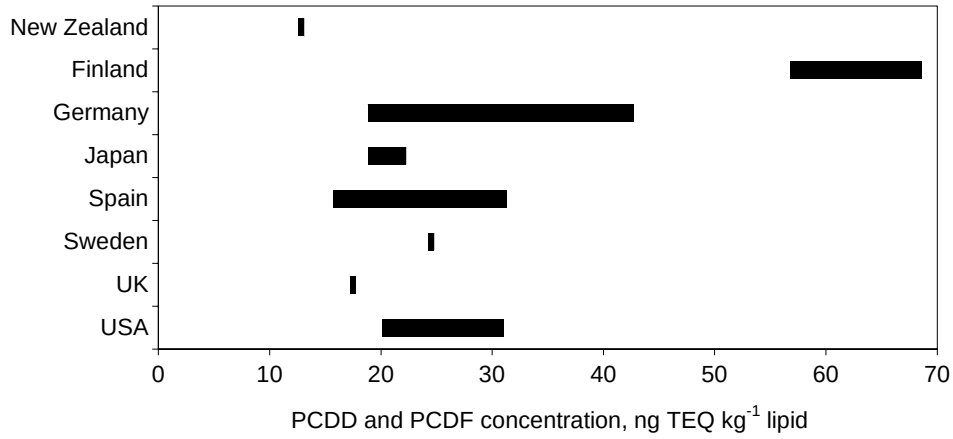

Figure H1 Comparative mean concentrations of PCDDs and PCDFs in non-exposed populations from various countries
[Overseas data taken from studies cited in Table H1. Each horizontal bar represents the mean concentration(s) reported for that country. *Short bars* occur when there is only a single mean concentration, or when, if more than one mean concentration, the means are similar. *Long bars* occur when there is a range of mean concentrations, and the highest and lowest mean concentrations are quite different to each other.]

Two Finnish studies of pulp and paper mill workers and timber treatment workers have measured PCDD and PCDF concentrations in concurrent non-exposed groups. In blood samples collected in 1989/90, Rosenberg *et al*. (1995) measured a mean level of 56.8 ng TEQ kg^{-1} lipid in a group of 14 controls, of average age 41 years (range 28–60 years). In the other study, Kontsas *et al*. (1998) measured a mean PCDD and PCDF concentration of 68.6 ng TEQ kg^{-1} lipid in a group of non-exposed workers sampled in 1993. These levels are up to approximately five times higher than the mean concentration reported in the current study.

Päpke (1998) has published data on PCDD and PCDF concentrations in a sample of the German population (age range 18–71 years) collected in 1996, and compared the levels found in that study with the levels reported in previous studies from Germany. The median and mean concentrations reported in the 1996 study were 17.8 ng TEQ kg^{-1} and 18.8 ng TEQ kg^{-1} lipid, respectively, which are similar to the current New Zealand data. Päpke (1998) presented data that showed the levels of PCDDs and PCDFs in the German population have been decreasing steadily over the last 10 years, with the mean concentration of these compounds more than halved since 1989. A similar finding has been shown by Wittsiepe *et al*. (2000), who have reported results from the analysis for PCDDs and PCDFs of several hundred German serum samples collected in the period 1989 to

1998. In a 1989 study of 228 subjects (average age 43.6 years), the mean PCDD and PCDF concentration was 52.2 ng TEQ kg^{-1} lipid. The latest study carried out on samples collected from nine subjects (average age 44.2 years) in 1997/98 reported a mean concentration of 24.1 ng TEQ kg^{-1} lipid. The mean concentration over the entire nine-year period was 42.7 ng TEQ kg^{-1} lipid.

In a study of 94 subjects from Fukuoka, Japan, Matsueda *et al.* (1999) reported a mean PCDD and PCDF blood concentration of 22.3 ng TEQ kg^{-1} lipid. This level is similar to the mean concentration reported from a study of 50 Japanese women before childbirth (mean age 20.5 years) of 18.9 ng TEQ kg^{-1} lipid (Iida *et al*., 1999).

A study in Madrid, Spain, of blood samples from 11 blood donors aged 19–55 years, collected in 1993, reported a mean PCDD and PCDF concentration of 16.2 ng TEQ kg^{-1} lipid (Jiménez *et al.*, 1996). In another study from Spain, blood samples were collected in 1995 from a random sample of 198 men and women, aged 18–69 years, from the city of Mataro (González *et al*., 1998). The aim of this study was to establish baseline measurements of blood PCDD and PCDF concentrations before a new municipal solid waste incinerator was built near the city. Samples were pooled according to age and gender in a similar way to the current New Zealand study. Consistent with the findings of the New Zealand study, this Spanish study showed increasing levels of contaminants with age, with little difference between the sexes. The mean concentration reported for that study was 15.7 ng TEQ kg^{-1} lipid, which is marginally higher than the mean concentration of 12.8 ng TEQ kg^{-1} lipid reported in this current New Zealand study.

A further Spanish study, carried out in 1997, also to establish baseline measurements of blood PCDD and PCDF concentrations before a new hazardous waste incinerator was built, has been reported by Schuhmacher *et al*. (1999). Blood samples were taken from 20 non-occupationally exposed people aged 28–62 years residing in the region of Tarragona. This study reported a mean plasma PCDD and PCDF concentration of 31.3 ng TEQ kg^{-1} lipid, which is approximately twice as high as the mean concentrations reported in the two earlier Spanish studies.

A Swedish study has compared the PCDD and PCDF blood concentrations of five referents (mean age 60 years) with five chlorophenoxy herbicide/chlorophenol workers (Littorin *et al*., 1994). The referent group had a mean concentration of 24.4 ng TEQ kg^{-1} lipid. The year in which the samples were collected was not stated in the publication.

In the UK, a study by Startin *et al.* (1994) has reported PCDD and PCDF concentrations in the plasma of 10 individuals (six women, four men, average age 39.6 years) who resided on Derbyshire farms and regularly ate their own produce. This study was undertaken following the discovery of high levels of PCDDs and PCDFs in cows' milk from a number of farms in the area. Two control samples were used for comparison – a sample of pooled plasma from a large multi-donor pool and a single plasma sample obtained from a random donor. The mean PCDD and PCDF concentration of the 10 people who resided on farmland was 196 ng TEQ kg^{-1} lipid (range of 57.5–339 ng TEQ kg^{-1} lipid), which was significantly higher than the level of 17.3 ng TEQ kg^{-1} lipid obtained for the pooled plasma control and 28.1 ng TEQ kg^{-1} lipid for the individual control sample.

In a US study investigating blood levels of PCDDs and PCDFs in 50 adult males from Michigan, Schecter (1994) has reported a mean concentration of 31.0 ng TEQ kg^{-1} lipid. Also from the US, Tepper *et al.* (1997) compared serum PCDD and PCDF concentrations in long-term workers at a

pulp and paper mill with 16 community residents who never worked at the mill. The median concentration reported for the community residents was 21.4 ng TEQ kg^{-1} lipid. This concentration is comparable to the mean concentration of 20.1 ng TEQ kg^{-1} lipid reported by the US EPA (2000) for a sample of 316 US residents. From these studies, it appears that the concentrations of PCDDs and PCDFs in the US population are, on average, approximately twice as high as those in adult New Zealanders.

Comparison of serum PCDD and PCDF concentrations found in different studies must be qualified by the fact that there is no consistent basis of sampling. Most overseas studies have focused on relatively small regions, and results are not necessarily representative of the entire country. Nonetheless, overall, it appears that concentrations found in New Zealand tend to be towards the lower end of the range, particularly for the younger age groups, when compared to other developed countries (Figure 6.1), although there is some evidence of a general downward trend in some overseas populations, particularly in Germany (Päpke, 1998; Wittsiepe *et al*. 2000). Similar downward trends have also been observed elsewhere in Europe and in North America when assessed using data from studies of organochlorines in breast milk (Liem *et al*., 2000).

The lower levels of PCDDs and PCDFs found in New Zealand serum reflect the finding that, on an international scale, levels of these compounds tend to be comparatively lower in the New Zealand environment (Buckland *et al*., 1998a,b; 1999). Similarly, exposures through dietary intake are also generally low compared to the intake of populations in other countries where comparable dietary studies have been undertaken (Buckland *et al*., 1998c).

H3 Polychlorinated biphenyls

A comparison of serum PCB levels found in the current study with PCB levels found in overseas studies of non-exposed populations is provided in Tables H2 and H3. Table H2 presents comparative data (expressed on a lipid weight basis) for the two PCB congeners that are the most potent in terms of their dioxin-like activity, namely PCB #126 and #169. These two congeners were detected in every stratum of the present study and contributed the major proportion of the TEQ measured (when excluding the contribution to TEQ levels from non-detected congeners by setting LODs to zero concentration). Table H3 presents comparative data (expressed on a whole sample [volume] basis) for the three PCB congeners that were detected in the highest concentrations in the current study, namely PCB #153, #138 and #180. These three congeners were also detected in all or most strata. Very few comparable data could be found in the published literature for concentrations of these three PCBs in serum expressed on a lipid weight basis.

A comparison of the mean PCB concentrations of the New Zealand exposure data with mean concentrations from the overseas studies reported in Tables H2 and H3, for PCBs #126 and #153, is illustrated in Figures H2 and H3 respectively.

The reason for limiting the comparison of the New Zealand and overseas PCB data to these five congeners is that investigations of PCB levels in the serum from non-exposed populations have been infrequent, and the number and range of PCB congeners reported in such studies have been quite variable. There is also little consistency in the way total PCB concentrations have been reported, with some studies reporting total PCBs as Aroclor equivalents, whilst others have reported total PCBs as the sum of a number of selected congeners. Reporting PCB totals is further complicated due to the various ways in which limits of detection are treated. Some studies include

full LOD values in calculating the sum of congeners; others exclude LOD values (i.e. set LOD values at zero concentration); and others include half the LOD values. It is also noteworthy that there are very few studies that have reported PCB concentrations as TEQ data. Even when studies have reported concentrations of individual PCB congeners, such studies provided data for only a limited number of congeners. This limitation, in effect, precludes meaningful TEQ levels being recalculated for comparison with the current New Zealand serum data.

H3.1 PCB congeners #126 and 169

In a Canadian study, Ayotte *et al.* (1997) measured PCB levels in the plasma of 499 adult Inuit from Nunavik, Arctic Quebec (age range 18–74 years), and used as a comparison group three pooled plasma samples from individuals living in Southern Quebec. Two of the pooled comparison samples were from Quebec City (each comprising five students, mean age of 30 years) and the third pooled sample consisted of copper refiners from Montreal (age, sex and number of individuals not given). The mean concentrations of PCB #126 and #169 reported for the Southern Quebec data set were 49.3 ng kg^{-1} and 29.0 ng kg^{-1} lipid respectively. The Inuit, who may be regarded as exposed because of their heavy consumption of sea mammal fat, had mean PCB #126 and #169 concentrations of 220 ng kg^{-1} and 419 ng kg^{-1} lipid respectively.

Table H2 Concentrations of PCB #126 and #169 in non-exposed populations from various countries

Country	No. of samples	Year of sampling	Mean PCB concentration, ng kg^{-1} lipid basis		Reference
			#126	#169	
New Zealand	**60[1] (1834)**	**1996/97**	**30**	**20**	**This study**
Canada	3[1]	1992	49.3	29.0	Ayotte *et al*., 1997
Finland	8	1993	69	83	Kontsas *et al*., 1998
Germany	104	1994	80.3	102	Päpke *et al*., 1996
Japan	94	1990 to1996	83.8	43.2	Matsueda *et al*., 1999
Japan	50	nr	46.5	23.1	Iida *et al*., 1999
Spain	11	1993	55	30	Jiménez *et al*., 1996
Sweden	5	nr	120	110	Littorin *et al*., 1994
USA (Arkansas)	70	1991	18.4	17.9	Anderson *et al*., 1998
USA (Great Lakes)	31	1993	148	80.8	Anderson *et al*., 1998
USA (Michigan)	50	nr	104	45.8	Schecter, 1994
USA (Missouri)	6	nr	49.8	29.9	Schecter, 1994
USA (Missouri)	150	nr	6.5[3]	13.9[3]	Shadel *et al*., 1999
USA (North East)	14/16[2]	nr	18	27	Kang *et al*., 1997

1. Pooled samples. Where reported in the publication, the number in parentheses denotes the total number of individual samples included in the study.
2. n = 14 for PCB #126, n = 16 for PCB #169.
3. Geometric mean.

nr = Not reported.

In a study of Finnish pulp and paper workers, Kontsas *et al*. (1998) reported mean concentrations of PCB #126 and #169 in a non-exposed comparison group of workers of 69 ng kg^{-1} and 83 ng kg^{-1} lipid respectively. Also from Scandinavia, a Swedish study (Littorin *et al*., 1994) compared five referents (mean age 60 years) with five phenoxy herbicide manufacturing workers. The mean concentrations of PCB #126 and #169 reported for the referents were 120 ng kg^{-1} and 110 ng kg^{-1} lipid respectively.

In a study from Germany, blood samples were collected from 104 people (mean age 38.5 years, range 18–65 years) to establish background levels of PCDDs, PCDFs and non-*ortho* PCBs in the general population (Päpke *et al.*, 1996). The mean concentration reported for PCB #126 was 80.3 ng kg^{-1} lipid (range 16.1–299 ng kg^{-1} lipid) and for PCB #169, 102 ng kg^{-1} lipid (range 17.5–278 ng kg^{-1} lipid). These mean concentrations are approximately three to five times higher than the mean concentrations reported in the current New Zealand study.

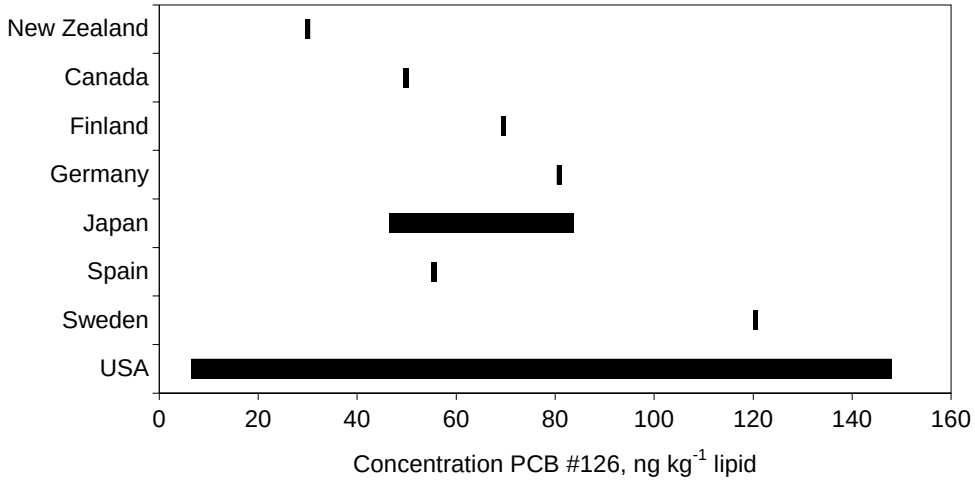

Figure H2 Comparative mean concentrations of PCB #126 in non-exposed populations from various countries
[Overseas data taken from studies cited in Table H2. For an explanation of the horizontal bars, see Figure H1.]

In a study of 94 subjects (31 men, 63 women, mean age 34.5 years) from Fukuoka, Japan, Matsueda *et al.* (1999) have reported mean blood concentrations for PCB #126 and #169 of 83.8 ng kg^{-1} and 43.2 ng kg^{-1} lipid respectively. These levels are approximately twice as high as those reported by Iida *et al.* (1999) in a study of 50 Japanese women before childbirth (mean age 20.5 years). The lower mean concentrations reported in this second study may be due to the younger age of the subjects, and other population differences between the two study groups.

Jiménez *et al.* (1996) analysed blood samples from a study of blood donors aged 19–55 years in Madrid, Spain. PCB #126 and #169 were found at mean concentrations of 55 ng kg^{-1} and 30 ng kg^{-1} lipid respectively, slightly higher than the mean concentrations reported for the current New Zealand study.

There have been several studies of PCB levels in populations from the United States. Schecter (1994) reported mean PCB #126 and #169 concentrations in six subjects from Missouri of 49.8 ng kg^{-1} and 29.9 ng kg^{-1} lipid respectively, and concentrations of 104 ng kg^{-1} and 45.8 ng kg^{-1} lipid, respectively, in a group of 50 men from Michigan. These concentrations are approximately two to four times higher than the mean concentrations reported in the current New Zealand study.

Another US study has investigated PCBs in community residents in the northeast United States (Kang *et al.*, 1997), and reported mean concentrations for PCB #126 and #169 of 18 ng kg^{-1} and 27 ng kg^{-1} lipid respectively, similar to the mean concentrations found in the current New Zealand

study. In comparison, from a study of 150 Missouri residents with no documented exposure to PCBs, Shadel *et al*. (1999) reported concentrations (as the geometric mean) of PCB #126 and #169 of 6.5 ng kg^{-1} and 13.9 ng kg^{-1} lipid respectively, slightly lower than the mean concentrations reported in the current New Zealand study.

Also in the US, Anderson *et al*. (1998) investigated the concentrations of a range of contaminants, including PCBs, in the serum of 31 consumers (21 men and 10 women, average age 52 years) of sports fish from three of the Great Lakes. The mean concentration of PCB #126 for the total study group was 148 ng kg^{-1} lipid. A comparison group of 70 non-exposed subjects from Arkansas, who would be unlikely to be frequent consumers of Great Lakes fish, was used. The mean concentration of PCB #126 reported for the comparison group was 18.4 ng kg^{-1} lipid, which is lower than the mean concentration of 30 ng kg^{-1} lipid reported for the current New Zealand study. The mean concentration of PCB #169 for the study group of 31 sports fish consumers was 80.8 ng kg^{-1} lipid. The mean concentration of PCB #169 reported in the comparison group from Arkansas was 17.9 ng kg^{-1} lipid, similar to the mean concentration of 20 ng kg^{-1} lipid reported in the New Zealand study.

H3.2 PCB congeners #153, #138 and 180

Pauwels *et al.* (2000) have reported concentrations of selected PCBs in the serum and adipose tissue of 96 infertile women from Flanders, Belgium. This study was undertaken to determine whether there was an association in the residue levels between the two matrices, and also to assess the impact of persistent organic contaminants on the occurrence of endometriosis. The mean serum concentrations of PCBs #153, #138 and #180 reported from this group were 0.36 µg L^{-1}, 0.46 µg L^{-1}, and 0.35 µg L^{-1}, respectively, which are approximately two to four times as high as those reported in the current New Zealand study. The findings of this study indicated that for most congeners, there was a high correlation between PCB concentrations in adipose tissue and serum when results were expressed on a lipid weight basis.

Table H3 Concentrations of PCB #153, #138 and #180 in non-exposed populations from various countries

Country	No. of samples	Year of sampling	Mean PCB concentration, µg L^{-1} whole sample basis[1]			Reference
			#153	#138	#180	
New Zealand	**60[2] (1834)**	**1996/97**	**0.19**	**0.12**	**0.16**	**This study**
Belgium	96	1996 to	0.36[3]	0.46[3]	0.35[3]	Pauwels *et al*., 2000
Finland	30	nr	1.2	1.2		Luotamo *et al*., 1991
Germany	6	1997	0.8	0.6	0.7	Petzold *et al*., 1999
Spain	10[2] (198)	1995	0.67	0.49	0.59	González *et al*., 1998
USA (New York)	7	1991 to	0.39	0.25		Greizerstein *et al*., 1999
USA (Great Lakes)	30	1993	1.1	0.8	0.4	Anderson *et al*., 1998
USA (Great Lakes)	41	1996	0.4	0.4	0.4	Anderson *et al*., 1998

1. The data reported for each study are on a whole blood serum or plasma basis, depending on the sample matrix taken for analysis.
2. Pooled samples. Where reported in the publication, the number in parentheses denotes the total number of individual samples included in the study.
3. Published data presented on a lipid weight basis. The levels reported in the table have been recalculated using the mean lipid content of the study group as reported by Pauwels *et al*. (2000).

nr = Not reported.

In a study from Finland, Luotamo *et al*. (1991) have reported the concentrations of selected PCB congeners in three groups of people. Group 1 (n = 30, average age 51.2 years) comprised people who had no occupational exposure to PCBs, whereas Groups 2 and 3 comprised people who had been occupational exposed. The mean concentrations of PCB #153 and #138 reported from the non-exposed group, Group 1, were 1.2 µg L^{-1} for each of the congeners.

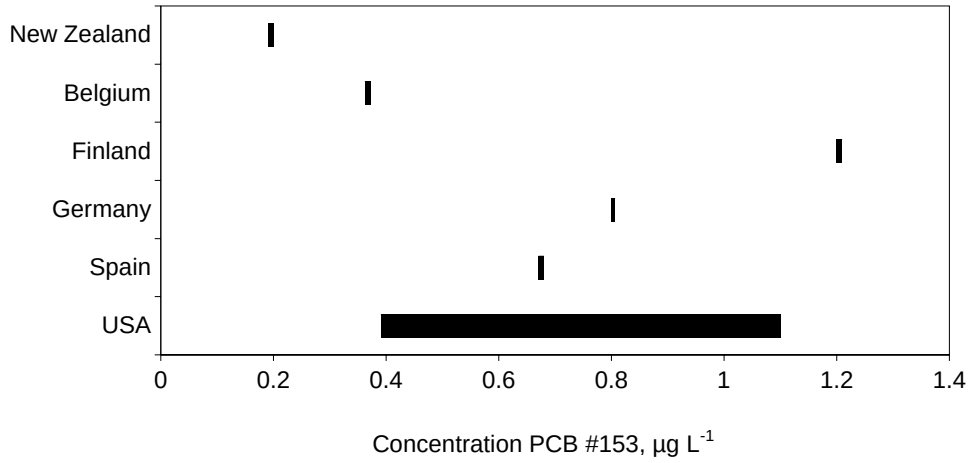

Figure H3 Comparative mean concentrations of PCB #153 in non-exposed populations from various countries
[Overseas data taken from studies cited in Table H3. For an explanation of the horizontal bars, see Figure H1.]

In a study of six adult women residing in North Germany, Petzold *et al.* (1999) have reported mean concentrations of PCBs #153, #138 and #180 of 0.8 µg L^{-1}, 0.6 µg L^{-1}, and 0.7 µg L^{-1} respectively. These concentrations are approximately four to five times higher than the mean concentrations reported in the current study.

González *et al*. (1998) have reported levels of PCBs in blood from a random sample of 198 men and women aged 18–69 years from the city of Mataro, Spain. Samples were pooled according to age and gender in a similar way to the current New Zealand study. As found in the New Zealand study, the Spanish study showed increasing levels of contaminants with age, with little difference between the sexes. The mean concentrations of PCBs #153, #138 and #180 reported from that study were 0.67 µg L^{-1}, 0.49 µg L^{-1} and 0.59 µg L^{-1} respectively. These concentrations are approximately three to four times higher than the mean concentrations reported in the current New Zealand study.

In a US study, serum and milk samples were collected from seven lactating women (age range 25–36 years) from the New York area (Greizerstein *et al.*, 1999). The mean serum concentrations reported for PCBs #153 and #138 were 0.39 µg L^{-1} and 0.25 µg L^{-1} respectively. A US study reported by Anderson *et al.* (1998), which investigated the levels of contaminants in the serum of consumers of sports fish from three of the Great Lakes, reported mean concentrations for PCBs #153, #138 and #180 of 1.1 µg L^{-1}, 0.8 µg L^{-1} and 0.4 µg L^{-1} respectively. These were compared to concentrations found in a comparison group of 41 subjects from the Great Lakes region who did not eat Great Lakes fish. The mean concentrations of PCBs #153, #138 and #180 reported for the comparison group were 0.4 µg L^{-1} for each congener. The concentrations for the comparison group are approximately twice as high as the mean concentrations reported for the current study.

On the assumption that the five congeners assessed (PCBs #126, #169, #153, #138 and #180) are representative of PCB exposure in general, it appears that the PCB concentrations in the serum of New Zealanders are at the low end of the concentration range relative to levels found in other developed countries for which comparable data have been collected (Tables H2 and H3, and Figures H2 and H3). This observation is in keeping with the fact that environmental concentrations of PCBs in New Zealand are typically lower than, by as much as an order of magnitude or more, those in overseas countries (Buckland *et al*., 1998a,b; 1999). Similarly, dietary intake of PCBs has also been shown to be lower in New Zealand than in other industrialised countries where studies have been undertaken (Buckland *et al*., 1998c).

H4 Organochlorine pesticides

When comparing pesticide residue levels in different countries, there is a qualitative difference to such comparison for PCDDs, PCDFs and PCBs. Residues of PCDDs, PCDFs and PCBs tend to reflect levels of pollution and industrialisation, whereas levels of pesticides and their metabolites may reflect local use patterns, at least historically.

A comparison of organochlorine pesticide concentrations found in this study with concentrations found in overseas studies of non-exposed populations is provided in Tables H4 and H5 (pp^{l}-DDE), Tables H6 and H7 (dieldrin) and Tables H8 and H9 (β-HCH). The comparison is limited to these three pesticides, as they were the most frequently detected of the investigated pesticides across all strata in the current study. The concentration data have been presented both on a lipid weight basis and whole sample [volume] basis, as both these reporting bases were frequently used in the various comparison studies.

Table H4 Concentrations of pp^{l}-DDE in non-exposed populations from various countries, lipid basis

Country	No. of samples	Year of sampling	Concentration, μg kg^{-1} lipid basis		Reference
			Median	Mean	
New Zealand	**60[1] (1834)**	**1996/97**	**919**	**1080**	**This study**
New Zealand	31	1992/93		1190	van Maanen *et al*., 1994
Belgium	96	1996 to 1998	672	1275	Pauwels *et al*., 2000
Japan	50	nr		347	Iida *et al*., 1999
Kenya	11	1986		1520	Kanja *et al*., 1992
USA	90	1987 to 1990	1358		Sturgeon *et al*., 1998
USA (Connecticut)	36	nr	967		Archibeque-Engle *et al*., 1997
USA (New York)	7	1991 to 1993		259	Greizerstein *et al*., 1999
USA (San Francisco)	82	1996 to 1998	1029	1572	Hoppin *et al*., 2000

1. Pooled samples. Where reported in the publication, the number in parentheses denotes the total number of individual samples included in the study.

nr = Not reported.

A comparison of the mean pp^{l}-DDE concentration of the New Zealand exposure data with mean concentrations from the overseas studies reported in Table H5 is illustrated in Figure H4.

Table H5 Concentrations of pp'-DDE in non-exposed populations from various countries

Country	No. of samples	Year of sampling	Concentration, µg L^{-1} whole sample basis[1]		Reference
			Median	Mean	
New Zealand	**60[2] (1834)**	**1996/97**	**7.29**	**8.59**	**This study**
Brazil	16	nr		14.3	Minelli *et al*., 1996
Brazil	331	1995/96	3.1	4.8	Mendonca *et al*., 1999
Germany	6	1997		1.3	Petzold *et al*., 1999
Honduras	19	nr	25.6	30.9	Steinberg *et al*., 1989
India	25	nr		28	Nair *et al*., 1996
India	31	1989/90	29.4	37.3	Bhatnagar *et al*., 1992
Mexico	65	1997/98		14.5	Waliszewski *et al*., 1999
Pakistan	21	nr	8.58		Krawinkel *et al*., 1989
Singapore	89	nr		15.9	Luo *et al*., 1997
USA (National)	4590	nr		18.1	Griffith and Duncan, 1985
USA (National)	4089	1976 to 1980	12.6		Stehr-Green, 1989
USA (Arkansas)	180	1991	2.8		Anderson *et al*., 1998
USA (Great Lakes)	30	1993	5.2		Anderson *et al*., 1998
Yugoslavia	10	1986/87	6.0		Krauthacker, 1991

1. The data reported for each study are on a whole blood serum or plasma basis, depending on the sample matrix taken for analysis.
2. Pooled samples. Where reported in the publication, the number in parentheses denotes the total number of individual samples included in the study.

nr = Not reported.

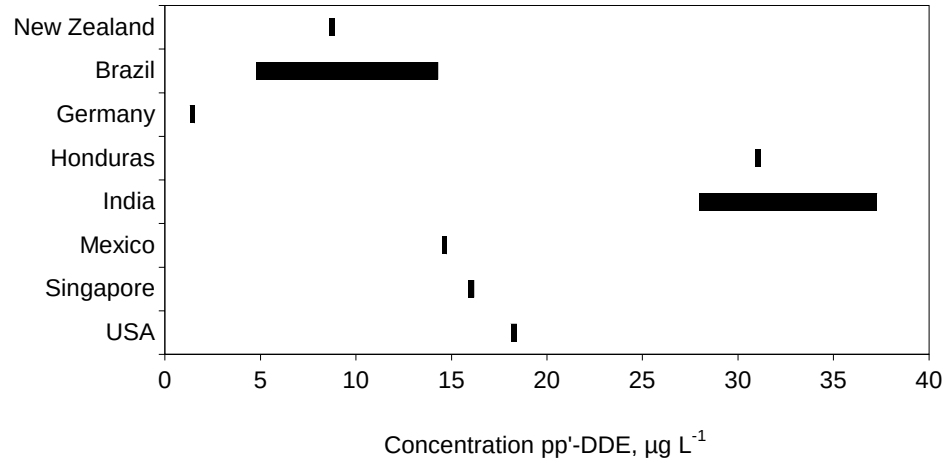

Figure H4 Comparative mean concentrations of pp'-DDE in non-exposed populations from various countries
[Overseas data taken from studies cited in Table H5. For an explanation of the horizontal bars, see Figure H1.]

A previous New Zealand study, carried out in 1992/93, investigated the levels of a range of organochlorine pesticides in the plasma of 31 non-occupationally exposed individuals from the Wellington region (age range 20–60 years) (van Maanen *et al.*, 1994). The mean concentration of pp'-DDE reported from that study was 1190 µg kg^{-1} lipid, which is comparable to the mean pp'-DDE

concentration of 1080 µg kg^{-1} lipid reported in the current study. The mean dieldrin concentration reported from the 1992/93 study was 30.5 µg kg^{-1} lipid, about twice as high as the mean concentration of 14.2 µg kg^{-1} lipid reported in the current study. This suggests that for New Zealanders, there has been a reduction in the body burden of dieldrin over the last five or so years, whereas there may have been little change in pp'-DDE concentrations. However, it is difficult to draw more definitive conclusions, as the earlier study involved a convenience sample obtained in a single urban area, and the sample size was much smaller than that in the current study. By way of comparison, a reduction in New Zealand breast milk concentrations of both dieldrin and pp'-DDE of approximately 70% and 60%, respectively, has been observed over a 10-year period from 1988 to 1998 (Bates *et al*., 2001).

Table H6 Concentrations of dieldrin in non-exposed populations from various countries, lipid basis

Country	No. of samples	Year of sampling	Concentration, µg kg^{-1} lipid basis		Reference
			Median	Mean	
New Zealand	**60[1] (1834)**	**1996/97**	**11.5**	**14.2**	**This study**
New Zealand	31	1992/93		30.5	van Maanen *et al*., 1994
Japan	50	nr		5.8	Iida *et al*., 1999

1. Pooled samples. Where reported in the publication, the number in parentheses denotes the total number of individual samples included in the study.

nr = Not reported.

Table H7 Concentrations of dieldrin in non-exposed populations from various countries

Country	No. of samples	Year of sampling	Concentration, µg L^{-1} whole sample basis[1]		Reference
			Median	Mean	
New Zealand	**60[2] (1834)**	**1996/97**	**0.091**	**0.11**	**This study**
India	31	1989/90	2.18	2.15	Bhatnagar *et al*., 1992
USA (National)	4590	nr		1.9	Griffith and Duncan, 1985
USA (Great Lakes)	30	1993	0.2		Anderson *et al*., 1998

1. The data reported for each study are on a whole blood serum or plasma basis, depending on the sample matrix taken for analysis.
2. Pooled samples. Where reported in the publication, the number in parentheses denotes the total number of individual samples included in the study.

nr = Not reported.

In a study from Flanders, Belgium, Pauwels *et al.*, (2000) have reported a mean pp'-DDE concentration in serum from 96 infertile women of 1275 µg kg^{-1} lipid, which is slightly higher than the mean concentration reported for pp'-DDE in the current New Zealand study.

In a study from Brazil, Minelli *et al.* (1996) have compared the concentrations of organochlorine pesticides in the serum of 26 malaria control sprayers (mean age 56 years) with a group of 16 non-exposed workers (mean age 54). The mean concentration of pp'-DDE reported in the control group was 14.3 µg L^{-1}, whilst the mean concentration of β-HCH was 3.3 µg L^{-1}.

Table H8 Concentrations of β-HCH in non-exposed populations from various countries, lipid basis

Country	No. of samples	Year of sampling	Concentration, µg kg^{-1} lipid basis		Reference
			Median	Mean	
New Zealand	**60[1] (1834)**	**1996/97**	**10.7**	**19.7**	**This study**
Japan	50	nr		258	Iida *et al*., 1999
USA	90	1987 to 1990	35		Sturgeon *et al.,* 1998

1. Pooled samples. Where reported in the publication, the number in parentheses denotes the total number of individual samples included in the study.

nr = Not reported.

Table H9 Concentrations of β-HCH in non-exposed populations from various countries

Country	No. of samples	Year of sampling	Concentration, µg L^{-1} whole sample basis[1]		Reference
			Median	Mean	
New Zealand	**60[2] (1834)**	**1996/97**	**0.087**	**0.16**	**This study**
Brazil	16	nr		3.3	Minelli *et al*., 1996
Germany	6	1997		0.3	Petzold *et al*., 1999
Honduras	19	nr	0.19	0.22	Steinberg *et al*., 1989
India	25	nr		31	Nair *et al*., 1996
Mexico	65	1997/98		1.4	Waliszewski *et al.,* 1999
Pakistan	21	nr	1.39		Krawinkel *et al*., 1989
USA (National)	4517	nr		2.4	Griffith and Duncan, 1985
USA (Great Lakes)	30	1993	0.05		Anderson *et al*., 1998
Yugoslavia	10	1986/87	18		Krauthacker, 1991

1. The data reported for each study are on a whole blood serum or plasma basis, depending on the sample matrix taken for analysis.
2. Pooled samples. Where reported in the publication, the number in parentheses denotes the total number of individual samples included in the study.

nr = Not reported.

In another study from Brazil, Mendonca *et al.* (1999) compared the concentrations of organochlorine pesticides detected in the serum of 162 women with breast cancer (mean age 56.9 years, range 30–75) with those in a group of 331 controls (all female, mean age 56.5 years, range 30–75). The median and mean concentrations of pp'-DDE in the control group were 3.1 and 4.8 µg L^{-1} respectively compared to concentrations in the cancer group of 3.1 and 5.1 µg L^{-1} respectively. These concentrations are slightly lower than those reported in the current New Zealand study.

In a study of six adult women residing in North Germany, Petzold *et al.* (1999) reported a mean pp'-DDE concentration of 1.3 µg L^{-1} (range 0.3–2 µg L^{-1}), which is markedly lower than the mean concentration found for New Zealand women in the current study. In contrast, the mean β-HCH concentration reported in the German study was 0.3 µg L^{-1} (range 0.1–0.4 µg L^{-1}), which is marginally higher than the mean concentration found in the current New Zealand study.

Steinberg *et al*. (1989) reported the levels of organochlorine pesticides in the blood of occupationally exposed farm workers and 19 controls (median age for the control group of 41.5 years, range 32–50) from Honduras. The median and mean concentrations of pp'-DDE reported for the control group were 25.6 and 30.9 µg L^{-1} respectively. These concentrations are approximately four times higher than the mean and median pp'-DDE concentrations reported in the current New Zealand study. The median and mean concentrations of β-HCH reported for the control group were 0.19 and 0.22 µg L^{-1} respectively. These concentrations are only slightly higher than the median and mean β-HCH concentrations reported in the current study.

A study from India (Nair *et al*., 1996) has reported concentrations of organochlorine pesticides in maternal blood, breast milk and cord blood from 25 mothers (average age 23.4 years, range 18–40). The mean concentration of pp'-DDE reported for the maternal blood was 28 µg L^{-1}, about double the mean pp'-DDE concentration for New Zealand women of similar age. The mean concentration of β-HCH reported for the maternal blood was 31 µg L^{-1}, which is markedly higher than the mean concentration determined for this pesticide in the current New Zealand study.

In another study from India, aimed at obtaining information on the background levels of organochlorine pesticides in a typical rural population, blood samples were collected from 31 non-occupationally exposed male subjects (mean age 28.4 years, range 18–57) (Bhatnagar *et al.*, 1992). The median and mean concentrations reported for pp'-DDE were 29.4 and 37.3 µg L^{-1} respectively, which is about four times higher than the median and mean pp'-DDE concentrations found in the current New Zealand study. The median and mean concentrations reported for dieldrin were 2.18 and 2.15 µg L^{-1}, respectively, about 20 times higher than the concentrations found in the current study.

In a study of 50 Japanese women before childbirth (mean age 20.5 years), Iida *et al*. (1999) have reported mean concentrations of pp'-DDE, dieldrin and β-HCH of 347 µg kg^{-1}, 5.8 µg kg^{-1} and 258 µg kg^{-1} lipid respectively. The pp'-DDE and dieldrin concentrations were both two to three times lower than the mean concentrations for these compounds reported for the current New Zealand study. In contrast, the mean concentration of β-HCH reported by Iida *et al*. (1999) was markedly higher than the mean concentration found for this pesticide in the current study.

A study from Nairobi, Kenya, has investigated the levels of organochlorines in the blood of 11 women (ages 18–30 years) who had just given birth (Kanja *et al.*, 1992). This study also reported organochlorine levels in maternal adipose tissue, milk and cord blood in order to establish whether there was any correlation in residue levels between the different matrices. The mean pp'-DDE concentration reported in the maternal blood was 1520 µg kg^{-1} lipid (range 630–2520 µg kg^{-1}), which is approximately two to three times higher than the mean concentration for New Zealand women of similar age as determined in the current study. The Kanja *et al*. (1992) study concluded that, when expressed on a lipid basis, there was a significant correlation between the concentrations of the sum of DDT in maternal blood and milk, maternal blood and adipose tissue, and maternal milk and adipose tissue.

In a study from Mexico, Waliszewski *et al.* (1999) reported the concentrations of organochlorine pesticides in the blood of 65 women living in Veracruz. A mean pp'-DDE concentration of 14.5 µg L^{-1} (range from not detected to 190 µg L^{-1}) was reported, which is about twice the mean pp'-DDE concentration reported in the current New Zealand study. The mean β-HCH concentration reported

was 1.4 µg L^{-1} (range from not detected to 100 µg L^{-1}), which is about 10 times higher than the mean concentration of this pesticide reported in the current study.

Krawinkel *et al.* (1989) have reported on the concentrations of organochlorines in the blood of 21 men and women (median age 25 years, range 10–80) living in the province of Baluchistan, Pakistan. The median concentration of pp'-DDE in that study was 8.58 µg L^{-1} (range 0.53–32.6 µg L^{-1}), which is marginally higher than the median pp'-DDE concentration of 7.29 µg L^{-1} for the current New Zealand study. In contrast, the median concentration of β-HCH reported by Krawinkel *et al.* (1989) was 1.39 µg L^{-1} (range from not detected to 6.05 µg L^{-1}), which is over 10 times the median concentration of 0.087 µg L^{-1} reported for β-HCH in the current study.

Luo *et al.* (1997) have reported on the serum concentration of pp'-DDE in the Singaporean population. Blood samples were taken from 89 healthy Singaporeans (28 males, 61 females, average age 44 years, range 19–67). The mean pp'-DDE concentration was 15.9 µg L^{-1} (range 1.5–88.1 µg L^{-1}), and a statistical correlation between DDE levels and age and gender was reported.

In the US, Griffith and Duncan (1985), in investigating the blood levels of organochlorine pesticides in Florida citrus field workers, have reported national average concentration data from the Health and Nutrition Examination Survey (HANES). The mean concentration of pp'-DDE from HANES was 18.1 µg L^{-1}, which is approximately twice the mean New Zealand concentration for this contaminant of 8.59 µg L^{-1} found in the current study. The mean concentrations for β-HCH and dieldrin from HANES were 2.4 µg L^{-1} and 1.9 µg L^{-1} respectively. These concentrations are markedly higher than the mean concentrations for β-HCH and dieldrin of 0.16 µg L^{-1} and 0.11 µg L^{-1}, respectively, reported in the current New Zealand study.

Stehr-Green (1989) has reported the concentrations of organochlorine pesticides in the serum of the US population as part of the second National Health and Nutrition Examination Survey (NHANES II). Survey participants were selected from across the US (52% female, 14.4% non-white), and were aged 12–74 years, with a mean age of 41.5 years. The median pp'-DDE concentration reported was 12.6 µg L^{-1} (range from not detected to 379 µg L^{-1}), which is approximately twice as high as the median pp'-DDE concentration of 7.29 µg L^{-1} reported in the current New Zealand study. The median concentration for β-HCH was reported as 'trace' (range from not detected to 27.8 µg L^{-1}). Similarly, the median concentration reported for dieldrin was 'trace' (range from not detected to 16.1 µg L^{-1}). Serum pp'-DDE concentrations (geometric means) were statistically related to age, sex, ethnicity and geographic region.

It should be noted that both the HANES (Griffith and Duncan, 1985) and NHANES II studies (Stehr-Green, 1989) were for samples collected approximately 10–20 years prior to the current New Zealand study. As the US pesticide residue levels may have decreased in the intervening years, in line with declining pesticide residue concentrations in the New Zealand population (Bates *et al*., 2001), any interpretation of the comparison with this national US data must be made with caution.

Also from the US, Anderson *et al.* (1998) have reported levels of organochlorine pesticides in the serum of consumers of sports fish from three of the Great Lakes. The median pp'-DDE concentration for the total study group (n = 30) was 5.2 µg L^{-1}. The median concentration of pp'-

DDE reported in a comparison group of 180 non-exposed subjects from Jacksonville, Arkansas, was 2.8 µg L^{-1}. (range from not detected to 38.5 µg L^{-1}) The median dieldrin concentration reported for the Great Lakes study group was 0.2 µg L^{-1}. The dieldrin concentrations reported in the comparison group from Arkansas ranged from not detected to 2.5 µg L^{-1}, with the median concentration being a non-detect value. The median β-HCH concentration reported for the Great Lakes study group was 0.05 µg L^{-1}. The β-HCH concentrations reported in the comparison group from Arkansas ranged from not detected to 1.8 µg L^{-1}, with the median concentration being a non-detectable value. These data are comparable to concentrations found in the current study.

A further US study has reported the levels of organochlorines in the serum and breast adipose tissue of 36 Connecticut women (mean age 62.7 years, range 50–80 years) (Archibeque-Engle *et al.*, 1997). The pp'-DDE concentration reported for the study group was in the range 240–2644 µg kg^{-1}, with a median concentration of 967 µg kg^{-1} lipid. By comparison, the pp'-DDE concentrations for New Zealand women aged 50–64 years in the current study were in the range 919–2780 µg kg^{-1} lipid and for those aged 65+ years were in the range 1090–2740 µg kg^{-1} lipid.

Also from the US, a study carried out to compare the blood levels of organochlorines in 90 subjects suffering from endometrial cancer with levels in 90 matched controls has been reported by Sturgeon *et al.* (1998). Subjects were selected from five geographic regions across the US. The median pp'-DDE concentration reported for the control group was 1358 µg kg^{-1} lipid, which was not dissimilar to the median concentration of 1417 µg kg^{-1} lipid reported for the cancer group. The median concentration of β-HCH in the control group was 35 µg kg^{-1} lipid, which again was not markedly different to the median level of 38 µg kg^{-1} lipid reported for the cancer group.

A similar US study has been carried out to determine any association between serum organochlorine levels and pancreatic cancer (Hoppin *et al.*, 2000). Concentrations of organochlorine pesticides were measured in 108 subjects with pancreatic cancer (mean age 65.5 years, range 32–84) and 82 control subjects (mean age 65.7 years, range 40–85). Median and mean concentrations of pp'-DDE measured in the control group were 1029 µg kg^{-1} and 1572 µg kg^{-1} lipid respectively, which compared with concentrations in the cancer subjects of 1287 µg kg^{-1} and 2054 µg kg^{-1} lipid respectively.

In another study from the US of seven lactating women (age range 25–36 years) from the New York area, Greizerstein *et al.* (1999) reported a mean pp'-DDE concentration in serum of 259 µg kg^{-1} lipid. The mean pp'-DDE concentration found for women of the corresponding age group in the current New Zealand study (25–34 years) is about two to three times higher, at 710 µg kg^{-1} lipid.

In a study from Yugoslavia aimed at obtaining data on the concentrations of organochlorine pesticides in people living in the northern Adriatic region, blood samples were collected from 10 women living in a small town on the Istria peninsula (Krauthacker, 1991). A median pp'-DDE concentration of 6 µg L^{-1} (range 4–13µg L^{-1}) was reported, comparable with the median concentration of 7.29 µg L^{-1} reported in the current New Zealand study. In contrast, the median β-HCH level reported from the Yugoslavian study was 18 µg L^{-1} (range 13–31 µg L^{-1}), which is more than 200 times higher than the median β-HCH concentration of 0.13 µg L^{-1} reported in the current New Zealand study.

How the New Zealand serum concentrations compare with concentrations from comparable overseas studies is variable for each pesticide. This is consistent with the view that concentrations in people may reflect local use patterns of these pesticides, at least historically. Overall, the information presented in this appendix suggests that:

- concentrations of β-HCH in adult New Zealanders are at the low end of the range of concentrations reported for overseas populations
- concentrations of pp'-DDE in adult New Zealanders are generally comparable to the concentrations measured in overseas populations, being, *in most cases*, neither markedly higher nor markedly lower.

For dieldrin, there is insufficient data available for overseas populations to allow any meaningful comparisons to be made with the New Zealand exposure data.

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