Ministry for the Environment
Manatū Mō Te Taiao

MAY 2001

Serum study: A summary of the findings

Background

This paper summarises the Ministry's publication, *Concentrations of selected organochlorines in the serum of the non-occupationally exposed New Zealand population.*

The serum study set out to:

(a) obtain estimates of baseline concentrations of persistent organochlorines in serum sampled from New Zealanders who had not been occupationally exposed to these chemicals

(b) determine the relationship of these chemicals to age, ethnicity, sex and geographic region, and

(c) obtain data that could be used, under the RMA, to develop national environmental standards for the protection of human health and the environment from organochlorine chemicals.

The study was not intended to identify or characterise highly exposed or at-risk populations, or to assess where the exposure may have come from.

The exposure data from this study has been used in a health risk appraisal of the New Zealand population to dioxins, which has been published by the Ministry for the Environment as a separate report (*Evaluation of the toxicity of dioxins and dioxin-like PCBs: A health risk appraisal for the New Zealand population* – February 2001). The Health Risk Appraisal found that the current background exposures to dioxin-like compounds for the New Zealand population had an insufficient margin of safety and recommended that steps should be taken to further reduce human exposure to these chemicals.

Study design

The serum study measured the concentrations of organochlorine chemicals in serum taken from a representative sample of the population. The samples were taken from December 1996 through to November 1997 from New Zealanders aged 15 years and over.

Analysis was done by the Centres for Disease Control and Prevention in Atlanta, Georgia, USA.

The serum samples were analysed for:

- dioxins (a generic name for the polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans)
- polychlorinated biphenyls (PCBs). Some PCBs show similar toxicity to the dioxins (these are known as the 'dioxin-like PCBs')
- organochlorine pesticides and their degradation products.

The blood serum was pooled into strata based on age, ethnicity, sex and geographic region. Strata had to have sufficient numbers of people and volume of serum in order to be included in the study.

Samples were pooled because there was insufficient blood for analysis from any one individual. Of the original 3376 people who provided a blood sample, only 1834 samples were actually used. (To be included, people needed to (a) have had no occupational exposure to organochlorines and (b) provide at least 2 millilitres of serum. In addition, when the serum was pooled for analysis, equal volumes from each individual had to be used, so this excluded some people.)

For Maori in some age groups, there were insufficient samples collected to provide the necessary volume of serum required for chemical analysis.

Results

The serum study found that for:

Dioxins

- the concentrations of dioxin in the New Zealand population increased with age. This variation with age is shown in Chart 1. In this chart, concentrations of dioxin are measured as nanograms of toxic equivalents (ng TEQ) per kilogram of fat. To understand how small a quantity this is, one ng TEQ per kilogram of fat is equivalent to one second in 32,000 years.

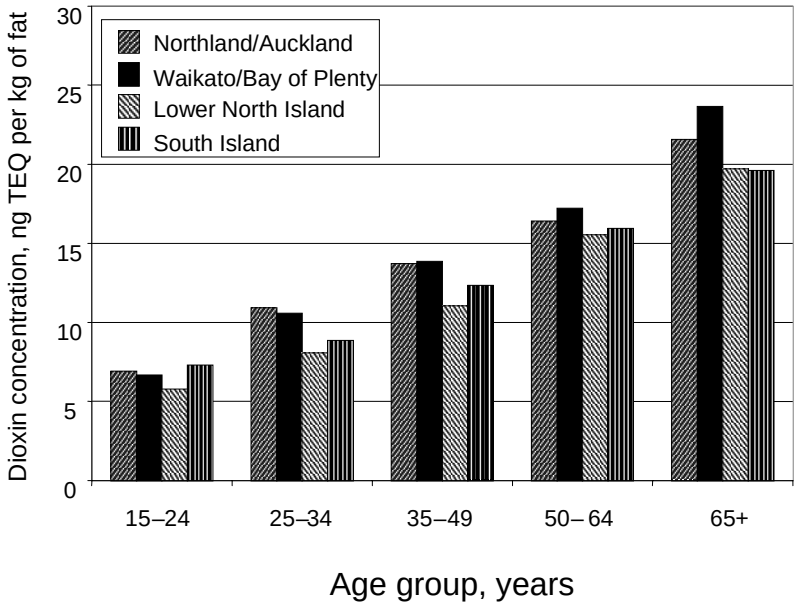

Chart 1. Average dioxin concentrations in serum fat for each region and age group

- the average dioxin concentration in New Zealanders aged 15–24 years was 6.69 ng TEQ per kilogram of fat, whereas the average concentration in people aged 65 years and older (65+) was 20.7 ng TEQ per kilogram of fat. The average dioxin concentration for the New Zealand population aged 15 years and older was 12.8 ng TEQ per kilogram of fat
- the concentration of dioxin was marginally higher in people living in the more northern parts of New Zealand (concentrations were higher in people living in Northland/ Auckland and Waikato/Bay of Plenty than those living in the lower North Island or the South Island)
- there were no consistent differences between Maori and non-Maori or between females and males
- on average, non-Maori women aged 65+ had higher concentrations of dioxins than non-Maori men of the same age.

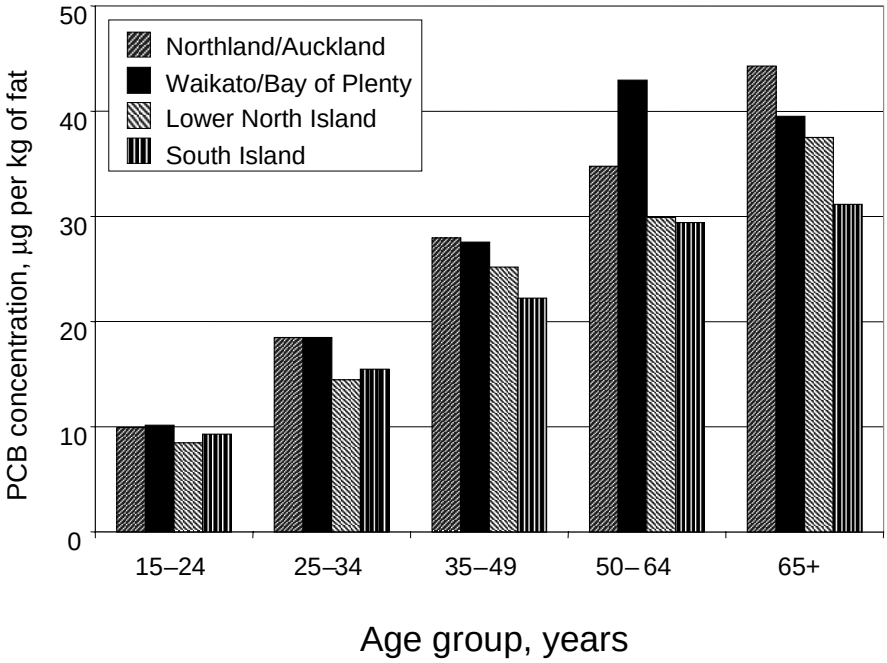

Chart 2. Average PCB concentrations in serum fat for each region and age group

PCBs

- there was a general trend of increasing concentration with age. This variation with age is shown in Chart 2 (above). In this chart, the concentrations of PCBs are measured as microgram (µg) per kilogram of fat. To understand how small a quantity this is, one microgram per kilogram of fat is equivalent to one second in 32 years
- the average PCB concentration in New Zealanders aged 15–24 years was 20.8 micrograms per kilogram of fat, whereas the average concentration in people aged 65+ was 139 micrograms per kilogram of fat. The average PCB concentration for the New Zealand population aged 15 years and older was 79 micrograms per kilogram of fat
- the concentrations of PCBs were marginally higher in the northern regions
- concentrations of PCBs were consistently higher in males than females across all age groups
- there were no obvious and consistent differences in concentrations of the dioxin-like PCBs, although concentrations were higher in non-Maori women aged 65+ compared to non-Maori men aged 65+.

Organochlorine pesticides

- DDE, dieldrin and beta-HCH were the most frequently detected pesticides
- concentrations of dieldrin, DDE and beta-HCH in New Zealanders' serum increased with age. This variation with age is shown for DDE in Chart 3 (below, left). In this chart, the concentrations of DDE are measured as micrograms per kilogram of fat
- the average DDE concentration increased from 646 micrograms per kilogram of fat for 15–24 year old New Zealanders to 1780 micrograms per kilogram of fat for people aged 65+. The average concentration across all age groups was 1080 micrograms per kilogram of fat. For dieldrin, the average concentration increased from 10.8 micrograms per kilogram of fat for 15–24 year olds to 22.4 micrograms per kilogram of fat for people aged 65+. The average dieldrin concentration across all age groups was 14.2 micrograms per kilogram of fat
- DDE concentrations in serum increased towards the south of the country. This north-south trend, which occurred in all age groups, can be seen in Chart 3 (left)

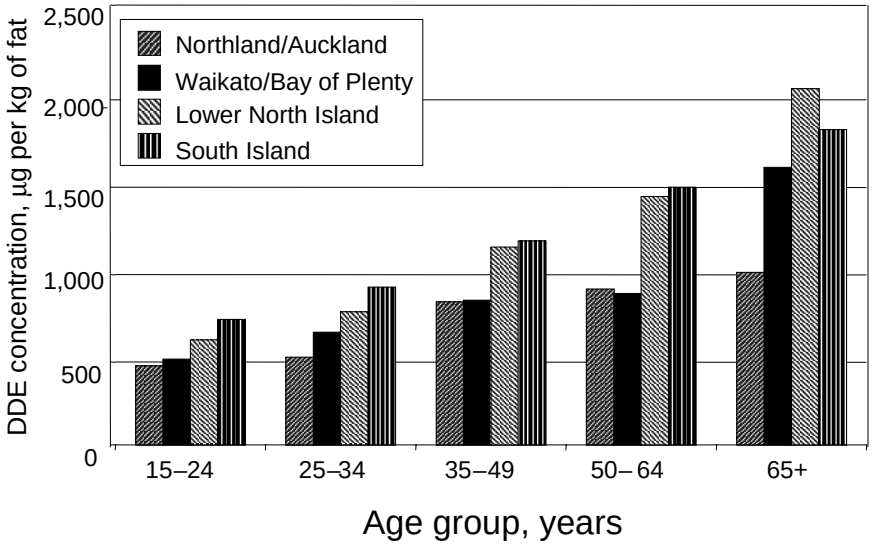

Chart 3. Average DDE concentrations in serum fat for each region and age group

- there were no consistent differences in concentrations between males and females and between regions for dieldrin and beta-HCH. However, beta-HCH concentrations were generally higher in non-Maori males aged 35–49.

Overall, the study showed:

- dioxins and PCBs were consistently found across all ages, regions and ethnic groups and across both sexes
- three pesticides were also consistently found: beta-HCH, dieldrin and DDE. Of these, DDE concentrations were 50 to 100 times the level of any other pesticide
- serum concentrations of dioxins, PCBs and organochlorine pesticides increased with age.

  One likely reason for this is that earlier exposures to all the chemicals may have been much higher than in more recent times. This would be consistent with results of studies in other countries which have found that exposure to organochlorines have fallen in the last two decades. The Ministry of Health has recently released the results of a study of organochlorines in breast milk; this study has found that concentrations were lower than concentrations measured a decade ago
- there were some regional differences:

  (a) dioxins and PCBs were marginally higher in the two northern study regions than the two southernmost regions. This may be due to higher population densities and levels of industrialisation in the north of New Zealand relative to the south

  (b) DDE concentrations were higher in the south than the north of New Zealand. This reflects the findings of studies of organochlorines in the breast milk of New Zealand women, which have found higher concentrations of DDE in women living in the South Island (Christchurch and Canterbury) than in women living in the upper North Island (Northland and Auckland)
- no *consistent* differences between the sexes or between Maori and non-Maori were found
- there was some evidence that women in the highest age group tended to have higher serum concentrations than men in the same age group even though the average ages of men and women in this age category were identical.

This is believed to be the first time such a study has been carried out for dioxins and PCBs on a sample representative of an entire national population for any country.

Comparison with international data

In comparing results from one country with those from another, there is always a caveat that needs to be made, because no two studies are ever alike.

Studies may vary in terms of design, data reporting, analytical methodologies etc, and these variations may mask or heighten real differences in results between studies from different countries. Therefore, comparisons need to be made carefully, ensuring the studies are as comparable as possible, and any differences in results should be interpreted with caution. Nevertheless, a comparison with data from other countries remains useful to benchmark the concentrations measured in serum from the non-occupationally exposed New Zealand population within an international perspective.

A comparison with international data found that for:

Dioxins

- concentrations of dioxins in New Zealanders tended to be towards the lower end of the international range, particularly for the younger age groups
- the lower concentrations of dioxins in New Zealand serum reflected the fact that, on an international scale:

  (a) concentrations of these chemicals are comparatively lower in the New Zealand environment

  (b) dioxin exposures through the diet are also generally low compared to dietary intakes of dioxins in other industrialised countries where studies have been undertaken.

PCBs

- New Zealand concentrations were at the low end of the range relative to concentrations found in other developed countries
- this is in keeping with the fact that:

  (a) environmental concentrations of PCBs in New Zealand are typically lower by an order of magnitude or more relative to those in overseas countries

  (b) dietary intake of PCBs is lower in New Zealand than in other industrialised countries where studies have been undertaken.

Organochlorine pesticides

- beta-HCH concentrations were low compared to those in overseas populations
- DDE concentrations were similar to concentrations measured in overseas populations
- there was limited overseas data available for dieldrin for any meaningful comparisons to be made with the New Zealand serum data.

Comparison with breast milk results

This report compares the concentrations of organochlorines measured in the serum of New Zealand women with concentrations measured in the breast milk of women as reported in a recently released Ministry of Health study. This comparison found that, overall, there was excellent agreement in the concentrations measured in the two media when reported on a fat weight basis.

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.

Summary of persistent organochlorines in New Zealand

Persistent organochlorines include the dioxins, polychlorinated biphenyls (PCBs) and organochlorine pesticides such as aldrin, chlordane, DDT and dieldrin. They are a group of environmental contaminants that are toxic, do not readily break down and which bioaccumulate in wildlife and people.

Dioxins

This is a collective term for the family of polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran chemicals.

Dioxins are unintentional products of thermal processes involving organic matter and chlorine as a result of incomplete combustion or chemical reactions. The combustion of wastes, the use of elemental chlorine for the bleaching of pulp and paper, and certain types of industrial processes, such as the processing or smelting of scrap metal, can all release dioxins. They may also be formed from natural sources such as forest fires. Dioxins continue to be emitted into the environment.

Dioxins have been linked to a number of adverse effects in humans, including cancer, immunotoxicity, reproductive system abnormalities and neurobehavioural effects.

Polychlorinated biphenyls (PCBs)

These compounds were used as heat exchange fluids, in electrical transformers and as additives in paint and plastics. Some PCBs exhibit similar toxicity to the dioxins, and these PCBs are known as the 'dioxin-like PCBs'.

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.

Organochlorine pesticides

Aldrin

Introduced in 1954 for use as a stock remedy 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.

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.

DDT

Used as a pasture insecticide to control grass grub and porina caterpillars. Frequently mixed with fertiliser or lime and applied particularly to agriculture pastures, as well as lawns, market gardens and parks. Its major breakdown product commonly found in the environment is DDE.

Dieldrin

Introduced in 1954 for use as a stock remedy in sheep sprays or dips for controlling sheep ectoparasites. 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.

Endrin and heptachlor

Only small amounts of these pesticides were ever used in New Zealand.

Hexachlorobenzene (HCB)

Used experimentally between 1970 and 1972 as a seed-dressing fungicide for cereal grain.

A succession of legislative measures under the Agricultural Chemicals Act (1959) progressively restricted the use of persistent organochlorine pesticides in New Zealand, so that by the mid 1970s their use had effectively ceased in agriculture and horticulture. They were deregistered by the Pesticides Board in the late 1980s, prohibiting their importation, manufacture or sale.

Visit our website at
www.mfe.govt.nz/issues/waste/organo.htm
for more information on organochlorines

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