The First Hong Kong Total Diet Study Report No. 8

The First Hong Kong Total Diet Study: Organochlorine Pesticide Residues

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EXECUTIVE SUMMARY

The Centre for Food Safety (CFS) is conducting the First Hong Kong Total Diet Study (the 1st HKTDS) aiming to estimate dietary exposures of the Hong Kong population and various population subgroups to a range of substances, including contaminants and nutrients, and thus assess any associated health risks. This is the 8th report of the series which presents the dietary exposure assessment of organochlorine pesticide (OCP) residues.

2. OCPs are toxic chemicals mainly consist of carbon, hydrogen and chlorine. They were widely used in agriculture worldwide in 1940s until restrictions were introduced in the late 1970s both in Europe and the USA, initially for DDT. Among various OCPs, aldrin, dieldrin, chlordane, chlordecone, DDT, endosulfan, endrin, heptachlor, hexachlorobenzene (HCB), α-hexachlorocyclohexane (α-HCH), β-hexachlorocyclohexane (β-HCH), and lindane (γ-hexachlorocyclohexane, γ-HCH), mirex, pentachlorobenzene, and toxaphene, are persistent organic pollutants (POPs) listed in the Stockholm Convention for elimination or restriction.

3. The principal acute toxic effect of OCPs is on the nervous system. In high dose, such as accidental exposures of DDT in humans, acute toxicity including vomiting, tremor, and seizures were observed. However, human health effects from OCPs such as DDT at low doses are unknown. Some OCPs have been linked to elevated rates of liver, thyroid or kidney cancer in animals but in humans there is inadequate evidence for

their carcinogenicity. Therefore, these OCPs were classified as possible carcinogenic to human (group 2B agents) by the International Agency Research for Cancer (IARC).

4. In the general population, diet is the main source of exposure to OCP residues. Most OCPs are accumulated in fatty tissues and found in higher concentrations in animals such as fish. Although most OCPs are no longer used in agriculture in many countries today, continuous monitoring of OCP residues in food and assessing the associated risks are warranted because food commodities may still contain low levels of OCP residues due to their persistence in the environment and potential for bioaccumulation.

Results

5. A total of 14 OCPs, namely aldrin, dieldrin, chlordane, chlordecone, DDT, dicofol, endosulfan, endrin, heptachlor, HCB, HCH, mirex, pentachlorobenzene, toxaphene, were analysed in 600 composite samples involving 150 TDS food items. Residues of OCPs were detected either singly or in combination in 332 (55%) composite samples, involving 109 TDS food items. The most commonly detected OCPs were DDT (detected in 32% of all composite samples), followed by HCB (30%) and endosulfan (22%). Higher proportion of samples from animal origin such as “fish and seafood and their products”, “meat, poultry and game and their products”, and “egg and their products” had detectable DDT and HCB. In contrast, higher proportion of samples from “vegetables and their products” had detectable endosulfan. Chlordecone was not detected in any samples.

The rest of the OCPs were detected in 10% or less of the composite samples. None of the detected levels exceeded the available Codex maximum residue limits (MRL) or extraneous maximum residue limits.

6. The CFS's risk assessment study in 2006 found the mean DDT concentration of "seafood (including fish)" was 29.7 μg/kg. In this study, the mean DDT concentration of "fish and seafood and their products" was 18 μg/kg. This finding was consistent with the declining trends of DDT in food reported by different countries since it was banned.

7. The estimated dietary exposures to all OCP residues were very low. For average local population, the lower bound and upper bound exposure estimates of OCP residues ranged from 0 to 0.5% and 0.1 to 8.4% of their respective health-based guidance values (HBGVs). For high consumers, the lower bound and upper bound exposure estimates ranged from 0-1.2% and 0.1 to 13.6% of their respective HBGVs.

Conclusion and Recommendations

8. The findings suggested that dietary exposures to all the OCP residues analysed in this study would be unlikely to pose unacceptable health risks to both the average and high consumer of the local population.

9. The farmers are advised to observe Good Agricultural Practices (GAP), such as using only pesticides registered with the competent authority, and applying the minimum quantities necessary to achieve adequate pest control. They should also use the pesticides in strict accordance with the label requirements, e.g. do not harvest the crops

within the specified withholding period after the last pesticide application. The public is also advised to have a balanced and varied diet which includes a wide variety of fruits and vegetables, and reduce fat intake.

The First Hong Kong Total Diet Study:

Organochlorine Pesticide (OCP) Residues

BACKGROUND

Total Diet Study (TDS) has been recognised internationally as one of the most cost effective ways to estimate dietary exposures to food chemicals or nutrients for various population groups and to assess their associated health risks. It provides a scientific basis for assessing food safety risks and regulating food supply. Since 1960s, various countries, such as the United Kingdom (UK), the United States of America (USA), Canada, Australia, New Zealand and Mainland China, have been conducting their own TDS.

Introduction of the first Hong Kong Total Diet Study (1st HKTDS)

2. This was the first time a TDS was carried out in Hong Kong by the Centre for Food Safety (CFS). It aimed to estimate dietary exposures of the Hong Kong population and various population subgroups to a range of substances, including contaminants and nutrients, and thus assess any associated health risks.

3. The 1st HKTDS is a large and complex project composing of food sampling and preparation, laboratory analysis and dietary exposure estimation. It covered the majority of food normally consumed by the

Hong Kong population with laboratory analysis of over 130 substances, including contaminants and nutrients.

Organochlorine pesticides (OCPs)

4. In simple term, pesticides are chemicals used for killing pests. Generally speaking, pesticide has been considered as any substance or mixture of substances intended for preventing, destroying, repelling or mitigating pests.* Although the proper use of pesticides could improve the quantity and quality of food, pesticides, by their natures, are potentially toxic to other organisms, including humans. Therefore, they need to be properly used according to Good Agricultural Practices (GAP).[1]

5. The 4th report of the 1st HKTDS on Pesticide Residues estimated the dietary exposures of the local adult population to 85 individual pesticide residues or their metabolites of four groups of pesticides, organophosphorus pesticides (OPPs), carbamates, pyrethrins and pyrethroids, and dithiocarbamates. It was found that all TDS food samples were either not detected with or contained very low residue levels of pesticides. Dietary exposures to all the pesticide residues analysed would be unlikely to pose unacceptable health risks to both the average and high consumer of the local adult population.[2]

* According to the Codex Alimentarius Commission, pesticide means any substance intended for preventing, destroying, attracting, repelling, or controlling any pest including unwanted species of plants or animals during the production, storage, transport, distribution and processing of food, agricultural commodities, or animal feeds of which many be administered to animals for the control of ectoparaites. The term includes substances intended for use as a plant growth regulator, defoliant, desiccant, fruit thinning agent, or sprouting inhibitor and substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport. The term normally excludes fertilizers, plant and animal nutrients, food additives and animal drugs.

6. This study focused on another group of pesticides, organochlorine pesticides (OCPs), which are toxic chemicals mainly consist of carbon, hydrogen and chlorine. The most well-known OCP is DDT. OCPs have been used heavily in agriculture worldwide since 1940s until restrictions were introduced in the late 1970s both in Europe and the USA, initially for DDT.[3,4] Due to the stable chemical nature of OCPs, they persist in the environment, particularly in soil and lead to environmental pollution. OCPs are also fat-soluble and can accumulate in fatty tissues of living organisms such as fish. As they move up through the food chain, they become more concentrated.[5]

7. Among 14 OCPs, aldrin, dieldrin, endrin, chlordane, DDT, heptachlor, hexachlorobenzene (HCB), mirex and toxaphene were initially listed along with other chemicals (i.e. dioxins, furans, and polychlorinated biphenyls) as the 12 persistent organic pollutants (POPs), informally called the "dirty dozen", under the Stockholm Convention in 2001. In 2009, chlordecone, pentachlorobenzene (an intermediate in the manufacture of pesticides), and alpha-hexachlorocyclohexane (α-HCH), beta-hexachlorocyclohexane (β-HCH), and lindane (gamma-hexachlorocyclohexane, γ-HCH) were included in the list of the nine new POPs under the Convention. In 2011, endosulfan (technical endosulfan and its related isomers) was added to the list of new POPs.[6] The Convention is administered by the United Nations Environment Programme which requires the parties to take measures to eliminate or reduce the release of POPs into the environment.

8. Today, many OCPs have been banned or heavily restricted in most countries in response to public concern and increasing scientific evidence of their adverse effects on living organisms and the environment. Nevertheless, continuous monitoring of OCP residues in food is needed because they are persistent in the environment and have high tendency to accumulate in living organisms and the food chain. This study estimated the dietary exposure of the local population to the residues of OCPs including the POP pesticides listed by the Stockholm Convention and assessing their associated potential health risks.

Sources of OCPs

9. Although many OCPs have been phased out, they have been widely distributed by global distillation effect (the transportation of chemicals, notably POPs, from warmer to colder regions of the Earth) and are still detected in air, water and soil from various regions. Food commodities may contain traces of OCP residues due to environmental pollution. In addition, certain OCPs such as dicofol which is not a POP under Stockholm Convention are currently in use. Also, DDT can still be used in disease vectors control in accordance with World Health Organization (WHO) recommendations and guidelines.[7] These OCPs can enter the environment after pesticide applications, disposal of contaminated wastes into landfills, and releases from manufacturing plants that produce these chemicals.[8]

Toxicity

10. The principal acute toxic effect of OCPs is on the nervous system. In high dose, such as accidental exposures of DDT in humans, acute toxicity including vomiting, tremor, and seizures were observed. [9] However, human health effects from OCPs such as DDT at low doses are unknown. Animal studies showed that chronic exposure to OCPs such as chlordane, DDT, hexachlorobenzene, and toxaphene may damage the liver and thyroid system.[9,10,11,12] Some OCPs have been linked to elevated rates of liver, thyroid or kidney cancer in animals but in humans there is inadequate evidence for their carcinogenicity. Therefore, these OCPs were classified as possible carcinogenic to human (group 2B agents) by the International Agency Research for Cancer (IARC) (see Appendix A).[13] There has been considerable concern in the interaction of OCPs with endocrine receptors, particularly estrogen and androgen receptors. In *vitro* and animal studies have showed endocrine disrupting activities of OCPs which may affect the reproductive development and success of animals and humans.[14]

11. Regarding the 14 OCPs tested in this Study, the Joint FAO/ WHO Meeting on Pesticide Residues (JMPR) has only established health-based guidance values (HBGVs) for aldrin/dieldrin, chlordane, chlordecone, DDT, dicofol, endosulfan, endrin, heptachlor, and lindane (γ-HCH).[15] For the remaining OCPs, references were made to the HBGVs set by the United States Environmental Protection Agency (EPA), Agency of Toxic Substance and Disease Registry (ATSDR), and the Ministry of Health (MOH) of the Peoples' Republic of China. The HBGVs for OCPs ranged from 0.0001 mg/kg bw/day for the more toxic compounds aldrin/dieldrin

and heptachlor, and up to 0.01 mg/kg bw/day for total DDT. The list of HBGVs for the 14 OCPs is showed in the Appendix A.

Sources of Dietary Exposure

12. In the general population, diet is the main source of exposure to OCPs. Most OCPs are found in fatty tissues, and are accumulated significantly in animals such as fish.[16] Contaminated drinking water and air are usually minor exposure sources. Infants can be exposed through breast milk, and the foetus can be exposed in utero via the placenta.[8]

Previous local study

13. The CFS has conducted a risk assessment study on dietary exposure to DDT of secondary school students in Hong Kong in 2006. It was found that most food samples contained non-detectable amount of DDT. The dietary exposures to DDT for average and high consumers of the secondary school students were 0.145 and 0.291 μg/kg bw/day respectively. Both levels fell well below the provisional tolerable daily intake (PTDI) of 0.01 mg (10 μg)/kg bw/day established by JMPR. It was concluded that both the average and high consumers of the secondary school students were unlikely to experience major toxicological effects of DDT. The results also showed that the food group “seafood”, particularly fish and oyster, was the main dietary source of DDT.[17]

METHODOLOGY AND LABORATORY ANALYSIS

Methodology of the 1st HKTDS

14. The 1st HKTDS involved purchasing samples of food commonly consumed throughout Hong Kong, preparing them as consumed and combining the foods into composite samples, homogenising them, and analysing them for a range of substances. The analytical results were then combined with food consumption information of various population groups, which were captured from the Hong Kong Population-based Food Consumption Survey (FCS)[18], to obtain the dietary exposures.

15. One hundred and fifty TDS food items were selected for the study, based on the food consumption data of the FCS. Three samples of each TDS food item were collected and prepared in a form of food normally consumed on four occasions from March 2010 to February 2011. A total of 1,800 samples were collected and combined into 600 composite samples for laboratory analysis.

16. Dietary exposure estimation was performed by an in-house developed web-based computer system, Exposure Assessment System, named as EASY, which involved food mapping and weighting of data. The mean and 95th percentile exposure levels were used to represent the dietary exposures of average and high consumers of the local population respectively.

17. Details of the methodology are given in the same series of report on Methodology.[19]

Laboratory analysis

18. Laboratory analysis of OCPs was conducted by the Food Research Laboratory of the CFS. All 150 TDS food items taken from the four occasions have been tested for the following 14 OCPs and their metabolites or related compounds including aldrin, dieldrin, chlordane (*cis*-chlordane, *trans*-chlordane, oxychlordane, *cis*-nonachlor, *trans*-nonachlor), chlordecone, DDT (*2,4'*-DDD, *4,4'*-DDD, *2,4'*-DDE, *4,4'*-DDE, *2,4'*-DDT, *4,4'*-DDT), dicofol (*2,4'*-dicofol, *4,4'*-dichlorobenzophenone), endosulfan (*alpha*-endosulfan, *beta*-endosulfan, endosulfan sulfate), endrin (endrin, endrin aldehyde, endrin ketone), heptachlor, (heptachlor, *cis*-heptachlor epoxide, *trans*-heptachlor epoxide), HCB, HCH (*alpha-*, *beta-*, *gamma-* and *delta-*), mirex, pentachlorobenzene and toxaphene (Parlars 26, 32, 42, 50, 56 and 62).

19. Except for chlordecone, analyses of all other analytes were performed by extracting the composite samples by matrix solid phase dispersion technique and cleaning up by gel permeation chromatography and florisil column. OCP levels were determined by gas chromatograph-mass spectrometer whereas toxaphene levels were determined by gas chromatograph-high resolution mass spectrometer.

20. For chlordecone, composite samples were extracted with acidified acetonitrile in the presence of magnesium sulphate and sodium acetate. Part of the extract was then cleaned up with appropriate dispersive solid phase material, and subsequently determined by liquid chromatograph tandem mass spectrometer.

21. The limit of detection (LOD) of OCPs in general food was 0.1 μg/kg and in drinking water, bottled distilled water, whole milk, skim milk

and Chinese tea was 0.01 µg/kg. The limit of quantification (LOQ) in general food was 0.5µg/kg and in drinking water, bottled distilled water, whole milk, skim milk and Chinese tea was 0.05µg/kg.

Treatment of analytical values below the LOD

22. In general, OCPs can persist in the environment as contaminants and accumulate in plants and animals, even though they have no longer been used for many years. Therefore, this study presented both lower and upper bounds dietary exposure estimations (values of 0 and LOD were assigned to all analytical values below LOD, respectively). This practice was consistent with the recommendation from the WHO regarding evaluation of low-level of contamination of food when treating analytical values below LOD.[20] In addition, no dietary exposure estimation for an OCP would be conducted if it was not detected in any samples.

RESULTS AND DISCUSSION

Concentrations of OCP residues in TDS food

23. A total of 600 composite samples (comprising 150 TDS food items from 15 food groups, collected and prepared on four occasions) were tested for OCP residues. It was found that 332 (55%) composite samples, involving 109 TDS food items contained detectable levels of OCPs, either singly or in combination. Chlordecone was not detected in any samples. The rest of the OCPs were detected in 10% or less of the composite samples. The most commonly detected OCP was DDT (detected in 32% of all composite samples), followed by HCB (30%) and endosulfan (22%).

The numbers of composite samples with detectable levels of one or more of the 14 OCPs in the 15 TDS food groups are summarised in Table 1.

Table 1: Numbers of Composite Samples in TDS Food Groups

Food group	No. composite samples analysed	No. composite samples with detectable level of OCPs													
		Aldrin	Dieldrin	Chlordane	DDT	Dicofol	Endosulfan	Endrin	Heptachlor	HCB	HCH(α,β,γ and δ)	-Lindane (γ-HCH)	Mirex	Pentachlorobenzene	Toxaphene
Cereals and their products	76	0	1	0	24	6	11	8	0	26	1	1	1	21	0
Vegetables and their products	140	0	1	1	7	3	59	0	0	10	3	3	0	9	0
Legumes, nuts and seeds and their products	24	0	2	0	8	1	6	0	2	6	7	1	0	1	3
Fruits	68	0	0	0	3	1	10	0	0	1	1	1	0	0	0
Meat, poultry and game and their products	48	1	1	0	44	1	1	0	0	46	6	0	2	1	0
Egg and their products	12	0	0	0	11	0	0	0	0	11	1	0	0	4	0
Fish, seafood and their products	76	0	2	24	67	0	25	0	1	46	12	0	8	16	4
Dairy products	20	0	2	0	9	0	0	0	0	3	0	0	0	0	0
Fats and oils	8	0	0	0	5	0	0	0	0	4	1	0	0	0	0
Beverages, alcoholic	8	Not detected in any samples													
Beverages, non-alcoholic	40	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Mixed dishes	48	0	0	0	10	0	20	0	0	27	8	1	0	6	0
Snack foods	4	0	0	2	0	0	0	0	1	1	1	0	0	0	0
Sugars and confectionery	8	0	0	0	2	0	0	0	0	1	0	0	0	0	0
Condiments, sauces and herbs	20	0	0	0	4	0	0	0	0	0	0	0	0	0	0
Total:	600	1	10	27	194	12	132	8	4	182	41	7	11	58	7
%:	100	<1	2	5	32	2	22	1	1	30	7	1	2	10	1

-Chlordecone was not detected in any sample.

24. Although the three OCPs, DDT, endosulfan and HCB, were commonly detected in food samples, the levels were very low in general (see Table 2). The levels of OCP residues in individual food items are shown in Table B1 of Appendix B. The 41 food items that were not detected with OCP residues are showed in Table B1 of Appendix B.

Table 2: The mean concentration (µg/kg) of three OCPs, DDT, Endosulfan and HCB.

Food group	DDT	Endosulfan	HCB
Cereals and their products	0.2	0.5	0.1
Vegetables and their products	0.0	3.2	0.0
Legumes, nuts and seeds and their products	0.4	0.2	0.0
Fruits	0.0	0.4	0.0
Meat, poultry and game and their products	1.0	0.0	0.7
Egg and their products	1.1	ND	0.6
Fish and seafood and their products	18	0.7	0.4
Dairy products	0.7	ND	0.0
Fats and oils	4.4	ND	0.6
Beverages, alcoholic	ND	ND	ND
Beverages, non-alcoholic	ND	ND	ND
Mixed dishes	0.1	0.4	0.1
Snack foods	ND	ND	0.1
Sugars and confectionery	0.1	ND	0.0
Condiments, sauces and herbs	0.1	ND	ND

-Non-detects were assumed to be 0 μg/kg when calculating the concentrations.
-Mean levels below 1.0 μg/kg have been rounded to one significant figure and levels equal to or above 1.0 μg/kg have been rounded to two significant figures.
-ND denotes not detected in any composite samples of the particular food groups.

25. Both DDT and HCB were widely used pesticides in the past. Because they are persistent in the environment, even though they were banned for agriculture use, they were still detected in various foods particularly from animal origin. In this study, only a small proportion (5% and 7%) of "vegetables and their products" samples were detected with DDT and HCB, respectively. However, higher proportion of DDT and HCB were found in "meat, poultry and game and their products" (92% and 96%, respectively), "egg and their products" (both 92%), and "fish and seafood and their products" (88% and 61%, respectively).

26. In contrast, higher proportion (42%) of "vegetables and their products" samples had detectable endosulfan when compared with food samples from animal origins. Endosulfan was mainly used to control insects in fruits and vegetables. During the sampling period of the TDS (March 2010 to February 2011), the use of it in crops had not yet been widely restricted. The pesticide was registered and permitted to be used in Hong Kong until 1 January 2013.[21] In the USA, endosulfan is being restricted to certain crops and is scheduled to be cancelled for all uses by 2016.[22] The percentage of composite samples in selected TDS food groups with detectable DDT, HCB and endosulfan were shown in Figure 1.

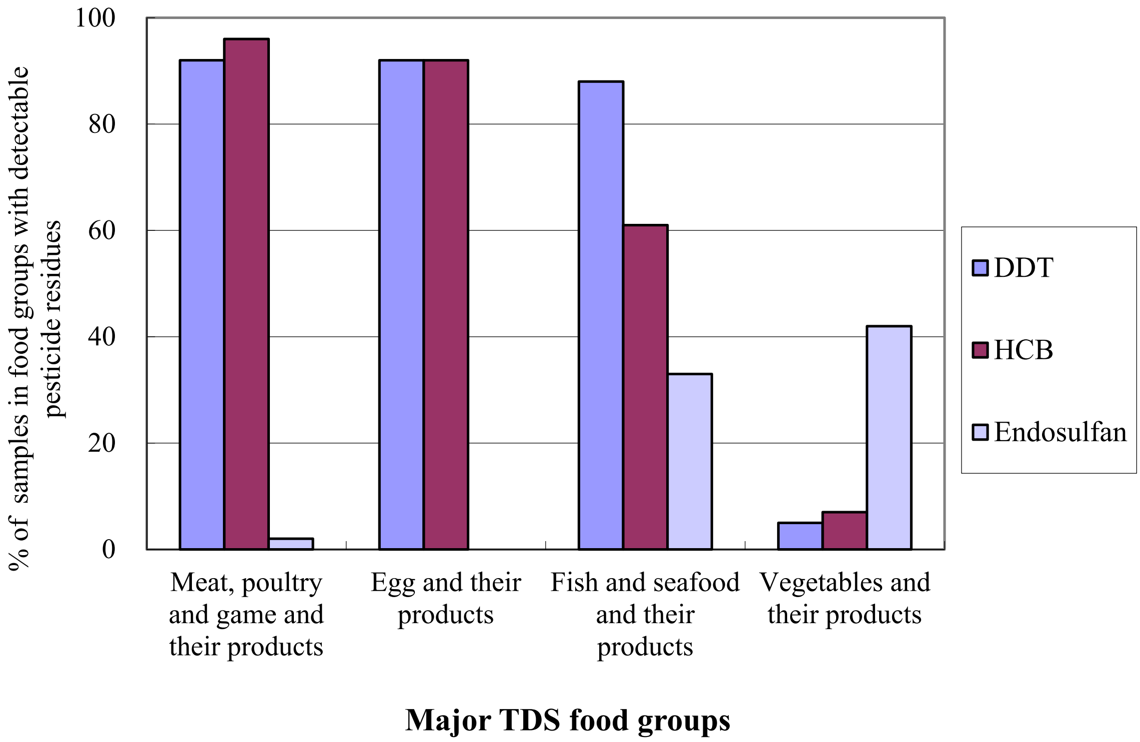

Figure 1: Percentage of Composite Samples in Major TDS Food Groups with Detectable DDT, HCB and Endosulfan.

27. In this study, the mean DDT concentration of the 76 composite samples of "fish and seafood and their products" was 18 μg/kg while in the 2006 risk assessment study the mean DDT concentration of 30 samples of "seafood (including fish)" was 29.7 μg/kg. Due to sample variation and differences in analytic methods, it should be cautious when making direct comparison of the results from the two studies. Nevertheless, reports from various countries such as Mainland China, the USA, and some European countries had also showed declining trends of DDT in food as well as dietary exposure levels to DDT since it was banned.[4,23,24]

Dietary exposure to OCP residues

28. The lower and upper bounds dietary exposure estimates to OCP residues for the average and high consumers of the local population and their contribution to HBGVs are shown in Table 3 and those of the individual age-gender groups are shown in Appendix C.

29. For average local population, the lower bound and upper bound exposure estimates of OCP residues ranged from 0 to 0.5% and 0.1 to 8.4% of their respective HBGVs. For high consumers, the lower bound and upper bound exposure estimates ranged from 0 to 1.2% and 0.1 to 13.6% of their respective HBGVs. The estimated dietary exposures to all OCP residues in all age-gender groups were very low. The findings indicated that dietary exposures to all OCPs analysed in this study would be unlikely to pose unacceptable health risks to the general population in Hong Kong.

Table 3: Ranges (lower bound and upper bound) of dietary exposure estimates (μg/kg bw/day) to the OCPs for the average and high consumers of the local population and their contribution to health-based guidance values (HBGVs).

OCPs	HBGVs (μg/kg bw/day)	Dietary exposure estimate (μg/kg bw/day) (Contribution to HBGVs) * #	
		Average	High consumer
Aldrin+Dieldrin	0.1	0.0003-0.0059 (0.3-5.9%)	0.0012-0.0096(1.2-9.6%)
Chlordane	0.5	0.0002-0.0142 (0-2.8%)	0.0010-0.0230(0.2-4.6%)
DDT	10	0.0238-0.0399 (0.2-0.4%)	0.0912-0.1099 (0.9-1.1%)
Dicofol	2	0.0005-0.0060 (0-0.3%)	0.0018-0.0098 (0.1-0.5)
Endosulfan	6	0.0085-0.0166 (0.1-0.3%)	0.0258-0.0359 (0.4-0.6%)
Endrin	0.2	0.0010-0.0091 (0.5-4.5%)	0.0021-0.0145 (1.0-7.3%)
Heptachlor	0.1	0-0.0084 (0-8.4%)	0-0.0136 (0-13.6%)
HCB	0.8	0.0024-0.0048 (0.3-0.6%)	0.0052-0.0084 (0.6-1.0%)
HCH (α,β,γ and δ)	5	0.0008-0.0120 (0-0.2%)	0.0023-0.0195 (0-0.4%)
-Lindane (HCH-γ)	5	0.0001-0.0029 (0-0.1%)	0.0002-0.0046 (0-0.1%)
Mirex	0.2	0-0.0028 (0-1.4%)	0.0001-0.0045 (0-2.3%)
Pentachlorobenzene	0.8	0.0003-0.0030 (0-0.4%)	0.0008-0.0049 (0.1-0.6%)
Toxaphene	2	0.0002-0.0171 (0-0.9%)	0.0011-0.0276 (0.1-1.4%)

* Figures for dietary exposure estimates and contributions to HBGVs were rounded to four and one decimal places, respectively.

\# Values of "0" denote < 0.00005 μg/kg bw/day for dietary exposure estimates and < 0.05% for contributions to HBGVs.

-Chlordecone was not detected in any sample so dietary exposure estimation was not conducted.

International comparison

30. Local dietary exposure estimates for selected OCPs and relevant data from total diet studies of Mainland China[25], Canada[26], France[27], Australia[28], and New Zealand [29] are shown in Appendix D. It

was found that all dietary exposure estimates to OCPs were low. However, caution should be exercised in making any direct comparison of the data due to the difference in time the reported studies were carried out, the methods of collection of consumption data, the methods of contaminant analysis and the methods of treating results below detection limits.

Limitations of the study

31. Of the food items captured by the FCS, only a limited number of food items have been sampled in our current study though the majority of food commonly consumed has been covered. To reflect the exposure from the whole diet, a set of food mapping was applied. However, occurrence of OCPs in different food items even within the same food group may vary with different factors such as the amount of OCP residues exposed by the animals or crops and the fat content of the food. The assumption of applying OCP levels detected in one food item to other similar foods may introduce uncertainty of the results. Other limitations have been described in the report of the 1st HKTDS on Methodology.[19]

CONCLUSIONS AND RECOMMENDATIONS

32. OCP residues were either not detected or detected at low levels in food. In addition, the estimated exposures of OCP residues were well below the HBGVs established by JMPR and other authorities. The findings suggested that dietary exposures to all the OCP residues analysed in this study would be unlikely to pose unacceptable health risks to the general population in Hong Kong.

33. The following general advices are recommended. The farmers are advised to observe Good Agricultural Practices (GAP), such as using only pesticides registered with the competent authority, and applying the minimum quantities necessary to achieve adequate pest control. They should also use the pesticides in strict accordance with the label requirements, e.g. do not harvest the crops within the specified withholding period after the last pesticide application. The public is also advised to have a balanced and varied diet, which includes a wide variety of fruits and vegetables, and reduce fat intake.

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Appendices

Appendix A

Health-based guidance values (HBGVs) of OCPs

Organochlorine pesticides	HBGVs (mg/kg bw/day)		Source [1]	Year	Evaluation of Carcinogenicity by IARC
Aldrin	0.0001 (Aldrin+Dieldrin)	PTDI[2]	JMPR	1994	3
Dieldrin					3
Chlordane	0.0005	PTDI[2]	JMPR	1994	2B
Chlordecone	0.0003	RfD[3]	USEPA	2009	2B
DDT (any combination of DDT, DDD, and DDE)	0.01	PTDI[2]	JMPR	2000	2B
Dicofol	0.002	ADI[2]	JMPR	1992	3
Endosulfan (α-endosulfan, β-endosulfan and endosulfan sulphate)	0.006	ADI[2]	JMPR	1998	-
Endrin	0.0002	PTDI[2]	JMPR	1994	3
Heptachlor	0.0001	PTDI[2]	JMPR	1994	2B
Hexachlorobenzene (HCB)	0.0008	RfD[3]	USEPA	1991	2B
Hexachlorocyclohexane (α-,β-,γ- and δ-)	0.005	ADI[4]	MOH of PRC	2012	2B
-Lindane (γ-HCH)	0.005	ADI[2]	JMPR	2002	2B
Mirex	0.0002	RfD[3]	USEPA	1992	2B
Pentachlorobenzene	0.0008	RfD[3]	USEPA	1988	-
Toxaphene	0.002	MRL[5]	ATSDR	2010	2B

[1] JMPR stands for the Joint Food and Agriculture Organization (FAO) / World Health Organization (WHO) Meeting on Pesticide Residues; USEPA stands for the United States Environmental Protection Agency; MOH of PRC stands for the Ministry of Health of the Peoples'Republic of China; ATSDR stands for the Agency for Toxic Substances and Disease Registry of the U.S. Department of Health Services.

[2] Provisional tolerable daily intakes (PTDIs)/ acceptable daily intakes (ADIs) established by JMPR are available from URL: http://www.fao.org/agriculture/crops/core-themes/theme/pests/lpe/en/

[3] Chronic reference doses (RfD) established by USEPA are available from URL: http://www.epa.gov/iris/

[4] The ADI established by MOH of PRC is available from URL: http://www.nhfpc.gov.cn/cmsresources/mohwsjdj/cmsrsdocument/doc16697.doc [in Chinese]

[5] The minimal risk level (MRL) (oral, intermediate) established by ATSDR is available from URL: http://www.atsdr.cdc.gov/toxprofiles/tp94-a.pdf

Appendix B

Table B1: OCP residue contents (μg/kg) detected in TDS food items

Substances (no. food items with detectable levels)	TDS Food Item*	No. composite Samples with detectable levels*	Mean# (μg/kg)	Range # (μg/kg)
Aldrin (1)	Roasted duck/goose	1	0.0	0-0.1
Dieldrin (9)	Cakes	1	0.1	0-0.2
	Cucumber	1	0.1	0-0.4
	Peanut	1	0.1	0-0.2
	Peanut butter	1	0.2	0-0.7
	Chicken, soy sauce	1	0.2	0-0.9
	Fish, Salmon	1	1.8	0-7.3
	Shrimp/ Prawn	1	0.2	0-0.6
	Cheese	2	2.6	0-7.9
	Coffee	1	0.2	0-0.7
Chlordane (10)	Water spinach	1	0.3	0-1.3
	Fish, Big head	3	0.2	0-0.3
	Fish, Mandarin fish	1	0.1	0-0.2
	Fish, Grass carp	3	0.2	0-0.4
	Fish, Pomfret	3	0.2	0-0.2
	Fish, Grey mullet	2	0.1	0-0.1
	Fish, Salmon	4	2.6	1.9-3.2
	Fish, Yellow croaker	4	0.5	0.4-0.6
	Oyster	4	2.4	1.7-3.3
	Potato chips	2	0.4	0-1.4
DDT (63)	Bread, plain	1	0.1	0-0.5
	Bread, raisin	4	0.3	0.1-0.5
	"Pineapple" bun	2	0.2	0-0.5
	Sausage/ham/luncheon meat bun	4	0.5	0.3-0.8
	Biscuits	3	1.0	0-2.5
	Cakes	3	0.4	0-1.0
	Pastries	4	0.2	0.1-0.3
	Pastries, Chinese	3	0.9	0-2.8
	Celery	3	0.7	0-1.9
	Chinese kale	1	0.1	0-0.3
	Spinach	1	0.0	0-0.1
	Sweet pepper	1	0.1	0-0.2
	Spring onion	1	0.0	0-0.1
	Peanut	4	1.9	0.7-5.3
	Peanut butter	4	0.7	0.6-0.9
	Apple	1	0.0	0-0.1
	Grapes	2	0.1	0-0.3
	Beef	4	1.2	0.3-2.6
	Mutton	4	5.5	0.1-13
	Pork	4	0.3	0.1-0.6
	Ham	3	0.3	0-0.5
	Luncheon meat	4	2.1	0.6-2.8
	Barbecued pork	4	0.4	0.3-0.5
	Roasted pork	4	0.2	0.1-0.3
	Pig liver	1	0.0	0-0.1
	Chicken meat	4	0.3	0.2-0.5
	Chicken, soy sauce	4	0.5	0.3-0.7
	Roasted duck/goose	4	0.4	0.2-0.5
	Meat sausage	4	0.7	0.2-1.4

Substances (no. food items with detectable levels)	TDS Food Item*	No. composite Samples with detectable levels*	Mean# (µg/kg)	Range # (µg/kg)
	Egg, chicken	3	0.2	0-0.3
	Egg, lime preserved	4	2.6	0.6-7.4
	Egg, salted	4	0.6	0.3-1.0
	Fish, Big head	4	13	4.5-26
	Fish, Mandarin fish	4	5.7	2.7-9.9
	Fish, Grass carp	4	8.3	3.1-14
	Fish, Golden thread	4	26	18-36
	Fish, Grouper	4	11	3.1-22
	Fish, Horse head	4	9.3	5.8-11
	Fish, Pomfret	4	60	40-72
	Fish, Tuna	2	0.1	0-0.2
	Fish, Grey mullet	4	13	2.3-32
	Fish, Salmon	4	8.1	6.0-9.5
	Fish, Yellow croaker	4	150	110-190
	Fish, Dace, minced	4	2.8	1.7-4.1
	Fish ball/fish cake	4	1.5	0.6-3.4
	Shrimp/ Prawn	4	0.9	0.3-2.5
	Crab	4	15	5.1-32
	Oyster	4	15	2.8-30
	Scallop	4	0.4	0.1-0.8
	Squid	1	0.2	0-0.9
	Cheese	4	2.9	0.6-6.9
	Yoghurt	2	0.2	0-0.5
	Ice-cream	3	0.2	0-0.5
	Butter	4	8.6	1.1-13
	Oil, vegetable	1	0.3	0-1.1
	Siu Mai	2	0.6	0-1.4
	Dumpling, including wonton	1	0.1	0-0.3
	Steamed minced beef ball	2	0.4	0-1.3
	Glutinous rice dumpling	3	0.3	0-0.8
	Hamburger	2	0.2	0-0.5
	Chocolate	2	0.2	0-0.7
	Oyster sauce	3	0.5	0-0.8
	Tomato paste/ketchup	1	0.1	0-0.2
Dicofol (10)	Rice, white	1	0.1	0-0.2
	Rice, unpolished	2	0.1	0-0.2
	Corn	2	0.1	0-0.2
	Bread, raisin	1	0.1	0-0.3
	Chinese spinach	1	0.0	0-0.1
	Eggplant	1	1.6	0-6.2
	Sweet pepper	1	0.1	0-0.4
	Green string beans, with pod	1	0.1	0-0.2
	Grapes	1	0.0	0-0.1
	Meat sausage	1	1.7	0-6.9
Endosulfan (60)	"Pineapple" bun	1	0.1	0-0.2
	Sausage/ham/luncheon meat bun	1	0.3	0-1.0
	Biscuits	1	3.2	0-13
	Cakes	2	1.4	0-4.7
	Pastries	2	0.5	0-1.7
	Pastries, Chinese	3	1.8	0-6.1
	Deep-fried dough	1	2.9	0-12

Substances (no. food items with detectable levels)	TDS Food Item*	No. composite Samples with detectable levels*	Mean# (µg/kg)	Range # (µg/kg)
	Potato	2	0.1	0-0.1
	Potato, fried	4	4.6	2.6-6.1
	Cabbage, Chinese flowering	2	0.9	0-3.3
	Cabbage, Petiole Chinese	2	0.3	0-0.9
	Celery	1	0.1	0-0.2
	Chinese kale	2	0.2	0-0.4
	Chinese spinach	4	0.3	0.1-0.9
	Leaf mustard	4	0.7	0.1-1.4
	Lettuce, Chinese	2	8.3	0-33
	Lettuce, European	1	0.0	0-0.1
	Spinach	1	9.3	0-37
	Water spinach	4	5.6	0.4-20
	Watercress	3	22	0-86
	Bitter melon	2	2.5	0-8.2
	Cucumber	3	0.4	0-0.7
	Hairy gourd	3	1.3	0-3.9
	Sponge gourd	4	9.3	0.9-27
	Wax gourd	1	0.2	0-0.9
	Zucchini	1	0.2	0-0.6
	Sweet pepper	4	17	2.0-53
	Tomato	3	3.9	0-12
	Spring onion	4	23	1.3-86
	Preserved vegetables	2	0.7	0-2.5
	Green string beans, with pod	1	0.1	0-0.2
	Peanut	4	1.1	0.7-1.4
	Peanut butter	1	0.1	0-0.3
	Apple	2	0.3	0-0.8
	Longan/ Lychee	1	0.1	0-0.3
	Mango	2	0.2	0-0.5
	Melons	2	5.5	0-19
	Orange	1	0.1	0.3
	Pear	1	0.8	0-3.1
	Pummelo /Grapefruit	1	0.1	0-0.5
	Roasted duck/goose	1	0.1	0-0.3
	Fish, Big head	4	0.9	0.5-1.3
	Fish, Mandarin fish	2	0.3	0-0.9
	Fish, Grass carp	4	1.7	1.2-2.5
	Fish, Pomfret	4	1.4	0.7-2.0
	Fish, Grey mullet	4	2.2	1.5-3.1
	Fish, Yellow croaker	4	6.3	1.3-20
	Fish, Dace, minced	2	0.1	0-0.3
	Shrimp/ Prawn	1	0.3	0-1.1
	Siu Mai	2	0.3	0-0.7
	Dumpling, steamed	2	0.3	0-1.0
	Dumpling, pan-fried	2	0.6	0-1.5
	Dumpling, including wonton	2	0.6	0-1.6
	Steamed barbecued pork bun	1	0.4	0-1.6
	Turnip cake	2	0.6	0-1.8
	Steamed minced beef ball	2	0.7	0-1.7
	Glutinous rice dumpling	1	0.1	0-0.5

Substances (no. food items with detectable levels)	TDS Food Item*	No. composite Samples with detectable levels*	Mean# (µg/kg)	Range # (µg/kg)
	Steamed rice-rolls with filling	1	0.2	0-0.7
	Steamed rice-rolls, plain	3	0.4	0-0.7
	Hamburger	2	0.7	0-1.4
Endrin (4)	Rice, white	3	0.2	0-0.3
	Rice, unpolished	2	0.1	0-0.3
	Corn	2	0.2	0-0.3
	Noodles, Chinese or Japanese style	1	0.1	0-0.3
Heptachlor (3)	Peanut butter	2	0.1	0-0.2
	Fish, Salmon	1	0.1	0-0.2
	Potato chips	1	0.1	0-0.3
HCB (64)	Bread, plain	2	0.1	0-0.3
	Bread, raisin	3	0.2	0-0.2
	"Pineapple" bun	4	0.2	0.1-0.2
	Sausage/ham/luncheon meat bun	4	0.3	0.2-0.3
	Chinese steamed bread	1	0.1	0-0.2
	Biscuits	2	0.1	0-0.1
	Cakes	2	0.1	0-0.2
	Pastries	4	0.2	0.1-0.2
	Pastries, Chinese	3	1.1	0-4.1
	Breakfast cereals	1	0.0	0-0.1
	Potato	2	0.2	0-0.7
	Potato, fried	1	0.1	0-0.2
	Spinach	2	0.1	0-0.2
	Cucumber	1	0.1	0-0.5
	Pumpkin	1	0.0	0-0.1
	Zucchini	2	0.1	0-0.2
	Mushrooms	1	0.0	0-0.1
	Fermented bean products	2	0.1	0-0.1
	Peanut	2	0.1	0-0.2
	Peanut butter	2	0.1	0-0.1
	Apple	1	0.0	0-0.1
	Beef	4	1.2	0.4-1.9
	Mutton	4	1.0	0.9-1.2
	Pork	4	0.5	0.2-1.1
	Ham	4	0.2	0.1-0.3
	Luncheon meat	4	0.9	0.6-1.2
	Barbecued pork	4	0.9	0.4-1.7
	Roasted pork	4	0.7	0.3-1.3
	Pig liver	2	0.1	0-0.3
	Chicken meat	4	1.5	0.4-4.4
	Chicken, soy sauce	4	0.9	0.6-1.3
	Roasted duck/goose	4	0.6	0.5-0.7
	Meat sausage	4	0.4	0.2-0.9
	Egg, chicken	3	0.2	0-0.4
	Egg, lime preserved	4	1.0	0.3-2.3
	Egg, salted	4	0.6	0.4-0.8
	Fish, Big head	4	0.6	0.4-0.8
	Fish, Mandarin fish	3	0.4	0-1.0
	Fish, Grass carp	4	1.0	0.8-1.5
	Fish, Golden thread	4	0.3	0.2-0.3
	Fish, Grouper	3	0.1	0-0.2

Substances (no. food items with detectable levels)	TDS Food Item*	No. composite Samples with detectable levels*	Mean# (μg/kg)	Range # (μg/kg)
	Fish, Horse head	4	0.2	0.2-0.3
	Fish, Pomfret	4	0.3	0.1-0.7
	Fish, Grey mullet	4	0.8	0.5-1.2
	Fish, Salmon	4	1.6	1.3-1.8
	Fish, Yellow croaker	4	0.8	0.7-0.9
	Fish, Dace, minced	4	0.4	0.2-0.7
	Shrimp/ Prawn	1	0.1	0-0.3
	Crab	2	0.2	0-0.6
	Squid	1	0.0	0-0.1
	Cheese	2	0.1	0-0.3
	Ice-cream	1	0.1	0-0.2
	Butter	4	1.2	0.7-1.7
	Siu Mai	4	0.3	0.2-0.4
	Dumpling, steamed	3	0.2	0-0.4
	Dumpling, pan-fried	4	0.2	0.1-0.3
	Dumpling, including wonton	4	0.2	0.1-0.3
	Steamed barbecued pork bun	3	0.2	0-0.2
	Turnip cake	1	0.0	0-0.1
	Steamed minced beef ball	3	0.2	0-0.2
	Glutinous rice dumpling	3	0.1	0-0.2
	Hamburger	2	0.1	0-0.2
	Potato chips	1	0.1	0-0.4
	Chocolate	1	0.0	0-0.1
HCH (α,β,γ and δ) (28)	Pastries, Chinese	1	0.3	0-1.1
	Sweet pepper	1	0.1	0-0.5
	Garlic	2	0.3	0-0.9
	Beancurd	1	0.1	0-0.4
	Peanut	4	2.3	1.1-4.2
	Peanut butter	2	0.8	0-2.0
	Pummelo /Grapefruit	1	0.2	0-0.9
	Beef	2	0.9	0-2.0
	Mutton	2	8.8	0-33
	Barbecued pork	1	0.3	0-1.2
	Roasted duck/goose	1	0.4	0-1.5
	Egg, lime preserved	1	0.1	0-0.3
	Fish, Big head	1	0.2	0-0.7
	Fish, Mandarin fish	2	0.2	0-0.4
	Fish, Grass carp	2	0.7	0-2.1
	Fish, Grouper	1	0.1	0-0.4
	Fish, Pomfret	1	0.2	0-0.9
	Fish, Grey mullet	2	0.9	0-2.7
	Fish, Yellow croaker	1	0.2	0-0.7
	Fish, Dace, minced	1	0.1	0-0.4
	Scallop	1	0.3	0-1.1
	Butter	1	1.6	0-6.4
	Siu Mai	2	0.3	0-0.7
	Dumpling, including wonton	1	0.2	0-0.7
	Steamed barbecued pork bun	1	0.3	0-1.2
	Steamed minced beef ball	2	0.3	0-1.0
	Glutinous rice dumpling	2	0.2	0-0.7

Substances (no. food items with detectable levels)	TDS Food Item*	No. composite Samples with detectable levels*	Mean# (μg/kg)	Range # (μg/kg)
	Potato chips	1	1.2	0-4.8
Lindane (6)	Pastries, Chinese	1	0.3	0-1.1
	Sweet pepper	1	0.1	0-0.5
	Garlic	2	0.3	0-0.9
	Peanut	1	0.1	0-0.5
	Pummelo /Grapefruit	1	0.2	0-0.9
	Steamed minced beef ball	1	0.3	0-1.0
Mirex (6)	Cakes	1	0.0	0-0.1
	Chicken, soy sauce	2	0.1	0-0.2
	Fish, Big head	1	0.1	0-0.5
	Fish, Pomfret	2	0.1	0-0.1
	Fish, Yellow croaker	4	0.2	0.1-0.2
	Crab	1	0.0	0-0.1
Pentachlorobenzene (25)	Bread, plain	2	0.2	0-0.5
	Bread, raisin	3	0.3	0-0.4
	"Pineapple" bun	4	0.3	0.2-0.4
	Sausage/ham/luncheon meat bun	4	0.3	0.2-0.3
	Chinese steamed bread	4	0.2	0.1-0.2
	Pastries	3	0.1	0-0.2
	Pastries, Chinese	1	0.1	0-0.3
	Potato	2	0.2	0-0.5
	Potato, fried	4	0.5	0.2-0.7
	Lettuce, Chinese	1	0.0	0-0.1
	Cucumber	1	0.1	0-0.3
	Zucchini	1	0.1	0-0.5
	Peanut butter	1	2.5	0-10
	Roasted duck/goose	1	0.1	0-0.2
	Egg, lime preserved	2	0.1	0-0.1
	Egg, salted	2	0.1	0-0.1
	Fish, Big head	1	0.1	0-0.2
	Fish, Mandarin fish	3	0.4	0-1.0
	Fish, Grass carp	2	0.1	0-0.3
	Fish, Pomfret	3	0.2	0-0.3
	Fish, Grey mullet	2	0.1	0-0.3
	Fish, Yellow croaker	3	0.2	0-0.3
	Fish, Dace, minced	2	0.1	0-0.2
	Dumpling, pan-fried	2	0.1	0-0.3
	Steamed barbecued pork bun	4	0.2	0.1-0.3
Toxaphene (2)	Peanut butter	3	0.9	0-1.7
	Fish, Salmon	4	4.5	3.5-5.2

* Four composite samples were tested for each TDS food item.

Non-detects were assumed to be 0 μg/kg. Mean levels below 1.0 μg/kg have been rounded to one significant figure and levels equal to or above 1.0 μg/kg have been rounded to two significant figures.

Table B2: TDS food items that were not detected with any OCP residues

No.	TDS Food Item	No.	TDS Food Item
1	Pasta, Western style	22	Watermelon
2	Instant noodles	23	Fish, Sole
3	Noodles, rice	24	Milk, whole
4	Oatmeal	25	Milk, skim
5	Carrot/ Radish	26	Beer
6	Broccoli	27	Red wine
7	Cabbage, Chinese	28	Tea, Chinese
8	Cabbage, European variety	29	Tea, Milk tea
9	Mung bean sprout	30	Malt drink
10	Onion	31	Soybean drink
11	Mushroom, dried shiitake	32	Fruit and vegetable juice
12	Ear fungus	33	Carbonated drink
13	Mung bean vermicelli	34	Tea, chrysanthemum
14	Banana	35	Water, bottled, distilled
15	Dragon fruit	36	Water, drinking
16	Kiwi fruit	37	Chinese soup
17	Papaya	38	Granulated white sugar
18	Peach	39	Table salt
19	Persimmon	40	Soya sauce
20	Pineapple	41	Cornstarch
21	Plum		

Appendix C

Table C1: Lower bound dietary exposures (μg/kg bw/day) to OCP residues and percentage contribution to the HBGVs by age-gender groups

		Dietary Exposure Estimate (μg/kg bw/day) (percentage contribution to HBGVs)																							
	Age	20-29				30-39				40-49				50-59				60-69				70-84			
	Gender	Male		Female		Male		Female		Male		Female		Male		Female		Male		Female		Male		Female	
			%		%		%		%		%		%		%		%		%		%		%		%
Aldrin+ Dieldrin	Average	0.0003	0.3	0.0003	0.3	0.0004	0.4	0.0003	0.3	0.0003	0.3	0.0003	0.3	0.0003	0.3	0.0003	0.3	0.0002	0.2	0.0002	0.2	0.0001	0.1	0.0001	0.1
	High Consumers	0.0013	1.3	0.0012	1.2	0.0014	1.4	0.0014	1.4	0.0013	1.3	0.0012	1.2	0.0012	1.2	0.0012	1.2	0.0010	1.0	0.0008	0.8	0.0008	0.8	0.0007	0.7
Chlordane	Average	0.0002	0	0.0002	0	0.0002	0	0.0003	0.1	0.0002	0	0.0003	0.1	0.0002	0	0.0002	0	0.0002	0	0.0002	0	0.0002	0	0.0002	0
	High Consumers	0.0010	0.2	0.0011	0.2	0.0011	0.2	0.0014	0.3	0.0010	0.2	0.0011	0.2	0.0009	0.2	0.0009	0.2	0.0008	0.2	0.0009	0.2	0.0007	0.1	0.0009	0.2
DDT	Average	0.0116	0.1	0.0170	0.2	0.0161	0.2	0.0252	0.3	0.0214	0.2	0.0232	0.2	0.0288	0.3	0.0289	0.3	0.0315	0.3	0.0315	0.3	0.0314	0.3	0.0360	0.4
	High Consumers	0.0412	0.4	0.0591	0.6	0.0556	0.6	0.1043	1.0	0.0799	0.8	0.0795	0.8	0.1068	1.1	0.1171	1.2	0.1151	1.2	0.1113	1.1	0.1230	1.2	0.1159	1.2
Dicofol	Average	0.0007	0	0.0006	0	0.0006	0	0.0005	0	0.0006	0	0.0005	0	0.0005	0	0.0004	0	0.0005	0	0.0004	0	0.0005	0	0.0004	0
	High Consumers	0.0025	0.1	0.0025	0.1	0.0018	0.1	0.0020	0.1	0.0018	0.1	0.0017	0.1	0.0016	0.1	0.0015	0.1	0.0012	0.1	0.0011	0.1	0.0013	0.1	0.0009	0
Endosulfan	Average	0.0061	0.1	0.0073	0.1	0.0063	0.1	0.0094	0.2	0.0075	0.1	0.0101	0.2	0.0095	0.2	0.0097	0.2	0.0096	0.2	0.0096	0.2	0.0083	0.1	0.0094	0.2
	High Consumers	0.0189	0.3	0.0206	0.3	0.0181	0.3	0.0305	0.5	0.0214	0.4	0.0306	0.5	0.0282	0.5	0.0318	0.5	0.0284	0.5	0.0286	0.5	0.0249	0.4	0.0311	0.5
Endrin	Average	0.0011	0.5	0.0007	0.4	0.0010	0.5	0.0008	0.4	0.0011	0.5	0.0008	0.4	0.0011	0.6	0.0009	0.4	0.0013	0.7	0.0010	0.5	0.0014	0.7	0.0011	0.5
	High Consumers	0.0023	1.1	0.0017	0.8	0.0021	1.1	0.0017	0.8	0.0023	1.1	0.0017	0.9	0.0022	1.1	0.0018	0.9	0.0026	1.3	0.0021	1.0	0.0026	1.3	0.0021	1.0
HCB	Average	0.0029	0.4	0.0025	0.3	0.0028	0.3	0.0025	0.3	0.0026	0.3	0.0023	0.3	0.0025	0.3	0.0022	0.3	0.0022	0.3	0.0019	0.2	0.0020	0	0.0018	0.2
	High Consumers	0.0064	0.8	0.0055	0.7	0.0052	0.7	0.0054	0.7	0.0054	0.7	0.0048	0.6	0.0052	0.7	0.0048	0.6	0.0049	0.6	0.0043	0.5	0.0044	0	0.0042	0.5
HCH (α,β,γ and δ)	Average	0.0010	0	0.0007	0	0.0009	0	0.0008	0	0.0009	0	0.0007	0	0.0009	0	0.0007	0	0.0008	0	0.0007	0	0.0007	0	0.0006	0
	High Consumers	0.0023	0	0.0023	0	0.0025	0	0.0022	0	0.0022	0	0.0020	0	0.0025	0	0.0021	0	0.0025	0.1	0.0021	0	0.0024	0	0.0019	0
Lindane (γ-HCH)	Average	0	0	0.0001	0	0	0	0.0001	0	0.0001	0	0.0001	0	0.0001	0	0.0001	0	0.0001	0	0.0001	0	0	0	0	0
	High Consumers	0.0001	0	0.0002	0	0.0002	0	0.0002	0	0.0003	0	0.0003	0	0.0003	0	0.0003	0	0.0002	0	0.0003	0	0.0003	0	0.0002	0
Heptachlor	Average	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	High Consumers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mirex	Average	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	High Consumers	0.0001	0	0.0001	0	0.0001	0	0.0001	0.1	0.0001	0	0.0001	0.1	0.0001	0.1	0.0001	0	0.0001	0	0.0001	0.1	0.0001	0.1	0.0001	0.1
Pentachloro -benzene	Average	0.0003	0	0.0004	0	0.0003	0	0.0004	0	0.0003	0	0.0003	0	0.0003	0	0.0003	0	0.0003	0	0.0003	0	0.0003	0	0.0003	0
	High Consumers	0.0008	0.1	0.0009	0.1	0.0007	0.1	0.0010	0.1	0.0007	0.1	0.0009	0.1	0.0008	0.1	0.0009	0.1	0.0009	0.1	0.0008	0.1	0.0007	0.1	0.0008	0.1
Toxaphene	Average	0.0002	0	0.0002	0	0.0002	0	0.0002	0	0.0002	0	0.0002	0	0.0001	0	0.0002	0	0.0001	0	0.0001	0	0.0001	0	0.0001	0
	High Consumers	0.0014	0.1	0.0013	0.1	0.0015	0.1	0.0015	0.1	0.0013	0.1	0.0013	0.1	0.0004	0	0.0014	0.1	0.0001	0	0.0007	0	0	0	0.0001	0

Note:

- Exposures of high consumers refer to the exposures at 95th percentile.
- Figures of dietary exposure estimates and percentage contributions to HBGVs were rounded to four decimal places
- Values of "0" denote < 0.00005 μg/kg bw/day for dietary exposure estimates and < 0.05% for contributions to HBGVs.
- Since chlordecone has not been detected in any composite samples, no dietary exposure was estimated and presented.

Table C2: Upper bound dietary exposures (μg/kg bw/day) to OCP residues and percentage contribution to the HBGVs by age-gender groups

		Dietary Exposure Estimate (μg/kg bw/day) (percentage contribution to HBGVs)																							
	Age	20-29				30-39				40-49				50-59				60-69				70-84			
	Gender	Male		Female		Male		Female		Male		Female		Male		Female		Male		Female		Male		Female	
			%		%		%		%		%		%		%		%		%		%		%		%
Aldrin+	Average	0.0058	5.8	0.0058	5.8	0.0060	6.0	0.0061	6.1	0.0061	6.1	0.0060	6.0	0.0062	6.2	0.0058	5.8	0.0059	5.9	0.0053	5.3	0.0052	5.2	0.0051	5.1
Dieldrin	High Consumers	0.0093	9.3	0.0096	9.6	0.0099	9.9	0.0102	10.2	0.0099	9.9	0.0095	9.5	0.0100	10.0	0.0096	9.6	0.0098	9.8	0.0090	9.0	0.0084	8.4	0.0083	8.3
Chlordane	Average	0.0140	2.8	0.0140	2.8	0.0143	2.9	0.0148	3.0	0.0147	2.9	0.0145	2.9	0.0149	3.0	0.0141	2.8	0.0144	2.9	0.0131	2.6	0.0129	2.6	0.0125	2.5
	High Consumers	0.0225	4.5	0.0228	4.6	0.0234	4.7	0.0235	4.7	0.0230	4.6	0.0232	4.6	0.0239	4.8	0.0227	4.5	0.0236	4.7	0.0224	4.5	0.0208	4.2	0.0206	4.1
DDT	Average	0.0276	0.3	0.0328	0.3	0.0323	0.3	0.0419	0.4	0.0380	0.4	0.0395	0.4	0.0457	0.5	0.0448	0.4	0.0477	0.5	0.0463	0.5	0.0459	0.5	0.0500	0.5
	High Consumers	0.0601	0.6	0.0757	0.8	0.0716	0.7	0.1213	1.2	0.0969	1.0	0.0930	0.9	0.1303	1.3	0.1301	1.3	0.1375	1.4	0.1254	1.3	0.1376	1.4	0.1327	1.3
Dicofol	Average	0.0061	0.3	0.0061	0.3	0.0061	0.3	0.0063	0.3	0.0062	0.3	0.0061	0.3	0.0063	0.3	0.0059	0.3	0.0060	0.3	0.0055	0.3	0.0054	0.3	0.0052	0.3
	High Consumers	0.0101	0.5	0.0103	0.5	0.0099	0.5	0.0102	0.5	0.0100	0.5	0.0096	0.5	0.0100	0.5	0.0095	0.5	0.0099	0.5	0.0095	0.5	0.0089	0.4	0.0086	0.4
Endosulfan	Average	0.0142	0.2	0.0152	0.3	0.0146	0.2	0.0178	0.3	0.0159	0.3	0.0183	0.3	0.0180	0.3	0.0176	0.3	0.0177	0.3	0.0170	0.3	0.0155	0.3	0.0164	0.3
	High Consumers	0.0300	0.5	0.0297	0.5	0.0280	0.5	0.0417	0.7	0.0314	0.5	0.0400	0.7	0.0390	0.7	0.0413	0.7	0.0379	0.6	0.0376	0.6	0.0321	0.5	0.0413	0.7
Endrin	Average	0.0090	4.5	0.0088	4.4	0.0091	4.6	0.0093	4.6	0.0094	4.7	0.0091	4.5	0.0096	4.8	0.0089	4.5	0.0094	4.7	0.0084	4.2	0.0085	4.3	0.0081	4.1
	High Consumers	0.0144	7.2	0.0143	7.1	0.0148	7.4	0.0146	7.3	0.0150	7.5	0.0142	7.1	0.0149	7.4	0.0145	7.3	0.0157	7.9	0.0139	7.0	0.0133	6.6	0.0134	6.7
Heptachlor	Average	0.0084	8.4	0.0083	8.3	0.0085	8.5	0.0088	8.8	0.0087	8.7	0.0086	8.6	0.0089	8.9	0.0084	8.4	0.0086	8.6	0.0078	7.8	0.0077	7.7	0.0075	7.5
	High Consumers	0.0134	13.4	0.0135	13.5	0.0140	14.0	0.0138	13.8	0.0137	13.7	0.0138	13.8	0.0143	14.3	0.0135	13.5	0.0141	14.1	0.0134	13.4	0.0122	12.2	0.0122	12.2
HCB	Average	0.0052	0.7	0.0049	0.6	0.0051	0.6	0.0050	0.6	0.0051	0.6	0.0047	0.6	0.0050	0.6	0.0046	0.6	0.0047	0.6	0.0041	0.5	0.0042	0.5	0.0039	0.5
	High Consumers	0.0098	1.2	0.0085	1.1	0.0084	1.1	0.0087	1.1	0.0088	1.1	0.0080	1.0	0.0086	1.1	0.0079	1.0	0.0083	1.0	0.0070	0.9	0.0073	0.9	0.0070	0.9
HCH	Average	0.0121	0.2	0.0117	0.2	0.0122	0.2	0.0125	0.2	0.0125	0.2	0.0121	0.2	0.0127	0.3	0.0118	0.2	0.0121	0.2	0.0110	0.2	0.0109	0.2	0.0104	0.2
(α,β,γ and δ)	High Consumers	0.0201	0.4	0.0194	0.4	0.0199	0.4	0.0200	0.4	0.0195	0.4	0.0195	0.4	0.0208	0.4	0.0197	0.4	0.0199	0.4	0.0185	0.4	0.0171	0.3	0.0170	0.3
Lindane	Average	0.0028	0.1	0.0028	0.1	0.0029	0.1	0.0030	0.1	0.0030	0.1	0.0029	0.1	0.0030	0.1	0.0029	0.1	0.0029	0.1	0.0026	0.1	0.0026	0.1	0.0025	0.1
(γ-HCH)	High Consumers	0.0045	0.1	0.0047	0.1	0.0047	0.1	0.0047	0.1	0.0046	0.1	0.0047	0.1	0.0049	0.1	0.0046	0.1	0.0048	0.1	0.0045	0.1	0.0042	0.1	0.0042	0.1
Mirex	Average	0.0028	1.4	0.0028	1.4	0.0028	1.4	0.0029	1.5	0.0029	1.5	0.0029	1.4	0.0030	1.5	0.0028	1.4	0.0029	1.4	0.0026	1.3	0.0026	1.3	0.0025	1.2
	High Consumers	0.0045	2.2	0.0045	2.3	0.0047	2.3	0.0047	2.3	0.0046	2.3	0.0046	2.3	0.0048	2.4	0.0045	2.2	0.0047	2.4	0.0045	2.2	0.0041	2.0	0.0041	2.0
Pentachloro	Average	0.0030	0.4	0.0030	0.4	0.0030	0.4	0.0032	0.4	0.0031	0.4	0.0031	0.4	0.0032	0.4	0.0030	0.4	0.0031	0.4	0.0028	0.3	0.0027	0.3	0.0027	0.3
-benzene	High Consumers	0.0048	0.6	0.0048	0.6	0.0050	0.6	0.0050	0.6	0.0049	0.6	0.0049	0.6	0.0049	0.6	0.0049	0.6	0.0052	0.6	0.0047	0.6	0.0043	0.5	0.0043	0.5
Toxaphene	Average	0.0169	0.8	0.0168	0.8	0.0172	0.9	0.0178	0.9	0.0176	0.9	0.0173	0.9	0.0179	0.9	0.0170	0.8	0.0172	0.9	0.0157	0.8	0.0155	0.8	0.0150	0.7
	High Consumers	0.0268	1.3	0.0273	1.4	0.0283	1.4	0.0283	1.4	0.0276	1.4	0.0278	1.4	0.0287	1.4	0.0273	1.4	0.0285	1.4	0.0269	1.3	0.0246	1.2	0.0247	1.2

Note:

- Exposures of high consumers refer to the exposures at 95th percentile.
- Figures of dietary exposure estimates and percentage contributions to HBGVs were rounded to four and one decimal places, respectively.
- Values of "0" denote < 0.00005 μg/kg bw/day for dietary exposure estimates and < 0.05% for contributions to HBGVs.
- Since chlordecone has not been detected in any composite samples, no dietary exposure was estimated and presented.

Appendix D

Dietary exposure estimates (µg/kg bw/day) for selected OCP residues of total diet studies from different countries

	China[25]	Canada[26]	France[27]	Australia[28]	New Zealand[29]		This study
Target group	Men 18-45	All age	Adults	Adults 17 yrs or above	25+yr males	25+yr females	Adults (20-84)
Treatment of not detected (ND) values	ND=0	ND=0	ND=0 and ND=LOD	ND=0	ND=0	ND=0	ND=0 and ND=LOD
Name of pesticides							
Aldrin and Dieldrin	NA	NA	NA	0.0059(mean)[a] 0.012(P90) [a]	0.00004 (mean) [a]	0.00005 (mean) [a]	0.0003-0.0059 (mean) 0.0012-0.0096 (P95)
Chlordane	0.006 (mean) 0.013 (P95)	0.001 (mean)	NA	NA	NA	NA	0.0002-0.0142 (mean) 0.0010-0.0230 (P95)
DDT	0.016 (mean) 0.052 (P95)	0.006 (mean)	NA	NA	0.0099 (mean)[b]	0.0073 (mean)[b]	0.0238-0.0399 (mean) 0.0912-0.1099 (P95)
Dicofol	NA	0.003 (mean)	NA	0.011(mean) 0.031(P90)	0.00002 (mean)	0.00003 (mean)	0.0005-0.0060(mean) 0.0018-0.0098 (P95)
Endosulfan	NA	0.017 (mean)	0.001 - 0.415 (mean) 0.005 - 0.713 (P95)	0.033(mean) 0.072(P90)	0.0031 (mean)	0.0036 (mean)	0.0085-0.0166(mean) 0.0258-0.0359(P95)
Endrin	NA	0.000 (mean)	NA	NA	NA	NA	0.0010-0.0091 (mean) 0.0021-0.0145(P95)
Heptachlor	0.001 (mean) 0.001 (P95)	0.001 (mean)	NA	NA	NA	NA	0-0.0084(mean) 0-0.0136 (P95)
HCB	0.009 (mean) 0.015 (P95)	0.001 (mean)	0.000 - 0.103 (mean) 0.000 - 0.185 (P95)	NA	NA	NA	0.0024-0.0048 (mean) 0.0052-0.0084 (P95)
HCH	0.002 (mean) 0.007 (P95)	0.004 (mean)	NA	NA	NA	NA	0.0008-0.0120 (mean) 0.0023-0.0195 (P95)
-Lindane (γHCH)	NA	NA	0.001 - 0.176 (mean) 0.01 - 0.287 (P95)	NA	NA	NA	0.0001-0.0029 (mean) 0.0002-0.0046 (P95)

Notes:
-LOD=limit of detection; NA=not available; P95=95th percentile; P90=90th percentile.
-Mean exposure estimates of Australia were expressed as per kg bw/day by taking an average body of 74 kg reported in its study.
-[a]Exposure estimates were for dieldrin only as aldrin was not detected in any samples
-[b]Exposure estimates were for DDE-4.4' only as other related DDT compounds were not detected in any samples.