The First Hong Kong Total Diet Study: Metallic Contaminants

11-1-2013

The 1st HKTDS

- First time carrying out in HK
- Period:2010-2014
- Objectives:
  - To estimate the dietary exposures of the HK population and various population subgroups to a range of substances, including contaminants and nutrients
  - To assess any associated health risks

The 1st HKTDS (2)

- **Food consumption data**
  - Hong Kong Population-Based Food Consumption Survey (FCS) 2005-2007
- **Cover 150 food items and over 130 substances**
  - Pesticide residues, POPs, metallic contaminants, mycotoxins, macro nutrients, elements, etc.
- **Released reports**

1. Dioxins and Dioxin-like Polychlorinated Biphenyls (PCBs)
2. Inorganic Arsenic
3. Polybrominated Diphenyl Ethers (PBDEs)
4. Pesticide Residues

The 5th Report: Metallic Contaminants

- Diet is the main source of exposure to common metallic contaminants, e.g. lead, cadmium, and methylmercury for ordinary adults
- Acute toxicity due to normal consumption of food is unlikely
- Chronic toxicity is the main concern for general population

Scope

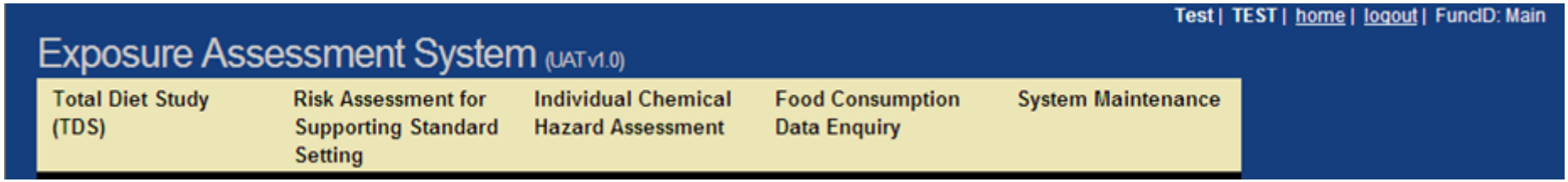
1. Aluminium
2. Antimony
3. Cadmium
4. Lead
5. Methylmercury
6. Nickel
7. Tin

Methodology

- **Food sampling and preparation:** 4 occasions from March 2010 to February 2011
  - Samples were collected and prepared as consumed
  - A total of 1800 samples were collected and combined into 600 composite samples
- **Laboratory Analysis:** by the Food Research Laboratory (FRL)
  - Methylmercury: 204 composite samples of 51 food items (mainly foods from animal origin)
  - Other metallic contaminants: 600 composite samples of 150 food items

Dietary exposure estimation

- Perform with the aid of an in-house developed web-based computer system called “EASY” (Exposure Assessment System)
- Involve food mapping and weighting of data
- Average: mean of exposure level
- High consumer: 95th percentile of exposure level



Summary of Exposure Estimates

Contaminant	Health-based Guideline Value or Reference Dose	% Contribution of dietary exposure to Reference Health Standard	
		Average Consumers	High Consumers (95th percentile)
Aluminium	PTWI: 2 mg/kg bw/week	30%	77%
Antimony	TDI: 6 µg/kg bw/day	0.3-0.7%	0.5-1.1%
Cadmium	PTMI: 25 µg/kg bw/month	33%	75%
Lead	1.2 µg/kg bw/day	MOE=6	MOE=3
Methylmercury	PTWI: 3.3 µg/kg bw/week	22%	82%
Nickel	TDI: 12 µg/kg bw/day	26%	48%
Tin	PTWI: 14 mg/kg bw/week	0.2%	1.1-1.2%

Aluminum-Toxicity

- Animal studies : may affect development
- JECFA 2011 established a PTWI of 2mg/kg bw for aluminium

Concentrations of Al in TDS Foods

- LOD:100 µg/kg general food, 20 µg/kg water & tea
- 31% of results<LOD
- Range : ND-450 mg/kg
- The highest Al level : “Cereals and their products”(mean:20 mg/kg, range:ND-450 mg/kg)

Concentrations in Al TDS Foods (2)

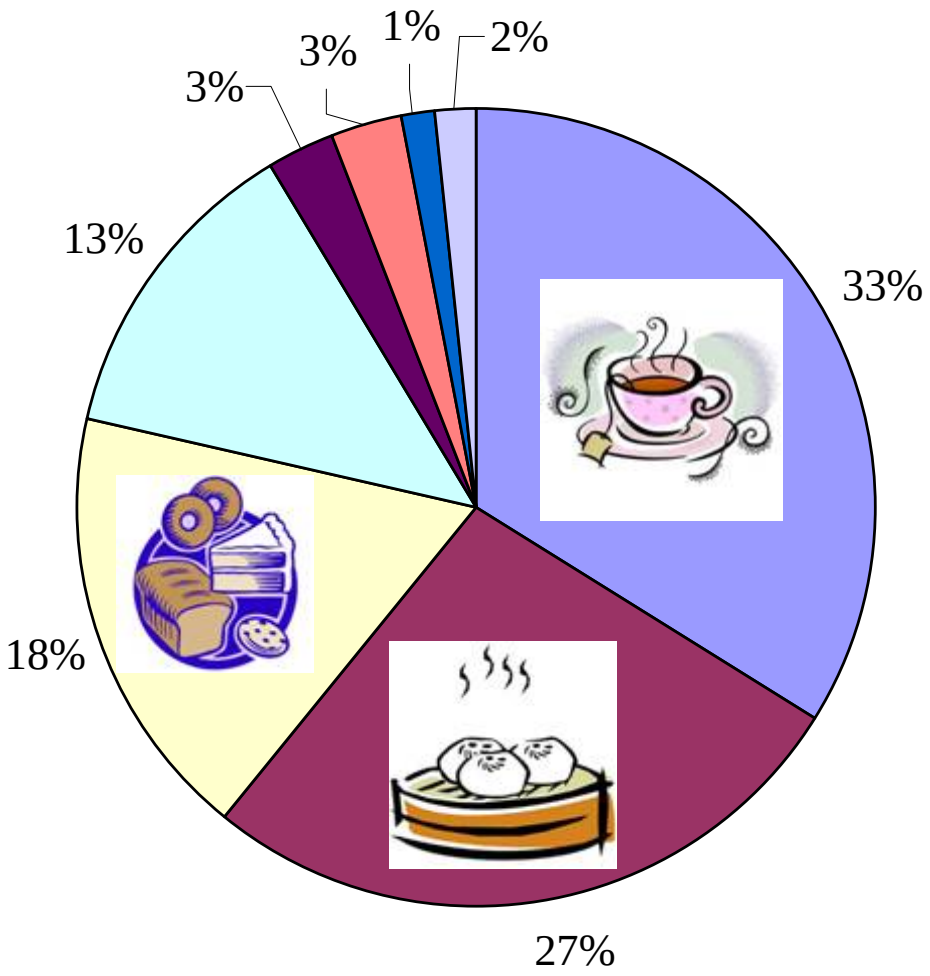
Food Items	Mean [mg/kg]	Range [mg/kg]
1. Deep fried dough	250	50-450
Previous study	46	2-330
2. Steamed barbecued pork bun	170	110-240
Previous study	150	37-220
3. Oyster	62	20-110

Dietary Exposures to Al of Average and High Consumers

	Average	High Consumer
Dietary Exposure (mg/kg bw/week)	0.60	1.5
% PTWI	30%	77%

PTWI =2 mg/kg bw/week

Major Food Contributors to Aluminium Exposure



A Comparison of Dietary Exposures to Aluminium

Places	Dietary exposure of adult (mg/kg bw/week)	
	Average	High Consumer
Europe 2008	0.2-1.3	-
Australia 2011	0.27-0.28	0.51-0.52 (90th percentile)
Ireland 2011	0.35	0.77 (97.5th percentile)
UK 2006	0.50	1.0 (97.5th percentile)
Hong Kong 2012	0.60	1.5 (95th percentile)
Hong Kong 2009	0.60	-
Canada 2007	0.63-0.81	-
China 2011	0.64-2.9	-
USA 1995	0.70–0.90	-

Cadmium Toxicity

- Kidney is the critical target organ
- IARC 1993: cadmium and cadmium compounds -Group 1 agents (i.e. carcinogenic to humans) upon occupational exposure
- No significant genotoxic and carcinogenic potential by the oral route
- JECFA in 2010 established a Provisional Tolerable Monthly Intake (PTMI) of 25 µg/kg bw to cadmium

Concentrations of Cd in TDS Foods

- LOD: 2 µg/kg general food, 0.4 µg/kg water & tea
- 42%of results<LOD
- Range : ND-1800 µg/kg
- The highest Cd level :“fish and seafood and their products” (mean: 150 µg/kg, range: ND-1800 µg/kg)

Concentrations in Cd TDS Foods (2)

Food Items	Mean [µg/kg]	Range [µg/kg]
1. Oyster	1300	1000-1800
2. Scallop	730	340-1200
3. Crab	540	260-890
4. Mushroom, dried shiitake	240	190-310

Concentrations of Cd in TDS Foods (2)

- 9 composite samples (including 1 Petiole Chinese cabbage, 1 Chinese spinach, 1 spinach, 1 watercress, 1 leaf mustard, and 4 dried shiitake mushroom samples) exceeded legal limit of 0.1 mg/kg for vegetables

- Follow-up: 17 individual samples exceeded legal limit [range 0.12-0.46 mg/kg]

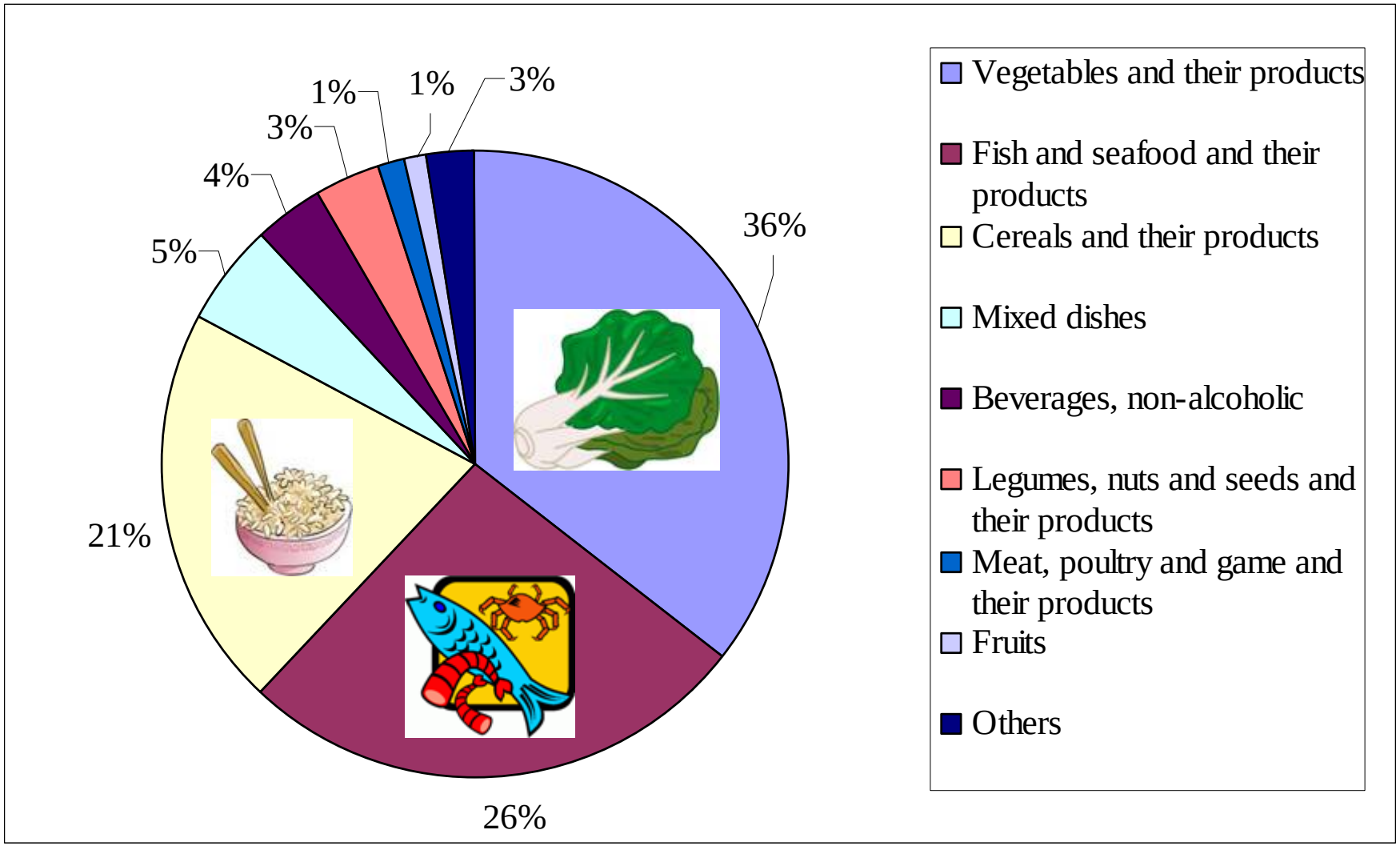
- Case referred to FSCD : 2 samples exceeded legal limit. Results were announced in the Food Safety Report of the CFS for May 2012

Dietary Exposures to Cd of Average and High Consumers

	Average	High
Dietary Exposure (µg/kg bw/month)	8.3	19
% PTMI	33%	75%

PTMI 25 µg/kg bw/month

Major Food Contributors to Cadmium Exposure



A Comparison of Dietary Exposures to Cadmium

Places	Dietary exposure of adult (μg/kg bw/month)	
	Average	High Consumer
Australia 2011	2.8-3.4	5.2-5.8 (90th percentile)
USA 2002	3.2-6.3	-
UK 2006	4.2-5.1	7.5-8.7 (97.5th percentile)
Canada 2007	4.5-7.5	-
New Zealand 2009	5.5-6.8	-
Europe 2012	7.6	13.4 (95th percentile)
South Korea 2006	7.7	-
Hong Kong 2012	8.3	19 (95th percentile)
Hong Kong 2002	11	24 (95th percentile)
Ireland 2011	10-13	23-26 (97.5th percentile)
China 2006	11	-
Japan 2011	12	-

MeHg - Toxicity

- MeHg is more toxic than inorganic mercury
- Primary health effect in foetuses, infants, and children:impaired neurological development
- MeHg exposure in the womb, which can result from a mother's consumption of fish and shellfish that contain MeHg, can adversely affect a baby's growing brain and nervous system

MeHg-Health-based guideline value

- JECFA 2003 : PTWI : 1.6 μg/kg bw/week for MeHg in order to protect the developing foetus from neurotoxic effects
  - Applies to children (up to ~ 17 yrs) and pregnant women

- JECFA 2006 : life-stages other than the embryo and foetus may be less sensitive to the adverse effects of MeHg. For adults, up to about twice the PTWI (i.e. 3.3 μg/kg bw/week)would not pose any risk of neurotoxicity

Concentrations of MeHg in TDS Foods

- LOD: 0.3 µg/kg
- 26% results<LOD [0.3 µg/kg]
- Range: ND-450 µg/kg
- Mean conc. in fish and seafood and their product: 68 µg/kg
- None exceeded Codex standards of 1000 µg/kg for large predatory fish and 500 µg/kg for all other fish
- Food samples other than fish and seafood has low level of methylmercury

Concentrations of MeHg in Fish

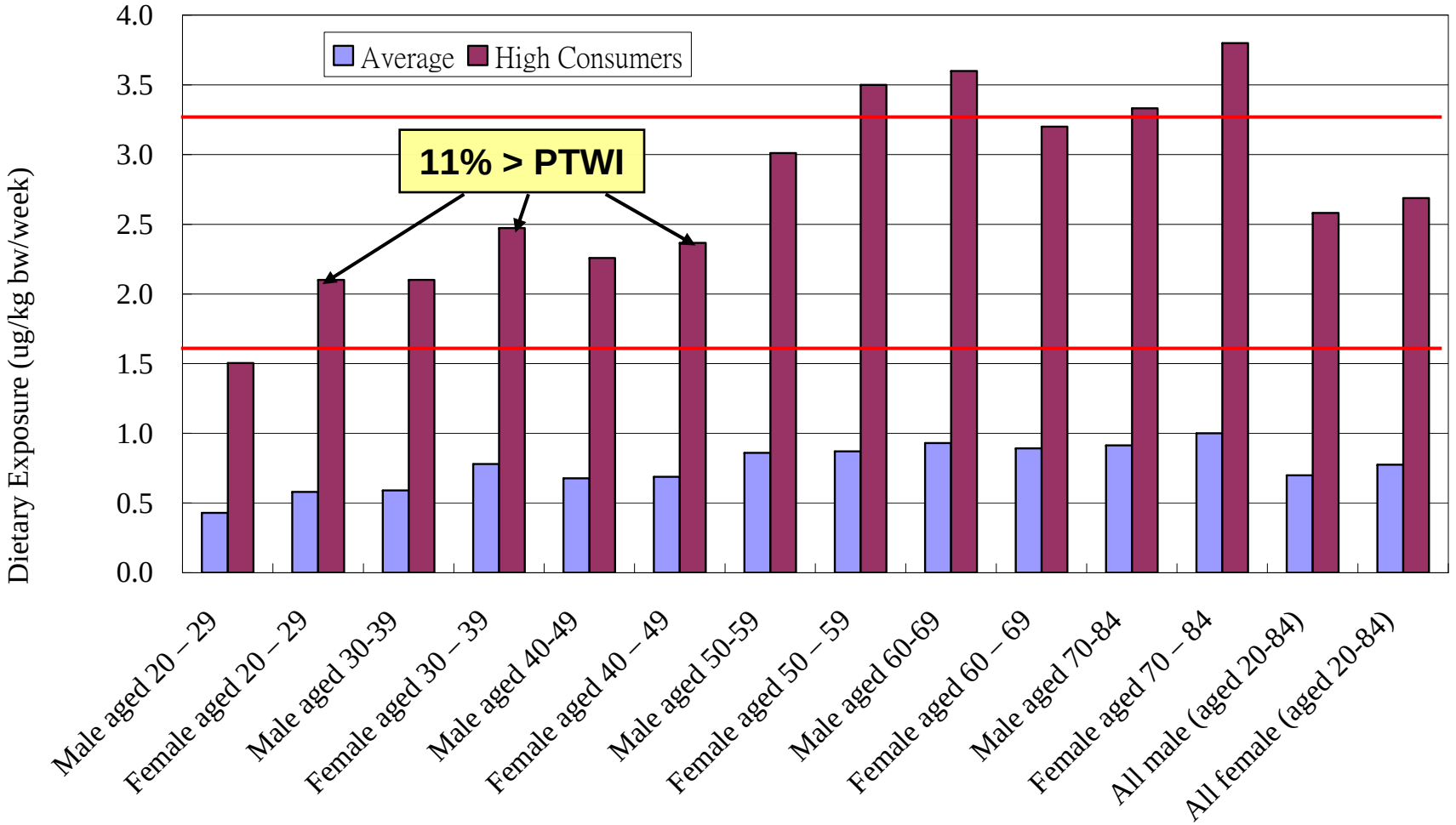
Fish	Mean (μg/kg)	Range ((μg/kg)
Tuna 吞拿魚 / 金槍魚	330	150-450
Grouper 海斑	160	100-240
Horse-head (Tilefish) 馬頭	160	63-250
Golden thread 紅衫	130	87-160
Mandarin fish 桂花魚	100	80-140
Yellow croaker 黃花魚	66	49-100
Big head 大頭魚	49	33-79
Pomfret 鯧魚(鯰魚)	36	26-42
Dace, minced 絞鯪魚肉	34	30-37
Salmon 三文魚	29	26-30
Grey mullet 烏頭	21	16-24
Sole fillet 龍脷柳	7.9	4.8-11
Grass carp 鯇魚	4.5	4.0-5.0

Dietary Exposures to MeHg of Average and High Consumers

	Average	High
Dietary Exposure (μg/kg bw/week)	0.74	2.7
% PTWI	22%	82%

PTWI for general population :3.3 μg/kg bw/week

Dietary Exposures to Methylmercury of Average and High Consumers



About 11% of women aged 20-49 (childbearing age) had dietary exposure to methylmercury exceeded the PTWI of 1.6 µg/kg bw/week.

A Comparison of Dietary Exposures to MeHg

Places	Dietary exposure of adult (μg/kg bw/week)	
	Average	High Consumer
China 2010	0.003 to 0.138	-
USA 2002	0.097-0.26	-
The Netherlands 2004	<0.1	0.4
UK 2006	0.14-0.35	0.70-0.91 (97.5th percentile)
Ireland 2011	0.14-2.0	0.7-3.3 (97.5th percentile)
Korea 2006	0.21	-
New Zealand 2009	0.27-0.33	-
Australia 2011	0.45	1.1 (90th percentile)
France 2004	0.30	-
Norway 2004	0.40	1.8
Hong Kong 2008	0.50-0.66	1.51-1.69 (95th percentile)
Greece 2004	0.50	2.2
Hong Kong 2012	0.74	2.7 (95th percentile)
Japan 2005	1.1	-
Portugal 2004	1.6	

Summary of Findings

- All dietary exposure estimates for aluminium, cadmium, antimony, methylmercury, nickel, tin were below their respective health-based guidance values for general population
- For lead, the dietary exposures of average and high consumers were below the level, 1.2 µg/kg bw/day, considered by JECFA to have a low risk of increasing the systolic blood pressure in adults

Summary of Findings 2

- For methylmercury, PTWI of 1.6 µg/kg bw/week applied to children up to 17 years and pregnant women
- ~11% of women aged 20-49 (childbearing age) had dietary exposure to methylmercury exceeded the PTWI

Conclusions

- The general adult population was unlikely to experience major undesirable health effects of the seven metallic contaminants
- Methylmercury exposure during pregnancy of this group of women is a public health concern due to potential health risks to their foetuses

Advice to the Trade

- Observe good agricultural and manufacturing practices to minimize metallic contamination of foods
- Obtain food supplies from reliable sources
- Maintain proper records to enable source tracing when required

Advice to the Public

- Maintain a balanced and varied diet as to avoid excessive exposure to metallic contaminants from a small range of food items.
- Fish contain many essential nutrients, such as omega-3 fatty acids and high quality proteins. Moderate consumption of a variety of fish is recommended
- Pregnant women, women planning pregnancy, and young children should avoid eating large or predatory fish and the types of fish which may contain high levels of methylmercury (e.g. tuna, alfonsino, shark, swordfish, marlin, orange roughy and king mackerel)

~End~