The First Hong Kong Total Diet Study Report No. 3: Polybrominated Diphenyl Ethers (PBDEs)

Total Diet Study (TDS)

- **A tool for estimating dietary exposure, one of the steps in risk assessment**
  - Involves food sampling and preparation, laboratory analysis, dietary exposure estimation
- **Internationally recognised**
  - Most cost effective way to estimate the dietary exposure of various population to a range of chemicals or nutrients
- **Provide scientific basis for assessing food safety risks and regulating food supply**

TDS Differs from Food Surveillance Programme

- Focus on substances in the **whole diet**, not on individual foods
- Prepare foods as **table-ready form**
- Take into consideration the impact of cooking
- Assess dietary exposure to **substances actually ingested** by the population, rather than concentrations of substances in food

Objectives

- To estimate dietary exposures of the Hong Kong population and various population subgroups to a range of substances, including contaminants and nutrients
- To assess any associated health risks

Study Reports

- 1st : Dioxins and dioxin-like PCBs
- 2nd: Inorganic Arsenic
- 3rd : Polybrominated Diphenyl Ethers (PBDEs)

Reasons to Study PBDEs

- Widespread and persistent in the environment and potentially toxic to humans
- Were found increasing in human bodies
- Received increasing attention by international health authorities because of their potential to impact upon human health and the environment
- Research from Baptist University found fish sold from HK market contained high levels of PBDEs and the exposure to PBDEs by the local population caused concern

PBDEs

- A group of industrial chemicals – flame retardants
  - Plastics, polyurethane foam, and textiles
- 3 main commercial products
  - PentaBDE, OctaBDE and DecaBDE
- PentaBDE and OctaBDE
  - POPs (persistent organic pollutants) under the Stockholm Convention in 2009

Properties

- Lipophilic
- Persistence in the environment
- Accumulate in living organisms through the food chain

Sources

- At low levels in air, water, soil, sediments, indoor dust and food

- Indoor air, indoor dust and food, including human milk are the main sources of human exposure

Sources in Food

- Fatty foods of animal origin
  - Some fish, meats and dairy products

- Food processing related sources
  - Food contact with PBDE containing packaging materials may result in elevated contamination of food (EFSA 2011)

Toxicity

- In general, the lower the bromination of the PBDE, the higher the toxicity (e.g. PentaBDE is more toxic than DecaBDE)

Animal studies

- Low Acute toxicity
- Chronic toxicity
  - Cause liver enlargement
  - Affect the development, particularly on the brain and the reproductive organs
  - Affect neurobehavioural development
  - Disrupt thyroid hormone levels

Toxicity (2)

- Genotoxicity
  - Majority studies: not genotoxic
- Carcinogenicity
  - IARC classification
    - DecaBDE: Group 3 agent, i.e. not classifiable as to its carcinogenicity to human
    - PentaBDE & OctaBDE: no evaluation

Toxicity (3)

Human data

- Epidemiological studies indicated
  - An association between exposure to PBDEs and altered thyroid hormone regulation
- EFSA 2011
  - Observed effects not always consistent
  - Other coexisting contaminants could have confounded the outcome

Margin of Exposure (MOE)

- The Joint Food and Agriculture Organization (FAO)/World Health Organization (WHO) Expert Committee on Food Additives (JECFA)
  - Available data on PBDEs were not adequate for allocating a safety reference value
  - For the more toxic [less brominated] PBDE congeners, adverse effects would be unlikely to occur in rodents at dose <100 µg/kg bw/day
  - International estimate of dietary intake:~4 ng/kg bw /day
  - Margin of Exposure (MOE) =25 000 (large MOE)
  - The larger the MOE, the lower the health concern

Methods

- Samples
  - 426 samples (collected on 2 occasions, each occasion 71 food items, each item 3 samples)
  - 3 samples from the same food item collected in each occasion were combined into one sample, →a total of 142 composite sample were analysed
- Tested substances
  - 24 PBDE congeners
- Dietary exposure estimation
  - Performed by an in-house developed web-based computer system, EASY
    - Mean average dietary exposure
    - 95th percentile exposure for high consumers

Results

PBDE Contents

Food Group	No.	Mean (pg/g) [range]	
Eggs and their products	6	1693.7	[124.7-8401.9]
Fats and oils	4	1031.6	[58.4-2060.1]
Confectioneries	2	525.7	[444.8-606.7]
Fish and seafood and their products	38	350.4	[15.4-2421.5]
Meat, poultry and game and their products	24	191.9	[37.6-791.0]
Cereals and their products	24	172.5	[11.8-776.9]
Mixed dishes	22	92.2	[5.6-340.1]
Vegetables and their products	2	74.2	[51.4-97.0]
Snack foods	2	62.2	[52.7-71.7]
Dairy products	10	43.0	[6.3-180.1]
Condiments, sauces and herbs	2	18.7	[14.2-23.3]
Beverages, non-alcoholic	6	11.6	[6.5-21.2]

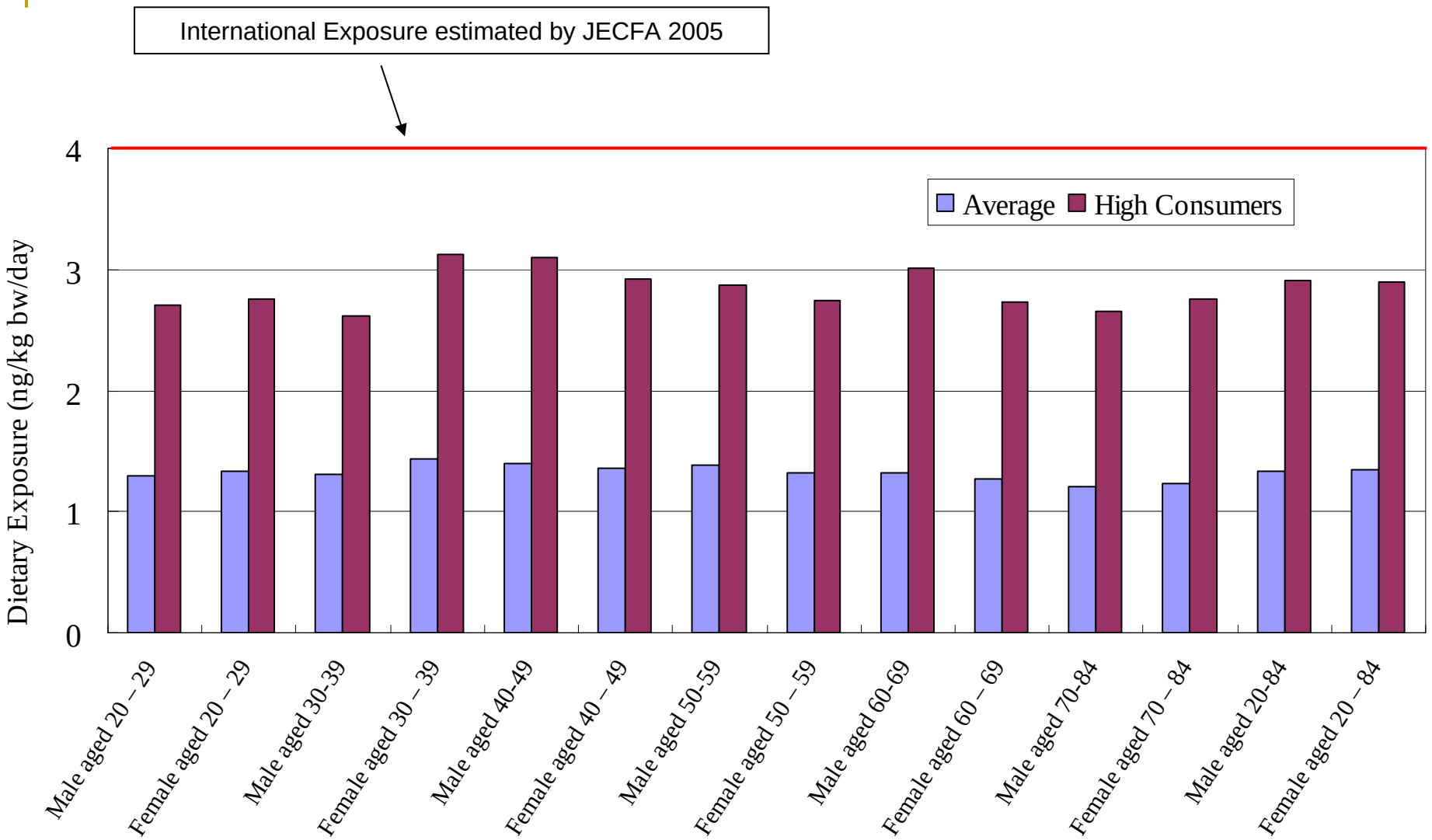
PBDE Contents (2)

Food items	Mean (pg/g) [range]	Compare to international data
Salted egg	4562.2 [722.5-8401.9]	NA
Vegetable oil	1962.7 [1865.3-2060.1]	Comparable
Yellow croaker	1632.8 [844.1-2421.5]	Comparable

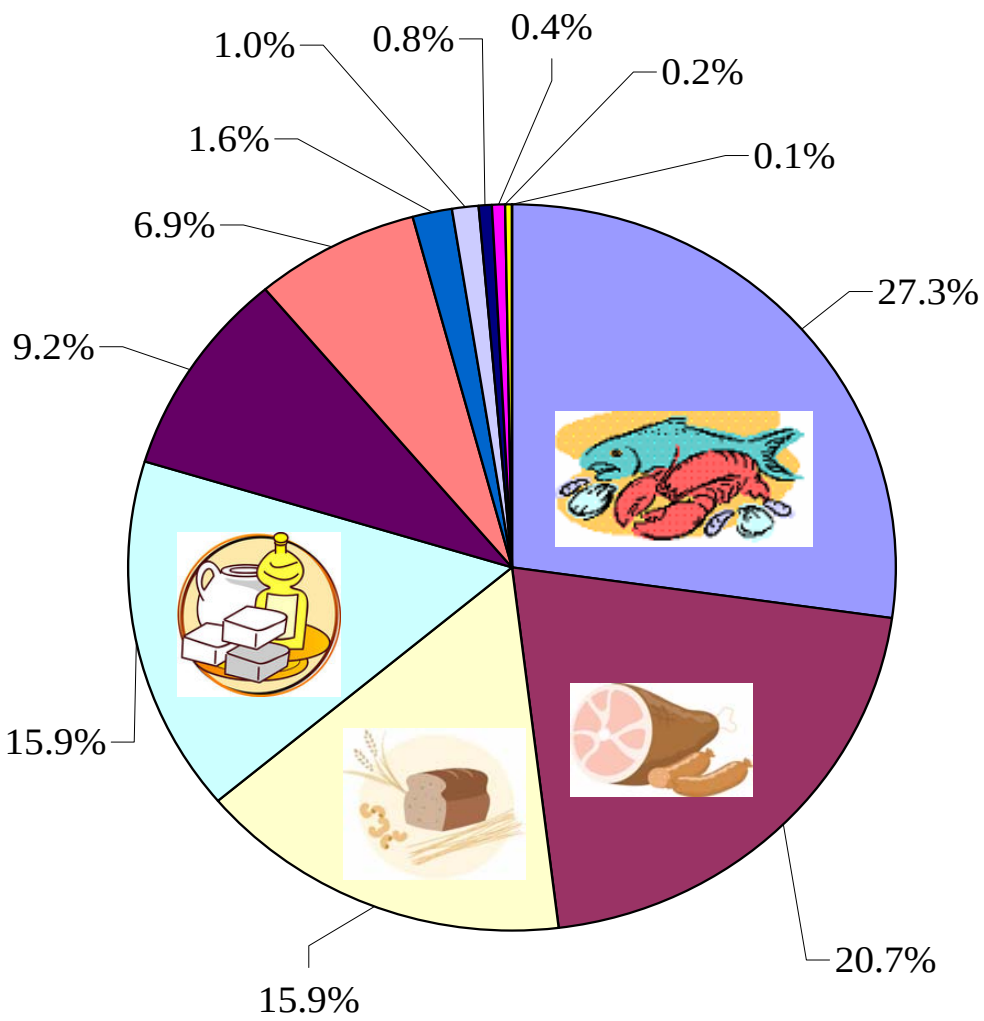
Dietary Exposure

- Average consumers: 1.34 ng/kg bw/day
- High Consumers: 2.90 ng/kg bw/day

Dietary Exposures to PBDEs of Different Age-gender Groups



Food Groups Contributing to Total Dietary Exposure to PBDEs



Comparison with Other Places

	PBDE exposure from dietary sources (ng/kg bw/day)		
Belgium 2007	Upper bound 0.80	Lower bound 0.38	
Japan 2008	Lower bound 1.1		
USA 2006	0.9-1.2		
Spain 2003	1.2-1.4		
Spain 2008	1.1		
HK 2012	1.34-2.90		
UK 2006	Upper bound 5.91		
Australia 2007	Upper bound 49-132	Middle bound 25-67	Lower bound 1-4

Be Cautious When Making Comparison

- No. of congeners tested
  - The more the congeners tested, the higher the PBDEs levels and dietary exposure calculated
- Limit of detection (LOD)
- Treatments of LOD values (upper bound vs lower bound)
- Types of food tested
- Consumption patterns

Limitations

- Small number of samples was analysed
  - 2 out of 4 occasions
- Only food likely to contain PBDEs were selected for testing
  - 71 out of 150 food items
  - →May lead to under-estimation

Conclusion

- Dietary exposure to PBDEs
  - Average consumer: 1.34 ng/kg bw/day
  - High consumer: 2.90 ng/kg bw/day
- Large MOE values→health concern is low. Dietary exposure of the population was unlikely to be a significant health concern

Advice to Trade

- Try to reduce the amount of fat in food products (e.g. select lean cuts of meat and poultry, use low-fat dairy products, use low-fat cooking methods, etc)
- Obtain food supplies from reliable sources
- Maintain proper records to enable source tracing when required

Advice to Public

- Maintain a balanced diet so as to avoid excessive exposure to chemical contaminants from a small range of food items
- Consume low-fat products, trim fat from meat and meat products
- To prepare food with less amount of fats and oils

The End