The First Hong Kong Total Diet Study: Inorganic Arsenic

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食物環境衞生署
Food and Environmental Hygiene Department

食物安全中心
Centre for Food Safety

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The 1st HKTDS

- **Period: 2010 ~ 2014**
- **Objectives:**
  - To estimate the dietary exposures of the HK population and population subgroups to a range of selected substances
    - including contaminants and nutrients
  - To assess any associated health risks

The 1st HKTDS (2)

- **Food consumption data source**
  - Population-Based Food Consumption Survey (FCS)
  - Select 150 TDS food items
    - based on food consumption pattern
- **Analysis of over 130 substances**
  - Pesticide residues, persistent organic pollutants (POPs), metallic contaminants, mycotoxins, macro nutrients, elements, etc.

The 1st HKTDS (3)

- **Methodology:**
  - **Food sampling and preparation**
    - Commission the Chinese University of Hong Kong to carry out
    - 4 occasions from March 2010 to February 2011
    - A total of 1800 samples were collected and combined into 600 composite samples
  - **Laboratory Analysis**
    - Mainly conduct by the Food Research Laboratory (FRL) of the CFS
    - Perform in batches with reference to the nature and stability of the selected substances

The 1st HKTDS (4)

- Reports will be issued in phases
- **First report** (released in December 2011)
  - Dioxins and dioxin-like PCBs
- **Second report**
  - **Inorganic arsenic**

Inorganic Arsenic

- Arsenic: a metalloid occurs in inorganic and organic forms
- Inorganic arsenic: more toxic form of arsenic
  - Arsenic trioxide ($As_2O_{3)}$

Sources of inorganic arsenic

- **Found in the environment**
  - **Natural sources**
    - Arsenic is present in soil, ground water and plants
  - **Human activities**
    - Arsenic compounds are used in manufacture of transistors, lasers, semiconductors, glass, pigments, etc, and to a lesser extent, as pesticides, feed additives and pharmaceuticals.
- **Major routes of exposure**
  - Food such as rice, seafood
  - Drinking water

Health effect of inorganic arsenic

- **Acute toxicity to human**
  - Gastrointestinal symptoms, disturbances of cardiovascular and nervous system functions and may eventually death
- **Chronic effect to human**
  - Skin lesions, cardiovascular disease, neurotoxicity and diabetes
- **Carcinogenicity**
  - Cancers of urinary bladder, lung and skin in human
  - International Agency for Research on Cancer (IARC)
    - classified inorganic arsenic as Group 1 agent, i.e. carcinogenic to human

$BMDL_{0.5}$

- **Joint Food and Agriculture Organization/World Health Organization Expert Committee on Food Additives (JECFA) (2010)**
  - **Determined the inorganic arsenic $BMDL_{0.5}$ in human:**
    - 3.0 μg/kg bw/day (ranged 2 – 7 μg/kg bw/day)
  - Withdrew the provisional tolerable weekly intake (PTWI) of 15 μg/kg bw/week (i.e. 2.1 μg/kg bw/day)
    - as it was no longer appropriate

$BMDL_{0.5}$ (Benchmark dose lower confidence limit for a 0.5% increased incidence of **lung cancer in human**)

- Lower confidence limit of a point on the dose-response curve that characterises adverse effect, to account for uncertainty in the data.

Margin of exposure

- **Margin of exposure (MOE)**

$$MOE = \frac{BMDL_{0.5}}{\text{Dietary Exposure}}$$

- **Provide an indication of the level of concern without actually quantifying the risk**
- **Use for priority setting for risk management actions**
- **Higher the MOE → Lower the concern**

Laboratory analysis on inorganic arsenic

- **Exposure studies in other places:**
  - Usually analysis as **total arsenic**
  - Assign inorganic arsenic levels derived from conversion factors applied
  - → introduce biases in the estimates
- **JECFA (2010)**
  - recommend using actual data of inorganic arsenic
  - rather than calculate from total arsenic by using generalised conversion factors

Study Findings

Inorganic arsenic contents

- Inorganic arsenic were analysed in our current study
- **Totally analysed 600 composite samples**
- Detected in 51% of samples
- **Food items with highest levels**
  - Water spinach (74 μg/kg)
  - Salted eggs (58 μg/kg)
  - Oyster (58 μg/kg)

Dietary exposure to inorganic arsenic

	Current study		Study in 2002*
	Dietary exposure (μg/kg bw/day)	MOEs	Dietary exposure (μg/kg bw/day)
Average	0.22	9 – 32	0.36
High consumer	0.38	5 – 18	0.97

- **All dietary exposures were below the $BMDL_{0.5}$**
- *** Lower than the previous study of secondary school students in 2002**

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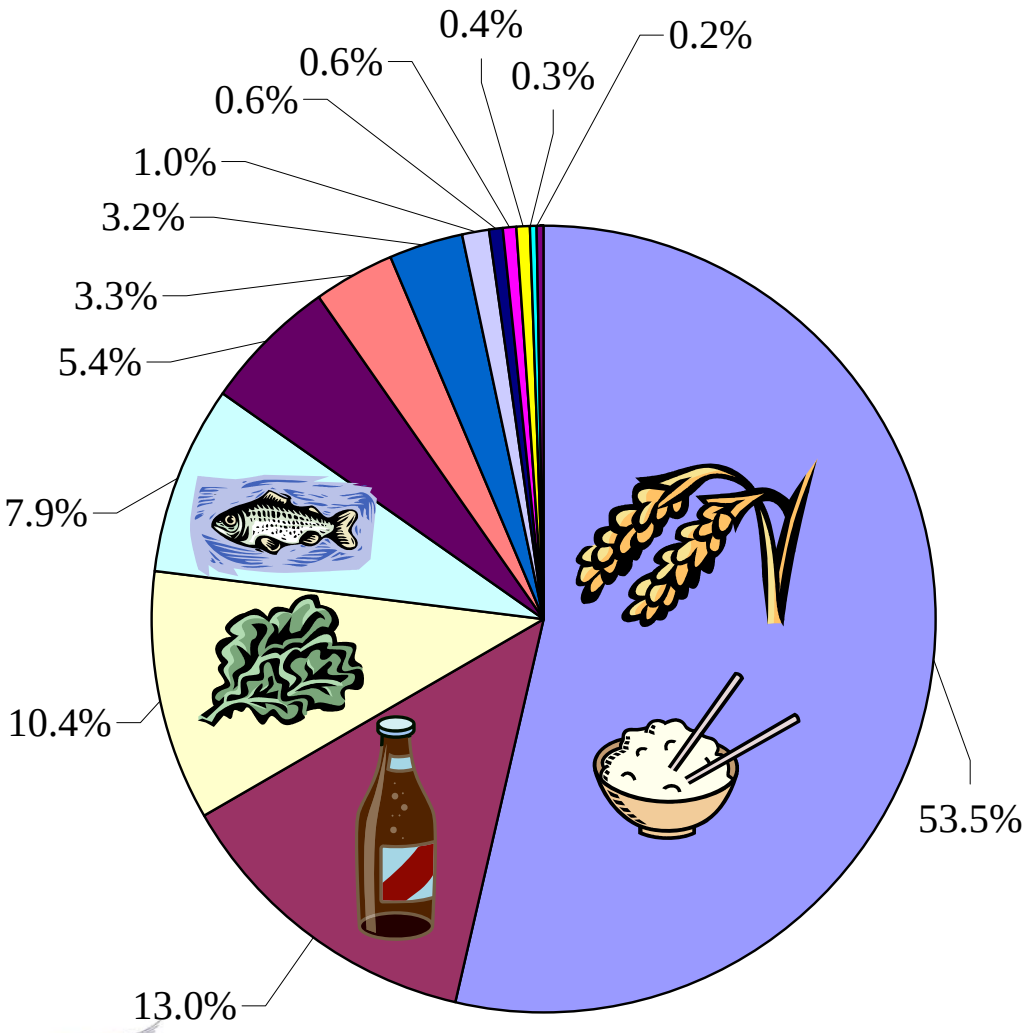
Comparison with other places

Places	Dietary exposure (μg/kg bw/day)	
	Average	High consumer
UK [a]	0.03 – 0.09	0.07 – 0.17 (97.5P)
France [b]	0.10	0.27 (95P)
USA[a]	0.08 – 0.20	0.16 – 0.34 (95P)
Hong Kong [a] (current study)	**0.22**	**0.38 (95P)**
New Zealand [b]	0.24 – 0.29	
Canada [b]	0.29	
Europe (19 countries) [b]	0.21 – 0.61	0.36 – 0.99 (95P)
Japan [a,b]	0.36 – 0.46	0.83 – 1.29 (95P)
China [a]	0.24 – 0.76	

a Analysed inorganic As b Converted from total As

Major food contributors



- Similar to other dietary exposure studies

Major food contributor (2)

- **Rice is the major contributor**
  - Mean levels:
    - White rice: 22 μg/kg
    - Unpolished rice: 43 μg/kg
  - Other cereals: noodles, bread and oatmeal
    - Lower levels of inorganic arsenic
    - Mean levels ranged from 1.5 to 9 μg/kg
- **Significant source of exposures:**
  - **White rice (include congee)**
    - 45.2% of total exposure
- Consistent with data in other countries where rice is the staple food

Conclusion

- Dietary exposures to inorganic arsenic of the population:
  - Below the range of $BMDL_{0.5}$
  - MOEs
    - Average population: 9 – 32
    - High consumer: 5 – 18
- **Having considered the carcinogenic risk, efforts should be made to reduce the exposure to inorganic arsenic of the population**
- Rice is the major contributor
  - Arsenic contamination of rice is regarded as a worldwide problem

Advice to Trade

- **Observe good agricultural practices to minimise inorganic arsenic contamination of foods**
  - Such as avoid using arsenic contaminated water for irrigation

Advice to Public

- **Study findings are not sufficient to warrant changes in the basic dietary advice on healthy eating**
  - Have a balanced and varied diet
  - Take cereals (such as rice, noodles, oatmeal and bread) as the major source

Advice to Public (2)

- **Those individuals, who wish to reduce inorganic arsenic exposure:**
  - Consider choosing more other cereals, which generally contain lower levels of inorganic arsenic than rice, as part of their diet
  - Observe the following advices: Wash rice thoroughly but without excessive washing as some nutrients may be lost, and discard the washed water before cooking so as to reduce the arsenic levels (about 10%), especially the inorganic form

Publicity

- **Study report on inorganic arsenic**
  - Upload in the webpage of CFS
- **Other TDS reports**
  - Will be released in phases and uploaded in the webpage of CFS

The End