The First Hong Kong Total Diet Study: Inorganic Arsenic

February 2012
Content

- The First Hong Kong Total Diet Study (the 1st HKTDS)
- Inorganic Arsenic
- Study Findings
- Recommendations
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 ($\text{As}_2\text{O}_3$)
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\textsubscript{0.5}

- Joint Food and Agriculture Organization/World Health Organization Expert Committee on Food Additives (JECFA) (2010)
  - Determined the inorganic arsenic BMDL\textsubscript{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\textsubscript{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)
  \[
  \text{MOE} = \frac{\text{BMDL}_{0.5}}{\text{Dietary Exposure}}
  \]

- 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

<table>
<thead>
<tr>
<th></th>
<th>Current study</th>
<th>Study in 2002*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dietary exposure (µg/kg bw/day)</td>
<td>MOEs</td>
</tr>
<tr>
<td>Average</td>
<td>0.22</td>
<td>9 – 32</td>
</tr>
<tr>
<td>High consumer</td>
<td>0.38</td>
<td>5 – 18</td>
</tr>
</tbody>
</table>

- All dietary exposures were below the BMDL<sub>0.5</sub>
- * Lower than the previous study of secondary school students in 2002
## Comparison with other places

<table>
<thead>
<tr>
<th>Places</th>
<th>Dietary exposure ($\mu$g/kg bw/day)</th>
<th>Average</th>
<th>High consumer</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>UK a</td>
<td>0.03 – 0.09</td>
<td>0.07 – 0.17 (97.5P)</td>
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<tr>
<td>France b</td>
<td>0.10</td>
<td>0.27 (95P)</td>
<td></td>
</tr>
<tr>
<td>USA a</td>
<td>0.08 – 0.20</td>
<td>0.16 – 0.34 (95P)</td>
<td></td>
</tr>
<tr>
<td><strong>Hong Kong a (current study)</strong></td>
<td>0.22</td>
<td>0.38 (95P)</td>
<td></td>
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<tr>
<td>New Zealand b</td>
<td>0.24 – 0.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada b</td>
<td>0.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Europe (19 countries) b</td>
<td>0.21 – 0.61</td>
<td>0.36 – 0.99 (95P)</td>
<td></td>
</tr>
<tr>
<td>Japan a,b</td>
<td>0.36 – 0.46</td>
<td>0.83 – 1.29 (95P)</td>
<td></td>
</tr>
<tr>
<td>China a</td>
<td>0.24 – 0.76</td>
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</tbody>
</table>

- a Analysed inorganic As
- b Converted from total As
Major food contributors

- 53.5% Cereals and their products
- 13.0% Beverages, non-alcoholic
- 10.4% Vegetables and their products
- 7.9% Fish and seafood and their products
- 5.4% Mixed dishes
- 3.3% Fruits
- 3.2% Meat, poultry and game and their products
- 1.0% Condiments, sauces and herbs
- 0.6% Beverages, alcoholic
- 0.4% Dairy products
- 0.3% Eggs and their products
- 0.2% Legumes, nuts and seeds and their products
- 0.6% Others

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