The Burden of Foodborne Chemicals

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Introduction

- Chemicals in food may arise from a variety of sources:
  - industrial pollution (e.g., PCBs, methyl mercury in fish)
  - cooking (e.g., acrylamide in potato chips)
  - storage utensils (e.g., lead in cans or pottery)
  - agricultural practices (e.g., arsenic in chicken feed)
  - crop uptake of metals from soil

- Among non-occupationally exposed adults, the major source of exposure to chemicals is from food
What do we know?

- Health effects for many chemical contaminants of food are known (e.g. dioxins, PAHs, PCBs, arsenic, cadmium, lead, methyl mercury, copper, etc.)

- Ranges of concentration in food for many chemical contaminants have been described.

- The quantity of various foodstuffs consumed have been estimated.

- Quantitative estimates of cancer risk from ingestion of many chemicals are available.

- Quantitative estimates of doses that are not expected to produce noncancer effects are available for many chemicals.
What don’t we know?

- Can a quantitative estimate of risk for chemicals in food be derived from a study on drinking water? Or does the food (fiber in the food, etc.) mitigate the exposure one might observe for drinking water?

- Can dose-response data from feeding or drinking water studies in animals be used to derive risks of disease in humans?

- What is the dose response for noncancer endpoints above a guideline value such as a Tolerable Intake?
What don’t we know? (cont.)

- What information is available on the distribution of chemical concentrations in food?
- What is known about international variation in food preparation, foodstuffs consumed, cooking utensils, and other factors which may affect chemical intake from food?
- What information is available on the quantity of prepared foodstuffs that are consumed?
Acrylamide

- General population intake: 1.0 µg/kg bw/day (J ECFA 2005)
- High intake: 4 µg/kg bw/day (J ECFA 2005)
- NOEL for morphological changes in nerves (rats): 200 µg/kg/day (J ECFA 2005)
- IARC 2A, probable human carcinogen
- BMDL for mammary tumors in rats (J ECFA 2005): 300 µg/kg/day

Mean Acrylamide Intake (µg/kg bw-day) in the U.S. (U.S. FDA/CFSAN 2006)

<table>
<thead>
<tr>
<th>Food</th>
<th>Intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restaurant chips (french fries)</td>
<td>0.070</td>
</tr>
<tr>
<td>Oven baked chips (french fries)</td>
<td>0.051</td>
</tr>
<tr>
<td>Crisps (potato chips)</td>
<td>0.045</td>
</tr>
<tr>
<td>Breakfast cereal</td>
<td>0.040</td>
</tr>
<tr>
<td>Biscuits (cookies)</td>
<td>0.028</td>
</tr>
<tr>
<td>Brewed coffee</td>
<td>0.027</td>
</tr>
<tr>
<td>Toast</td>
<td>0.023</td>
</tr>
<tr>
<td>Pies and cakes</td>
<td>0.018</td>
</tr>
<tr>
<td>Crackers</td>
<td>0.017</td>
</tr>
<tr>
<td>Soft bread</td>
<td>0.014</td>
</tr>
<tr>
<td>Chile con carne</td>
<td>0.014</td>
</tr>
</tbody>
</table>
“Chemicals” for which the data are **more** reliable for BOD estimates

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Associated disease endpoint (type of study showing the association)</th>
<th>Quantitative information</th>
<th>Assumptions to estimate foodborne burden of disease</th>
</tr>
</thead>
</table>
| Arsenic   | • Skin cancer and lesions (cohort, cross sectional, and ecological studies of As in drinking water)  
• Bladder cancer (ecological, case-control, cohort studies of As in drinking water)  
• Lung cancer (ecological, case-control, cohort studies of As in drinking water)  
• Diabetes (cross sectional, case-control studies of As in drinking water)  
• Cardiovascular disease (cohort, case-control, cross sectional, and ecological studies of As in drinking water) | • Dose response information from several countries including Taiwan, India, Bangladesh, Argentina, Chile, and USA  
• The amount of arsenic consumed in food has been reported for a number of countries including Australia, Brazil, Canada, Croatia, Japan, Spain, UK, and USA  
• Mean total arsenic intake from food and beverages is reported to range from 15 µg/day for Canadian 1-4 year olds to 291 µg/day for adults in the Basque region of Spain | • Inorganic arsenic in drinking water is the same as inorganic arsenic in food  
• The contribution of arsenic from water used to prepare food can be estimated  
• The amount of inorganic arsenic in food can be estimated |
| Cadmium   | • Itai-itai disease (cross-sectional, ecological, and cohort studies) | • Increase in abnormal urinary variables associated with Cd content in food; increase in total mortality assoc. with Cd content in rice; increase in mortality from renal disease associated with Cd content in rice; increase in itai-itai disease associated with Cd content in rice (studies all conducted in Japan)  
• Cadmium concentrations in foods have been reported for a number of countries including Denmark, Finland, Japan, The Netherlands, Sweden, UK, USA; daily dietary intake from food known for Belgium, Finland, New Zealand, Sweden, UK, and USA | • Urinary variables can be used as indicators of disease.  
• The increase in total mortality and the increase in mortality from renal disease are caused reflect an increased risk from cadmium. |
“Chemicals” for which the data are **more** reliable for BOD estimates

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| Fluoride       | • Dental fluorosis (cross-sectional studies)  
• Skeletal fluorosis (cross-sectional studies)  
• Skeletal fracture (cohort studies)                                                     | • Dose response association of skeletal fluorosis and dental fluorosis with fluoride in drinking water found in several countries including India and China  
• Dose response association of dental fluorosis with fluoride in drinking water  
• Dental fluorosis found at low concentrations in drinking water  
• The amount of fluoride consumed in food has been reported for a number of countries including Australia, Canada, China, Germany, Hungary, India, New Zealand, and USA | • Fluoride in drinking water is the same as fluoride in food  
• The contribution of fluoride from water used to prepare the food can be estimated  
• Inadequate nutrition is not a factor with respect to skeletal fluorosis                                                                                     |
| Lead           | • Excess mental retardation (cross-sectional, cohort studies)  
• Cardiovascular disease (cohort, case-control, cross-sectional studies)  
• Anemia (ecological, cross-sectional)                                                                                                               | Dose response association of blood lead levels with blood pressure and neurologic effects (Numerous studies in several countries)                                                                                      | The contribution of lead in food to the lead levels in blood can be estimated                                                                                     |
| Methyl mercury | • Neurological effects (cohort studies)  
• Blood pressure (cohort)  
• Heart rate variability (cohort)                                                                                                                    | Dose response association of mercury in cord blood and maternal hair with effects on neurological tests, blood pressure, and heart rate variability in children (Studies have been conducted in the Faroe Islands, New Zealand, and Seychelles) | Estimates of the amount of methyl mercury in fish can be made from the biologic indices of mercury exposure (blood and hair)                                                                                       |
"Chemicals" for which the data are less reliable for BOD estimates

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<td>Acrylamide</td>
<td>• Neurotoxicity (peripheral neuropathy in Chinese workers, rats, and primates)</td>
<td>• No dose-response data are available for humans; NOAEL is 0.5 mg/kg-bw/day based on peripheral neuropathy in rodent and primate studies</td>
<td>• Animal data can be used to estimate dose response in humans</td>
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<td></td>
<td>• Genotoxicity (genotoxic in vivo in somatic cells and germ cells)</td>
<td>• The amount of acrylamide consumed in food has been reported for a number of countries including Australia, Denmark, France, Germany, Greece, Italy, Norway, Spain, Sweden, Switzerland, Netherlands, UK, and USA</td>
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<td>• Carcinogenicity (tumors at 2 mg/kg/day acrylamide in drinking water in animal studies; cohort study of acrylamide inhalation by workers found no excess cancer)</td>
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<td>• No dose-response data are available for humans; NOAEL is 0.5 mg/kg-bw/day based on peripheral neuropathy in rodent and primate studies</td>
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<td>• Animal data can be used to estimate dose response in humans</td>
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<td>Dioxins (includes CDD, CDF, and certain PCBs)</td>
<td>• Chloracne (cross-sectional study)</td>
<td>• Dose response association of TCDD in blood, TCDD per body weight, and duration of exposure to TCDD with cancer (all sites) risk in occupational studies (Studies have been conducted in Germany and USA)</td>
<td>• Dose response estimates for TCDD can be translated to TEQ for dioxins</td>
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<tr>
<td></td>
<td>• Cancer (cohort, case-control)</td>
<td>• Some data on the amount of dioxin and dioxin-like compounds consumed in food has been reported for a number of countries including Canada, Japan, Sweden, and USA</td>
<td>• Studies of occupational exposure can be used to estimate risk from food</td>
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Conclusions

- Estimates of the burden of disease from certain chemicals in the food supply can be made.
- It is necessary to make assumptions in making these estimates.
- Data on the amount of particular foodstuffs consumed will need to be factored into the BOD estimates.
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