Global Disease Burden of
Four Foodborne Chemicals

Herman Gibb, Ph.D., M.P.H.
Gibb Epidemiology Consulting LLC
Arlington, VA, USA
Food safety

Chemical risks

Chemicals can end up in food either intentionally added for a technological purpose (e.g. food additives), or through environmental pollution of the air, water and soil. Chemicals in food are a worldwide health concern and are a leading cause of trade obstacles.

WHO develops scientific risk assessments to define safe exposure levels which form the basis for the development of national and international food safety standards to protect the health of the consumers and ensure fair trade practices.
Poisoned food in shops for THREE WEEKS: Supermarkets clear shelves of cakes and quiches containing contaminated eggs from Germany

By DAVID DERBYSHIRE FOR MAILONLINE
UPDATED: 08:32 EST, 8 January 2011

Food Safety News
Breaking news for everyone’s consumption

Dioxin Scare Halts German Egg Sales

By News Desk | January 5, 2011

Melamine

WHO Expert meeting to review toxicological aspects of melamine and cyanuric acid

Held in collaboration with FAO and supported by Health Canada Ottawa, Canada, 1-4 December 2008
Global Disease Burden of Four Foodborne Chemicals

Follow up survey of cyanogenic glycosides in ready-to-eat cassava chips

Public Perceptions of the Dioxin Crisis in Irish Pork

June 2009

Urinary and Dietary Analysis of 18,470 Bangladeshis Reveal a Correlation of Rice Consumption with Arsenic Exposure and Toxicity

Stephanie Melkonian¹, Maria Argos¹, Megan N. Hall², Yu Chen¹, Faruque Parvez², Brandon Pierce¹, Hongyuan Cao¹, Brisels Aschebrook-Kilfoy¹, Alauddin Ahmed³, Tariqul Islam³, Vesna Slavcovich³, Mary Gamble³, Parvez I. Haris⁶, Joseph H. Graziano²,³, Habibul Ahsan¹,⁷
Global Disease Burden of Four Foodborne Chemicals
Chemical & Toxins Task Force

- Herman Gibb (USA), Chairperson
- Gabriel Adegoke (Nigeria)
- Reza Afshari (Iran)
- Janis Baines (Australia)
- Kalpana Balakrishnan (India)
- David Bellinger (USA)
- Michael Bolger (USA)
- Rolaf van Leeuwen (Netherlands)
- John Pitt (Australia)
- Philippe Verger (France)

Global Disease Burden of Four Foodborne Chemicals
Groups of Chemicals & Toxins Considered by the Chemical & Toxins Task Force

- Elemental contaminants (e.g., lead, mercury, cadmium, manganese, arsenic)
- Mycotoxins (e.g., aflatoxins, ochratoxins, fumonisins, trichothecenes)
- Food additives (e.g., sulphites, nitrites/nitrates, benzoic acid)
- Pesticides/residues (e.g., organophosphates, carbamates, DDT, pyrethrins)
- Organic industrial pollutants (e.g., persistent organic pollutants)
- Veterinary drugs/residues (e.g., antibiotics, hormones – but not antimicrobial residues)
- Seafood toxins (e.g., tetrodotoxin, ciguatera, shellfish toxins, DSPs, PSPs, histamines)
- Process contaminants (e.g., acrylamide, PAHs, chloropropanol)
- Allergens (e.g., peanuts)
- Natural toxicants (e.g., cyanide in cassava, aminoglycosides)
- Radionuclides and depleted uranium
Hazards were Ranked on:

- Severity of potential health effects
- Prevalence of exposure
- Availability of data to make burden estimates
## Hazards Selected and the Scientists Commissioned to Work on the Hazard

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Commissioned Scientist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aflatoxin</td>
<td>Dr. Felicia Wu (Michigan State University, USA)</td>
</tr>
<tr>
<td>Peanut allergen</td>
<td>Dr. Janine Ezendam (National Institute for Public Health and the Environment, Netherlands)</td>
</tr>
<tr>
<td>Cyanide in cassava</td>
<td>Dr. Julie Cliff (Eduardo Mondlane University, Mozambique)</td>
</tr>
<tr>
<td>Dioxin</td>
<td>Dr. Marco Zeilmaker (National Institute for Public Health and the Environment, Netherlands)</td>
</tr>
<tr>
<td>Arsenic</td>
<td>Drs. Aaron Barchowsky and Shilpi Oberoi (University of Pittsburgh, USA)</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Dr. Janet Zang (Food and Drug Administration, USA)</td>
</tr>
<tr>
<td>Lead</td>
<td>Dr. Clark Carrington (Food and Drug Administration, USA)</td>
</tr>
<tr>
<td>Methyl Mercury</td>
<td>Dr. David Bellinger (Boston Children’s Hospital, Harvard Medical School, USA)</td>
</tr>
</tbody>
</table>
Cyanide in Cassava

- Important staple for over 800 million people in approximately 80 countries
- Cassava tubers contain varying quantities of cyanogenic glucosides to protect the tuber against attack by animals and insects
- High dietary cyanide processing occurs when high cyanogenic cassava and insufficient processing are combined
- Worldwide reports of acute poisoning exist, but Dr. Cliff, the Commissioned Scientist, believed that the data were inadequate to make burden estimates
- The data are sufficient, however, to make estimates of konzo
  - Associated with consumption of bitter cassava and low protein intake
  - Disease of extreme poverty
  - Case definition:
    - Visible symmetrically spastic abnormality of gait while walking or running
    - History of abrupt onset (less than one week), irreversible
    - Bilaterally exaggerated knee and/or ankle jerks without signs of disease in the spine
  - Case-fatality is estimated to be 21%
  - Estimate was made for six countries in Africa:
    - Cameroon, Central African Republic, Democratic Republic of Congo, Mozambique, United Republic of Tanzania, Angola
Different Degrees of Severity of konzo in Children from Democratic Republic of Congo


Global Disease Burden of Four Foodborne Chemicals
Peanut Allergy

- Occurs early in life (< 5 years) and believed to be lifelong.
- Peanut ingestion → duration of symptoms is short (< 2 days).
- Symptoms vary from mild to severe and can be fatal – prevalence of anaphylaxis: 4.7-9%.
- Disease is assumed to be lifelong.
- Prevalence confirmed with oral challenges: 0.5-1.5%.
- Limited data on mortality rate of peanut-induced anaphylaxis but the majority of studies found similar rates ranging from 0.00125 to 0.017 per 100,000 person-years.
- Estimates were made only for high income countries.
- Gender distribution assumed to be equal.
- Because of the short duration of the allergic response, the contribution of the actual disease to the Burden of Disease is not substantial but the impact on Quality of Life can be significant.

Source: www.wikipedia.org
Dioxin

- More than 90% of dioxin exposure is through the food supply, mainly meat and dairy products, fish and shellfish
- The dioxin body burden rather than daily exposure is the dose metric for the assessment of dioxin
- Many national authorities monitor dioxin in the food supply and breast milk
- Fifty countries have reported dioxin concentrations in breast milk
- The most sensitive non-cancer endpoints for dioxin are prenatal and postnatal hypothyroidy and prenatally induced sperm production
- Estimates of dose response were done using benchmark dose
- Human data were used to make estimates of hypothyroidy resulting from prenatal exposure
- Animal toxicology studies were used to make estimates of hypothyroidy from postnatal exposure and impaired fertility from prenatal exposure
Aflatoxin

- Aflatoxins are secondary metabolites of the fungi *Aspergillus flavus* and *Aspergillus parasiticus* and less frequently other *Aspergillus* species such as *A. nomius*.

- These species are prevalent in food crops – particularly maize, peanuts (groundnuts), oilseeds, and tree nuts in tropical and subtropical regions worldwide.

- All aflatoxin exposure results from food consumption.

- Aflatoxin increases the risk of hepatocellular carcinoma, a disease with a high case-fatality.
## Median Number of Foodborne Illnesses, Deaths, and Disability Adjusted Life Years (DALYs) with 95% Uncertainty Intervals, 2010

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Foodborne Illnesses (95% UI)</th>
<th>Foodborne Deaths (95% UI)</th>
<th>Foodborne DALYs (95% UI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aflatoxin</td>
<td>21,757 (8,967-56,776)</td>
<td>19,455 (7,954-51,324)</td>
<td>636,869 (267,142-1,617,081)</td>
</tr>
<tr>
<td>Cyanide in cassava</td>
<td>1,066 (105-3,016)</td>
<td>227 (22-669)</td>
<td>18,203 (1,769-53,170)</td>
</tr>
<tr>
<td>Dioxin</td>
<td>193,447 (155,963-1,085,675)</td>
<td>0 (0-0)</td>
<td>240,056 (192,608-1,399,562)</td>
</tr>
<tr>
<td>Peanut Allergens</td>
<td>107,167 (6,262-210,093)</td>
<td>28 (2-56)</td>
<td>99,717 (5,827-195,489)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>338,611 (185,705-1,238,725)</td>
<td>19,736 (8,210-51,700)</td>
<td>1,012,362 (562,087-2,822,481)</td>
</tr>
</tbody>
</table>
The Relative Contributions from YLLs and YLDs for Each of Four Chemicals

YLL = Years of Life Lost
YLD = Years Lost due to Disability

Global Disease Burden of Four Foodborne Chemicals
The Relative Contribution to the DALY Incidence for Four Chemicals by Region

Global Disease Burden of Four Foodborne Chemicals
DALYs for Each of Four Chemicals from Contaminated Food Ranked from Lowest to Highest

Global Disease Burden of Four Foodborne Chemicals
Summary

- Of the four chemicals assessed, Aflatoxin has the greatest impact on deaths and DALYs.
- Cyanide in cassava has the second greatest impact on deaths, but estimates were made for only 6 countries in Africa.
- Dioxin is associated with the greatest number of illnesses of the four chemicals evaluated.
- Peanut allergens are associated with the second highest number of illnesses; estimates were only made for high income countries.
- Virtually all exposure to these four chemicals is through the food supply.
- The results for these four chemicals should be considered the tip of the iceberg regarding the impact of chemicals in food on the burden of disease.
Thank you,
Arie H. Havelaar!!!