Workshop on Risk-Benefit Assessment of Foods

Risk-benefit assessment in Europe

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Introduction

Papers published in Pubmed about “Food + Health” (in title and/or abstract)
Food Factors affecting Human/Animal Health:

- Risk-Benefit Assessment (RBA)
  - Scientific evaluation of known or potential adverse/beneficial health effects resulting from human (or animal) exposure to specified agents in food
  - Integrates in a global perspective: risks and benefits related to microbiology, toxicology and nutrition
Consumers are eating anyway…

We need to break borders among areas of research and work together to address cross-cutting issues.
Objectives

Introduce what has been done so far in RBA in Europe: concrete case studies and methodological developments.
Introduction

1. History of Risk-Benefit Assessment (RBA)
2. Summary of RBA Case studies Topics
3. Strategies of Risk-Benefit comparison
4. RBA of Fish

RBA Workshop, G. Boué, May 21st 2018
History

of Risk-Benefit Assessment (RBA)
RBA has emerged at the beginning of the 21st century:

- EFSA colloquium meetings in 2006 and 2010
- **RBA has emerged at the beginning of the 21st century:**
  - EFSA colloquium meetings in 2006 and 2010
  - European projects: BRAFO (Hoekstra et al., 2012), QALIBRA (Hart et al., 2012), …

- **BEPRARIBEAN:** (Hoekstra et al., 2012)
  - 6 Reviews + 1 ccl on best Practices for Risk-Benefit Analysis: lessons from other fields
  - experience from out of food into food
    - Food and nutrition
    - Pharma/medicine
    - Microbiology
    - Environment
    - Economics and marketing-finance
    - Consumer science

- **BRAFO:** (Boobis et al., 2013)
  - How best to assess foods and food component?
    - Methodology
    - Case study
    - Consensus

- **QALIBRA:** (Hart et al., 2012)
  - How best to assess foods and food component?
    - Online Tool
    - Not really used … (or not yet!)
RBA methodology:

- RBA approach followed similar to steps of universal Risk Assessment
- Still under development:
  - "no international consensus on the general principles or approaches for conducting risk-benefit assessment of foods and food components" (Eneroth and Zetterberg, 2016)

Two experts workshops were organised:
- Sept 2016, NFA (Sweden)
- May 2017, DTU (Denmark)
Summary of

RBA Case studies Topics
Who is doing RBA?
The main findings focused on effects of...

- **Single food consumption**
  - Fish / Fish products
  - Fruits and vegetables
  - Infant milk
  - Nuts
  - Red meat

- **Food preparation**
  - (Meat cooking)

- **Diet**
  - Smartphone application for whole diet
  - Meat substitution with fish

- **Food components**
  - Soy proteins
  - Trans fatty acids
  - Sugar substitution by intense sweeteners
  - Vitamins
  - Iron and folate (MPLs)

- **Manufacturing process**
  - Water treatment
  - Milk treatment
  - Sterilization of vegetables
  - Cooking cookies

- **Product formulation**
  - Bread fortification with folic acid
  - Margarine fortified with plant sterols
  - Reduction of salt and nitrite content of processed meat
Risk-Benefit ANALYSIS Goals...

Improve available food quality

Change food habits into a more healthy food dietary

Food standards

Food recommendations

Healthy diet

Consumers recommendations

- Food choices
- Meat cooking...

Food products optimizations

- Manufacturing process
- Product formulation

- Change of heating settings
- Food supplementation
- Additional regulatory limits...
Fields of research concerned

- Nutrition (12)
- Chemistry (1)
- Micro (7)

- ALL (7)
Strategies of Risk-Benefit comparison
**Criteria of comparison used in RBA:**

- Safety reference levels, comparison under constraint (e.g. Toxicological reference values)
- Common metric (e.g. number of sick of the disease x, intellectual quotient)
- Composite metric (e.g. DALY, Disability Adjusted Life Year)
Risk-Benefit comparison

- **Comparison under constraint: preventive / safety reference**
  - **Nutrition**: Minimum and maximum level of exposure of micronutrients
    - Reference Nutrient Intake (RNI)
    - No-observed-adverse-effect level (NOAEL)
    - Cumulative incidence of deficiency
    - Cumulative incidence of toxicity
    - Acceptable range of intake?
    - Daily intake of vitamin or mineral (From Renwick et al. 2008)

- **Chemistry**: Maximum level of exposure
  - Hypothetical dose response curves
    - HUMANS sensitive subjects
    - HUMANS population mean
    - ANIMALS population mean
    - ADI
    - TWI
    - NOAEL
    - INTRASPECIES
    - INTERSPECIES

  (From Renwick et al. 2008)

**Advantage**: stop at the exposure assessment step

**Limitation**: health impacts are considered equally important

- EAR
- RDA
- ...
Comparison under constraint

- All over the European Union
- Different fish species
- Fish Choice tool

Recommendation:
- Sub-populations
- Individual regarding chemicals and nutrients
- Suggest ideas to improve diet
Risk-Benefit comparison

- Common metric: same criteria collected for all endpoints
  - **Mortality rate**: Number of death per year for the considered sub-population
  - **Morbidity rate**: Number of illness per year for the considered sub-population
  - **Years of life lost**: Number of years of life lost compared with the remaining life expectancy
  - **Increase/decrease of biological parameters**: blood pressure, cholesterol, …
  - **Increase/decrease of Intellectual quotient point**
  - **Days of work lost**
  - **Monetary cost**
  - …
Risk-Benefit comparison

- Common metric: same criteria collected for all endpoints
  - Pregnant women childbearing age - Adult population
  - Mortality VS mortality saved

Table 6. Estimated changes in mortality per million people from consuming fish with different dioxin and EPA plus DHA contents at one, two, four and seven 100 g servings per week

(a) One serving per week

<table>
<thead>
<tr>
<th>EPA + DHA</th>
<th>x ≤ 3 mg/g</th>
<th>3 &lt; x ≤ 8 mg/g</th>
<th>8 &lt; x ≤ 15 mg/g</th>
<th>x &gt; 15 mg/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>2</td>
<td>5.5</td>
<td>11.5</td>
<td>20</td>
</tr>
<tr>
<td>x ≤ 1 pg/g</td>
<td>+50</td>
<td>+50</td>
<td>+50</td>
<td>+50</td>
</tr>
<tr>
<td></td>
<td>-4550</td>
<td>-12 500</td>
<td>-26 200</td>
<td>-39 800</td>
</tr>
<tr>
<td>1 &lt; x ≤ 4 pg/g</td>
<td>+600</td>
<td>+600</td>
<td>+600</td>
<td>+600</td>
</tr>
<tr>
<td></td>
<td>-4550</td>
<td>-12 500</td>
<td>-26 200</td>
<td>-39 800</td>
</tr>
<tr>
<td>4 &lt; x ≤ 8 pg/g</td>
<td>+1400</td>
<td>+1400</td>
<td>+1400</td>
<td>+1400</td>
</tr>
<tr>
<td></td>
<td>-4550</td>
<td>-12 500</td>
<td>-26 200</td>
<td>-39 800</td>
</tr>
<tr>
<td>x &gt; 8 pg/g</td>
<td>+4800</td>
<td>+4800</td>
<td>+4800</td>
<td>+4800</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>
Risk-Benefit comparison

- **Risk-Benefit Comparison: DALY** (Disability Adjusted Life Years)
  - Objective and weighted public health indicator

- Estimate burden of disease
- Assessing the impact of diseases on duration and quality of life
- Compare the benefits / costs
- Compare the risks and benefits relating to different scientific fields

Illustration of the DALY calculation from (Boué et al, 2015),

**Advantage:** enable all comparison

**Limitation:** difficult to understand + assumptions

For more information see:
http://www.who.int/healthinfo/global_burden_disease/gbd/en/
**Composite metric:**
- Netherlands
- General population

**Recommendation:**
- Consumption of 200g/week would improve Dutch population health of 27 healthy years per 10,000 people per year, compared with current consumption.

**Fig. 10.** The change in DALYs of the combined effect and each single health effect with uncertainty when quantified.
RBA case studies on Fish
Main investigations:

Health effect contributing factors

Nutrition: Omegas 3 (DHA et EPA)

Chemistry: Methyl mercury et dioxins

Microbiology: Listeria monocytogenes

Potential health effects

Beneficial: decrease of cardiovascular diseases, improvement of neuro-development, …

Adverse: Listeriosis, cancer, …

Scientific field:
- 67 Chemistry vs Nutrition
- 2 Chemistry vs Nutrition vs Microbiology
- 1 Nutrition vs Microbiology

Type of Risk-Benefit comparison:
- 45 Food safety levels
- 20 Common metric
- 5 DALY / QALY

Population:
- Norway, Netherlands, Poland, France, China, USA …
- Pregnant women, adults, children, …

Type of product consumed:
- Fish specie
- Farmed or wild

Particular cases:
- Intensive consumer
- Fishing communities
- Individual tools
Main result:

The French recommendation: Translated from (ANSES, 2012)

<table>
<thead>
<tr>
<th>FRENCH Recommendation</th>
<th>General population</th>
<th>Girls and teenagers</th>
<th>Women of childbearing age</th>
<th>Breastfeeding mother</th>
<th>Pregnant women and children under the age of 3</th>
<th>Other sensitive people (elderly people, immunosuppressed, …)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main recommendation</td>
<td>Consume 2 servings of fish per week, including one with high content in EPA and DHA (* Salmon, Sardine *, Mackerel, herring *, ** Smoked trout), varying species and supply points</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshwater fish highly bioaccumulative (eel, barbel, bream, carp, catfish)</td>
<td>Limit at 2 times a month</td>
<td>Limit at 1 time every 2 months</td>
<td>Limit at 2 times a month</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild predatory fish ***</td>
<td>No specific recommendation</td>
<td>Limit</td>
<td>No specific recommendation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swordfish, marlin, siki, shark and lamprey</td>
<td>No specific recommendation</td>
<td>Limit</td>
<td>Avoid</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other precautions to be observed:
- Cooking at heart fresh sea fish or freezing for 7 days in a home freezer after rapid evisceration of caught fish for raw consumption
- Avoid shellfish consumption, if they do not come an authorized and controlled breeding area
- Consumption of shellfish and raw seafood in two hours from the refrigerator
- Avoid eating raw or undercooked fish and smoked fish
- Avoid eating raw or undercooked shellfish
- Avoid the consumption of cooked crustaceans sold (cook yourself crustaceans)

* Any type of conservation (fresh, frozen, smoked, canned…)
** Smoked trout is a different species of brown trout “classic”
*** Lotte (monkfish), wolf (bar), skipjack tuna, eel, emperor, pomegranate, halibut, pike, bream, skate, sword, tuna…
Fish and fish products

Bioavailability

Culinary treatment

Fish choices

Available for intestinal absorption?

Boiling, grilling, and roasting?
RBA Needs identified (non-exhaustive list)

**Food and food components**
- Coffee
- Tea
- Red wine
- Broccoli
- Meat
- Chocolate
- Phyto estrogens
- Folic acid
- Isoflavone
- Nitrite / nitrate
- Gluten free diet

**Agricultural / manufacturing practices**
- Organic Agriculture
- Use of pesticides
- Use of GMOs
- Heat treatment
- Irradiation of food
- Use of preservatives
- Raw / heated cow milk
- cooking practices red meat
- Nanotechnologies in agri-food industry
- Antimicrobial use
- Food fortification
- Maillard reaction