Seafood Consumption and Public Health: a “Risk – Benefit” approach

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AGENDA

1. Introduction and objective
   Conflict model related to seafood
   Research objective

2. Methodology

3. Data used

4. Results

5. Conclusions
SEAFOOD: CONFLICT MODEL

Fish consumption → omega-3 FA (EPA&DHA) → Positive to health

Nutritional-toxicological conflict

contaminants → Negative to health
OBJECTIVE

Analysis of benefits and risks:
Detailed *intake assessment* of *nutrients* and *contaminants* via seafood consumption

- EPA&DHA
- Vitamin D
- Iodine
- Fat

- Mercury
- PCBs
- Dioxins
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Model for intake assessment

\[ Y_i = \sum_v \sum_a \sum_t \left( \frac{b_{v,a} \cdot X_{v,i,t} \cdot C_{v,a}}{BW_i \cdot T} \right) \]

- \( Y_i \): intake of a contaminant/nutrient of individual \( i \)
- \( X_{v,i,t} \): seafood consumption (species \( v \)) of individual \( i \)
- \( C_{v,a} \): concentration of a contaminant/nutrient in fish \( v \)
- \( b_{v,a} \): probabilistic factor to express the origin
- \( BW_i \): body weight of individual \( i \)
- \( T \): time

\( v \): fish species
\( a \): origin of the fish
\( t \): time
\( i \): individual
Probabilistic approach

Deterministic:

“point values”

Disadvantages:

not so realistic (simplification)
not so transparent
(unclear how conservative)
Why probabilistic?

Variability in:

• seafood consumption: inter-individual
• body weight: inter-individual

• nutrient/contaminant concentration:
  » spatial
  » inter-species
Probabilistic intake model

Variability Characterisation:
Data (+ weight) out of databases used to characterise distributions
BestFit\textsuperscript{®} was used to select and fit distributions
Methodology: tool for combined intake assessment (2)

Probabilistic approach: takes into account variability of consumption and concentration data

Each consumption point is combined with a concentration point of multiple compounds

Combined intake assessment
Probabilistic intake model

Variability propagation through intake model:

\[ Y_i = \sum_v \sum_a \sum_t \left( \frac{b_{v,a} \cdot X_{v,i,t} \cdot C_{v,a}}{BW_i \cdot T} \right) \]

Probabilistic approach (Monte Carlo): probability distributions instead of point estimates to represent variability
Multiple nutrients, contaminants, origins, fish products

Concentration

Consumption

Body weight

MODEL

\[ Y_i = \sum \sum \left( \frac{b_{v,i} \cdot x_{v,i} \cdot c_{v,i}}{BW_i \cdot T} \right) \]

Intake

Multiple nutrients, contaminants
Multi-dimensional space of contaminants and nutrients

Multiple nutrients, contaminants

MODEL

\[ Y_i = \sum \sum \sum \left( \frac{b_{ij} \cdot X_{ij} \cdot C_{ij}}{BW_i \cdot T} \right) \]

Intake

2D projections of all combinations
Methodology: tool for combined intake assessment

Development of a **software model** as tool for this objective:

**ProbIntake**

- can be used for real intake assessments
- also useful for scenario analysis
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Data used (1/3)

1. Consumption data of Flemish adolescents and Belgian adults

a) Adolescent data base (n=341; 13-18y; 7 days; Ghent region; 1997)  
   64% seafood consumers; 34 different species consumed  
   Mean of 106.8 g seafood/week; 167.0 g seafood/week for consumers-only

b) Adult data base (n=821: 202 ♂, 619 ♀; weekly consumption; 19-83y; 2004)  
   Cod, salmon and tuna: most consumed species  
   Mean of 215.5 g seafood/week
Data used (2/3)

2. Concentration data of nutrients and contaminants (newly compiled data bases)

- 1. Methyl-mercury
- 2. PCBs
- 3. Dioxins

1. EPA&DHA
2. Vitamin D
3. Iodine

Mercury concentration data were used to calculate methylmercury concentrations
Data used (3/3)

Concentration data < newly compiled data bases containing published nutrient/contaminant concentrations in fish and shellfish
(127 data source screened)
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EPA&DHA: current intake via seafood

ADOLESCENTS

ADULTS
Nutrients: ratio of the intake via seafood versus the RDA

ADOLESCENTS

ADULTS
Methyl mercury: current intake via seafood

![Graphs showing cumulative probability for adolescents and adults with different intake levels of methyl mercury.](image-url)
Dioxin-like compounds: ratio of the intake via seafood versus the TDI – INcluding Baltic fish
Dioxin-like compounds: ratio of the intake via seafood versus the TDI – EXcluding Baltic fish
Result of combined intake assessment (adults)
Detail of result of combined intake assessment

Frequency distributions of all individual compounds (axes log-scale)

Ratio of intake of two different compounds
Correlation coefficients of the ratio of intake of two different compounds:

- dlPCB: 0.70, 0.71, 0.57
- Dioxin: 0.74, 0.47
- totTEQ: 0.55
- EPA&DHA
Risk-benefit analysis

Comparing assessed intakes with reference values:
1. RDA for nutrients
2. TDI for contaminants

- Focussed on EPA&DHA and total dioxin-like compounds
- Results for adults are shown
Adults consuming enough fish to answer their personal EPA-DHA requirement, without exceeding the 2 pg TEQ/kg bw/day limit

Adults consuming enough fish to answer their personal EPA-DHA requirement, but exceeding the 2 pg TEQ/kg bw/day limit

Adults consuming too little fish to answer their personal EPA-DHA requirement, and not exceeding the 2 pg TEQ/kg bw/day limit

Adults consuming too little fish to answer their personal EPA-DHA requirement, but exceeding the 2 pg TEQ/kg bw/day limit
CURRENT INTAKE, EXCLUDING CONCENTRATION DATA
OF BALTIC SALMON AND HERRING

1.0×10^12

3.0%

2.8%

92.1%

2.1%

EPA&DHA (intake/RDA)
totTEQ (intake/TDI)
Consumption of 150 g cod and 150 g non-Baltic salmon per week
Consumption of two portions of 150 g non-Baltic salmon per week
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Conclusions (1/2)

• Current consumption of seafood: too low & below recommendations

• Combined intake assessment: strong correlation between beneficial nutrients and hazardous contaminants
Conclusions (2/2)

The model predicts that

• weekly consumption of **two portions** (of 150 g) **fatty fish** leads to an adequate intake of EPA&DHA

• with **exclusion of specific origins** of highly contaminated seafood: feasible to increase intake of EPA&DHA without exceeding TDI’s

**Variation** is recommended to avoid repeated consumption of the most contaminated species