Food consumption databases: use in supporting food regulation
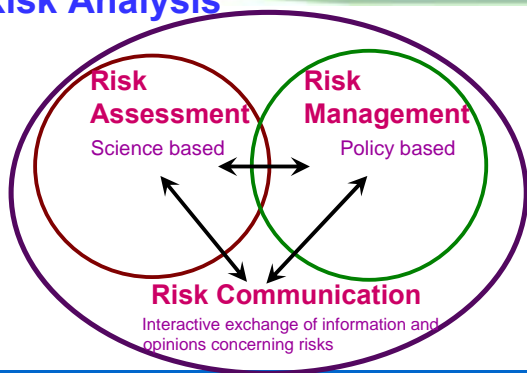
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Overview

- Role in risk analysis for food regulation
- Food consumption data
- Use in dietary exposure assessments
- Approaches to dietary exposure assessments
- Challenges

Risk Analysis

Risk Assessment
Science based

Risk Management
Policy based

Risk Communication
Interactive exchange of information and opinions concerning risks

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Risk Assessment Process

1. Hazard identification (adverse effects)

2. Hazard characterisation (dose response relationship)

3. Exposure Assessment (population exposure)

4. Risk characterisation (comparison of exposure to reference health standards)

What is a dietary exposure estimate?

A dietary exposure estimate is where food consumption data and food chemical data are combined to estimate dietary exposure to food chemical(s) or nutrients.

$$\text{Dietary Exposure} = \sum \text{Food consumption} \times \text{Food chemical concentration}$$

Summed for all foods

Can be adjusted for body weight

Chemical concentration data

- Maximum levels (eg Codex or FSANZ Code permissions)
- Reported use levels (from food labels or manufacturers)
- Monitored levels (raw food or commodities)
- Levels in foods as consumed (total diet study)

First estimate

Best estimate
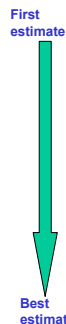
Food consumption data

simple

Per capita data (apparent consumption or food supply data, WHO cluster diets)	One data point for whole population No individual data
Model diets (constructed for age/gender groups)	One data point for each group No individual data
Household diets (Household Expenditure Survey)	Data for each household No individual data
National nutrition survey	Individual data Distributions of data

complex

Food balance sheet data

- Per capita food consumption for a country

= Food produced + food imported
  - food exported - use for animals - waste
  number of people in country

Per capita data

- Set of theoretical diets, based on food balance data (eg WHO cluster diets for different regions of the world)

- Data mainly for raw or minimally processed commodities and therefore may not be useful for information on consumption of processed or packaged food

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WHO new cluster diets

FINAL CLUSTERS
A (22)
B (9)
C (10)
D (18)
E (17)
F (7)
G (14)
H (13)
I (16)
J (10)
K (23)
L (16)
M (7)

Reference: http://www.who.int/foodsafety/chem/gems/en/index1.html

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Model diets

- Use available data on food supply, known dietary patterns or dietary survey data to construct a model diet for:

  – different age/gender groups
  – different ethnic groups
  – different regions within country
  – different life stage groups (e.g. pregnant women)

Individual dietary records

Suitable at national level:

√ 24 hour recall

√ Written diary records (1-7 days)

? Weighed food records in diary (1-7 days)

√ Food frequency questionnaire

X Diet history

X Duplicate diet records

Daily records (recall or diary)

What did you eat yesterday?

- **First morning meal (breakfast)**
  - Mid morning snack
- **Mid day meal**
  - Afternoon snack
  - Drinks
- **Evening meal**
  - Before bed snack
  - Midnight snack

Detailed food records

1st question Meal consumed?	2nd question Type of ingredients?	3rd question Amount food eaten? How was it prepared?
Noodles with meat and vegetables	What sort of noodles?	How much rice noodles?
	What kind of vegetables?	How much carrots? How much corn? Fried or steamed?
	What type of meat?	Pork? Lean or fatty? Beef? Fried or steamed?

Quantifying amounts

Real life models of foods and utensils

Quantifying amounts

3-D shapes of common containers

What % lie above this value?

20%
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%

50 150 250 350 450 550 650 750 850 950 1050 1150
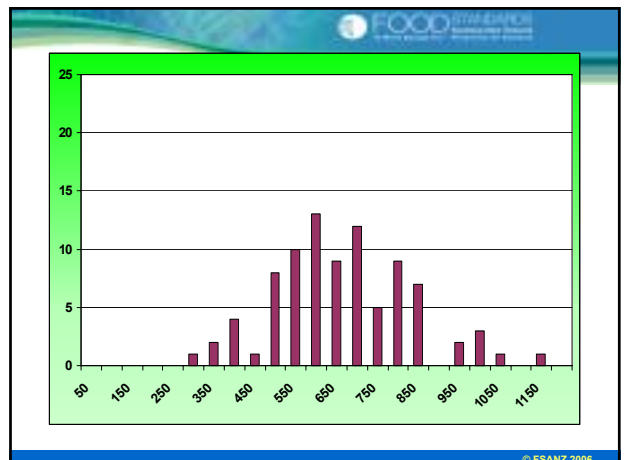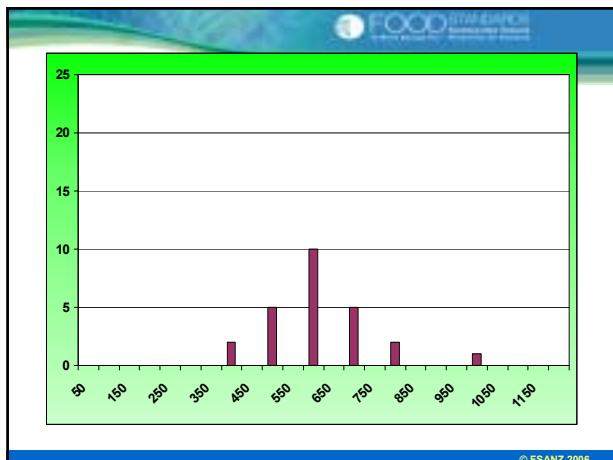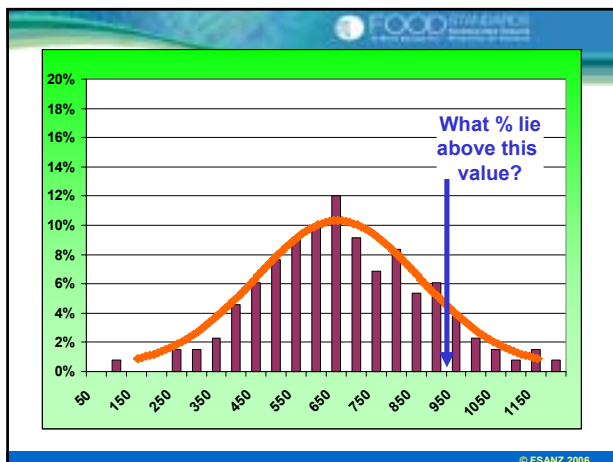
Food Frequency questionnaire
How often do you eat this food?
– every day
– 2 or 3 times a week
– once a week
– once a month

- Can give us additional useful information on <u>long term dietary patterns</u>
- **Not** a replacement data set for 24 hour records
- Can combine data sets to give a fuller picture of consumers' patterns of behavior
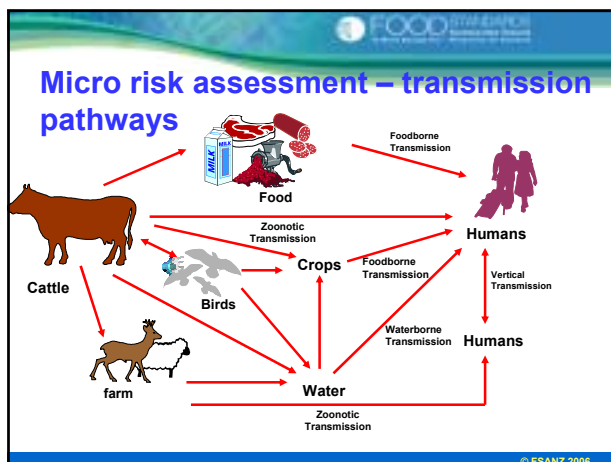

Dietary exposure assessments
How do we choose data and method?

- Case by case - depends on:
  – purpose of assessment
  – nature of hazard (time period for development of adverse effects, sensitive populations)
  – data available (quantity, quality)
  – time and resources available
  – statistical capability
  – existence and type of reference health standards

Micro risk assessment – transmission pathways

Foodborne Transmission
Food
Zoonotic Transmission
Crops
Foodborne Transmission
Humans
Cattle
Birds
Vertical Transmission
Waterborne Transmission
Humans
farm
Water
Zoonotic Transmission

Micro risk assessment

- Food consumption data used to assess contribution from food borne transmission of microbiological hazard
- 'Per serve' data more important than average daily amount

Types of Dietary Exposure Estimates

- **Chronic Exposure**: expected daily exposure to a food chemical over a lifetime or long period of time
  – use range of food consumption amounts or mean food consumption
  – can be for all people in survey (all respondents)
  – or for 'eaters only' of food containing the chemical (consumers only)
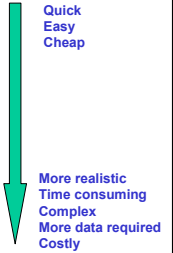
Types of Dietary Exposure Estimates

- **Acute Exposure:** expected exposure to a food chemical from short-term exposure (e.g. usually from one meal or over one day)

    – use high percentile food consumption amount (97.5th percentile)
    – 'eaters only' of food containing the chemical (consumers only)

Dietary exposure assessments of food chemicals

- Screening method
    – Aim to overestimate exposure, especially for high consumers or brand loyal customers
- Point estimate
- Probabilistic method

Quick
Easy
Cheap

More realistic
Time consuming
Complex
More data required
Costly

Point estimate or deterministic approach

EQUATION:

$$\text{Dietary Exposure} = \sum \text{Single data point consumption amount} \times \text{Single data point chemical concentration}$$

Adjusted for body weight using mean population body weight

Deterministic Approach (cont.)

Food	Mean consumption (g/day)	Mean concentration (mg/kg)	Estimated exposure (mg/day)
Rice	15.6	3.7	0.058
Oat porridge	7.1	4.3	0.031
Milk	602.6	2.9	1.748
Beef	72.7	55	3.999
Tomato	54.8	0.94	0.052
Total			**5.888**

or 0.088 mg/kg bw/day = 5.888 (exposure in mg/day) / 67 (mean body weight in kg)

Probabilistic Approach

EQUATION:

$$\text{Dietary Exposure} = \sum \text{Random food consumption amount from a distribution} \times \text{Random individual chemical concentration from a distribution}$$
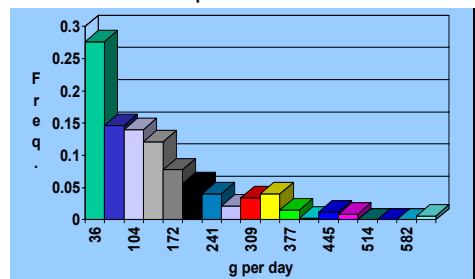
(Preferable to adjust consumption amount on a body weight basis prior to estimating exposure)

Calculation <u>repeated thousands of times</u> to give a range of estimated dietary exposures.
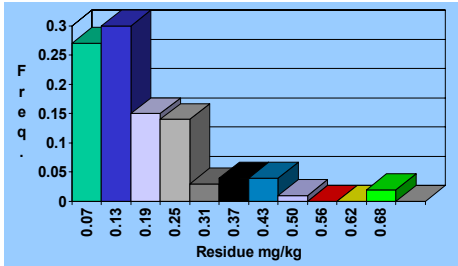

Probabilistic Approach

Consumption of Food X
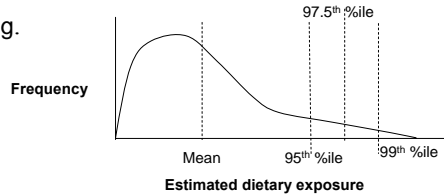
Probabilistic Approach

Residues of chemical Y

Probabilistic Approach (cont.)

- A **distribution of exposures** is obtained.
- Mean and other percentile dietary exposures can be derived from the exposure distribution.

e.g.

Probabilistic Approach (cont.)

Estimate of dietary exposure for a single food using probabilistic modelling.

Iteration	Random consumption kg/day	Individual body weight (kg)	Random concentration mg/kg	Exposure mg/kg bw/day
1	0.125	57	0.10	0.0002
2	0	63	0.20	0
3	0.273	98	0.45	0.0017
n	0.187	72	0.13	0.0003

Range of estimated exposures = 0 to 0.0017 mg/kg bw/day

Mean and percentiles can be derived from the exposure distribution.

Roles for food consumption data and dietary exposure assessments in food regulation

- Risk assessment
- Development of risk management options
- Monitoring and surveillance
  (eg Total Diet Studies, ad hoc surveys such as dioxins in seafood)
- Development of labelling standards
- Development of advisory or educational material **(eg mercury in fish advisory)**
- Input to international food standards system **(Codex, JECFA, JMPR, GEMS/Food at WHO)**

Challenges

- Limited data sets
- How to make best use of data available
- Age of food balance sheet or national nutrition survey data (changes in food supply and food habits over time)
- Adjustment of 24 hour data to account for long term or 'usual' food consumption patterns
- Applying methods for food chemicals to nutrient risk assessments (deficiency and excess)
- Using data in microbiological risk assessments