
DTU

Risk ranking of dietary risks

Parma Summer School June 11-13 2019
Morten Poulsen, Head of research group
Research Group for Risk-Benefit Assessment
National Food Institute, Technical University of Denmark
morp@food.dtu.dk

Outline

1. What is risk ranking?
2. Why do risk ranking?
3. Risk ranking – what can it be used for - example
4. Ranking of interventions
5. Risk ranking methods

What is risk ranking ?

A process where risks are assessed either quantitatively or qualitatively, to ascertain which ones have the highest likelihood of occurrence and which ones have the greatest health impact to rank the risks in order of importance

Ranking is something we all do

Ranking of dietary risks is something you do in your daily life

When you are buying, preparing and eating foods

Dependent on previous knowledge, cultural and social background, personal preferences etc.

Why do risk ranking?

Too many risks (chemical, pathogens, nutritional)

Why – do risk ranking ?

Governmental and regulatory organisations

- can use risk ranking for the prioritisation of the allocation of resources to mitigate food related hazards.

Consumers

- Important to rank risks in communication with consumers
- Distorted media debate causing unnecessary fears and need for a simple and transparent adaptive system
- Increase public trust in authorities

Risk ranking – what can it be used for?

Case from Denmark

Burden of Disease in Denmark

Objectives:

- Estimate BoD (DALY) of food-associated risks in Denmark
- **Compare and rank risks**
- Provide evidence to prioritise interventions

Food-associated risks:

- Microbiological
- Chemical
- Nutritional

Public health impact of dietary risks?

- Estimate **incidence** of the variety of foodborne diseases caused by the risks
- Compare **disease burden** taking into account
  - Incidence
  - Mortality
  - Duration
  - Severity

Overview of hazards and diseases

Pathogens

- Salmonella
- Campylobacter
- VTEC
- L. monocytogenes
- Congenital toxoplasmosis
- Yersinia
- Norovirus

Gastroenteritis

Kidney disease

Invasive infection, meningitis

Neurological disease

Sequeale – reactive arthritis, IBS

Chemicals

- Methyl-mercury
- Acrylamide
- (Inorganic) Arsenic
- BaP – barbecued meats
- Dioxins

Neurodevelopment effects ↓ (IQ)

Cancer

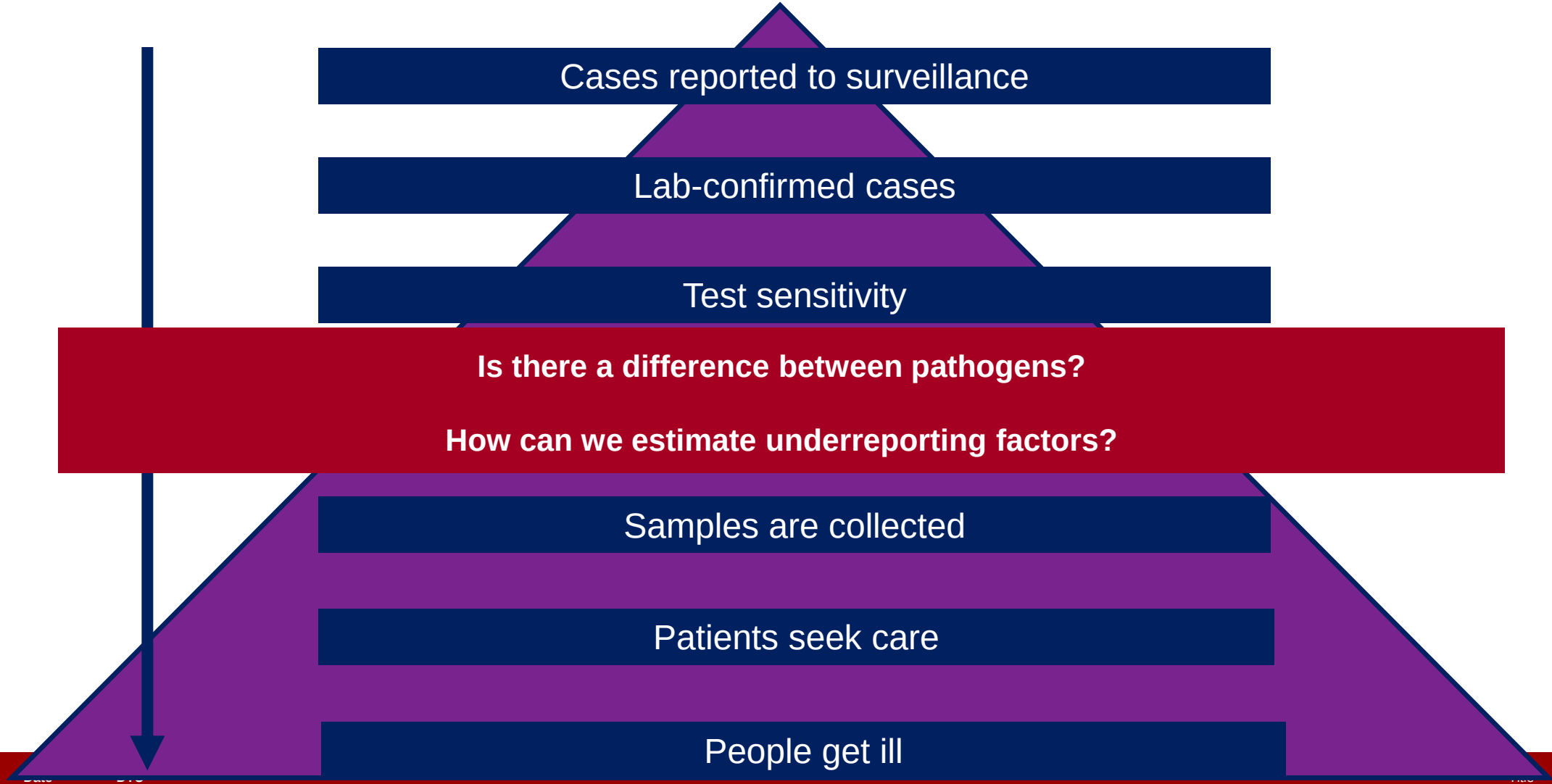
Tyroid effects

Infertelity

Foodborne chemicals
Exposure vs Disease

- Chronic disease
- Long lag time between exposure and development of disease/symptoms
- Difficult to establish cause and effect relationship

Foodborne pathogens
The surveillance pyramid

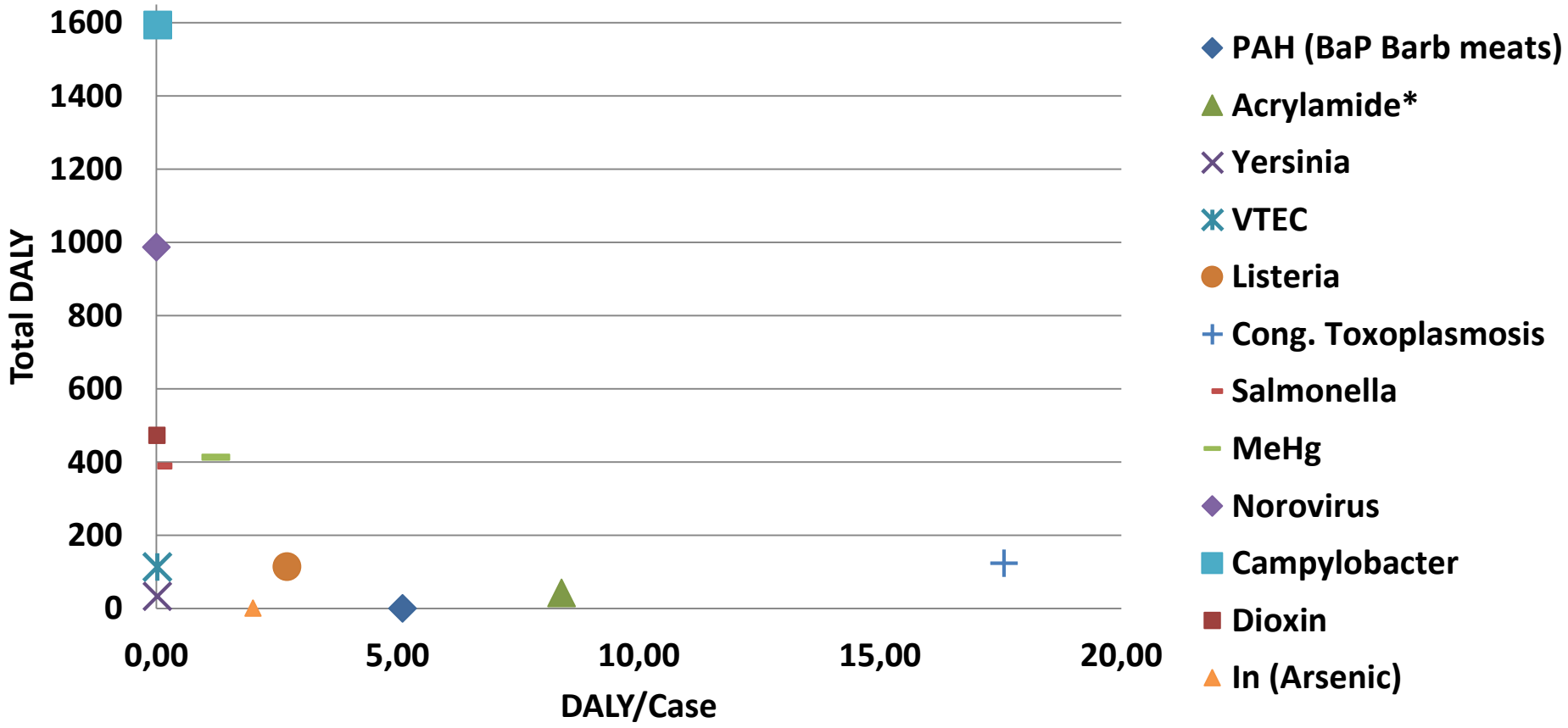


Results (still in progress)

RANKING OF FOODBORNE RISKS IN DENMARK, 2017

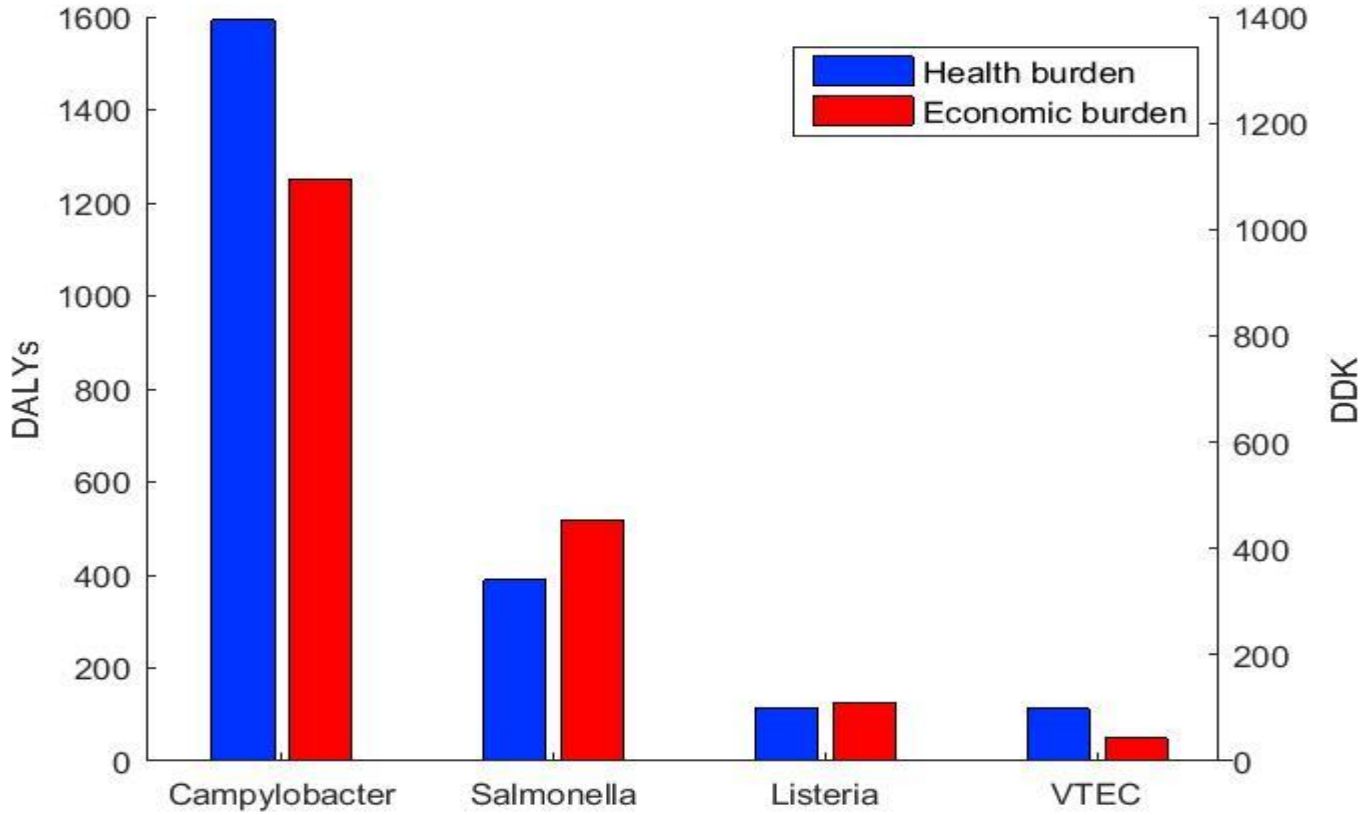
Results

DALY per case



Burden of Foodborne Risks in Denmark

Health and **Economic** Burden (2015)*



*Source: IFRO, Christensen and Dejgård, 2017

What have we learned from the ranking of dietary risks in Denmark?

Main challenges and opportunities

Comparing disease burden of chemicals and pathogens challenging

- Very different health outcomes
- Diverse levels of strength of evidence

Risk ranking exercise should be a complex integration of **various indicators**

- Health burden (incidence, mortality and severity)
- Economic impact
- Potential for and type of interventions

What's next?

- **Acknowledging**
  - DALY reduces complex information into a single number
  - Knowledge base is incomplete; large uncertainties
- **Structured approach for communication data, methods and results**
- **Nutritional risk factors**
- **Disease burden of subpopulations**
  - Diet, lifestyle, susceptibility to disease
  - *Are there clusters in the population that are "hotspots" for exposure and associated disease burden?*

GBD Compare | Viz Hub

https://vizhub.healthdata.org/gbd-compare/

GBD visualization results tool

Hosted by the Institute for Health Metrics and Evaluation (IHME), which is an independent global health research center at the University of Washington

Single | Explore | Compare ▾

Shared Settings Use advanced settings

Measure Deaths | YLDs | DALYs

Location Italy

Year 2017

Age All | <5 | 5-14 | 15-49 | 50-69 | 70+

Sex Male | Female | Both

Top chart Settings

Risk Diet low in fiber

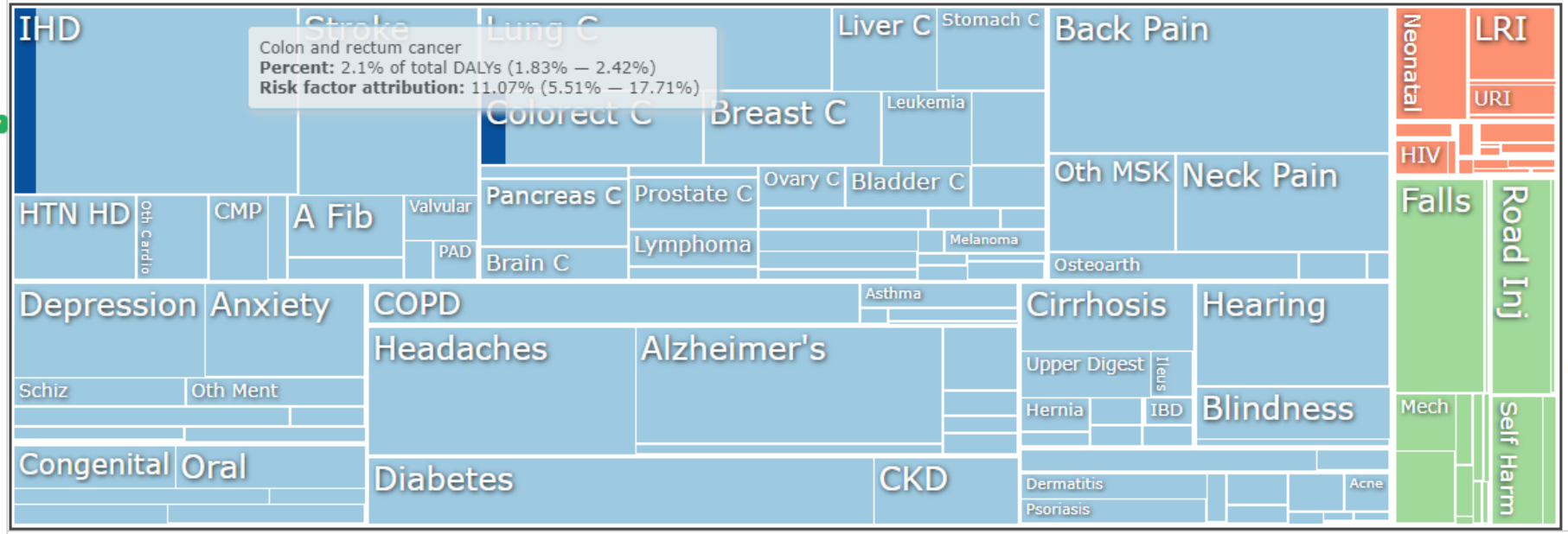
Bottom chart Settings

Risk Diet high in sodium

Take tour ▶

IHME

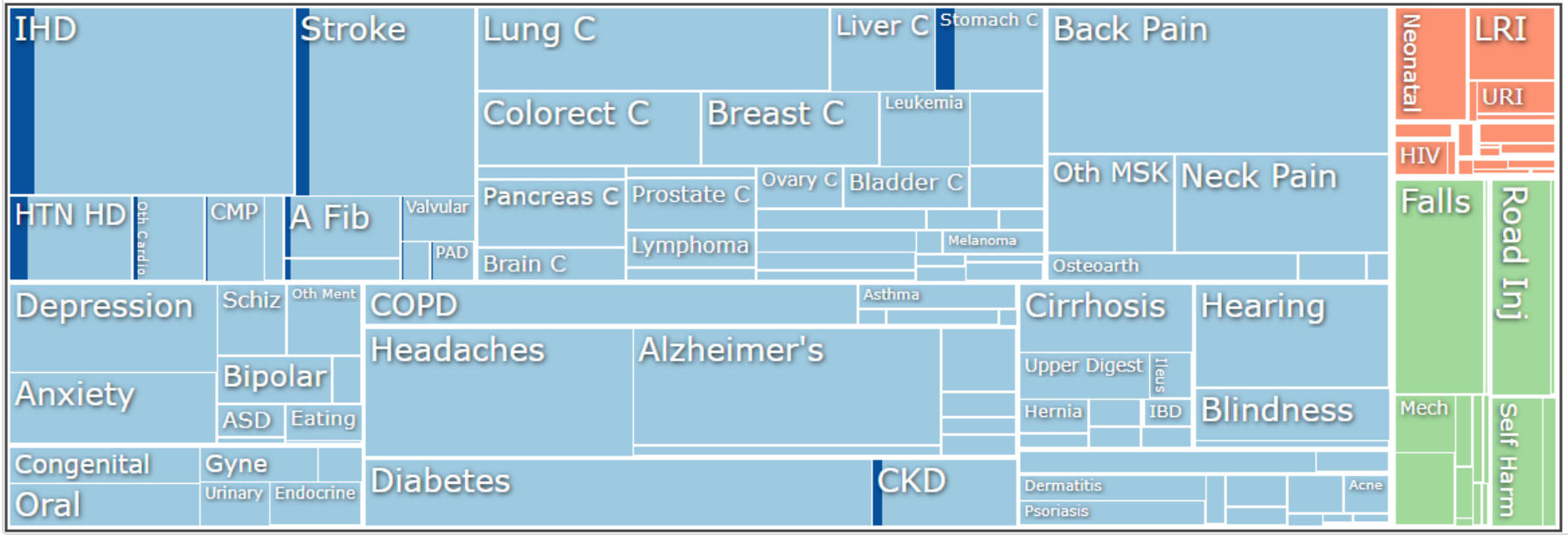
Italy
Both sexes, All ages, 2017, DALYs attributable to Diet low in fiber



DALYs attributable to risk

DALYs not attributable to risk

Italy
Both sexes, All ages, 2017, DALYs attributable to Diet high in sodium



DALYs attributable to risk

DALYs not attributable to risk

Ranking of food safety interventions

To prioritise effective **food safety interventions**, it is important to determine:

1. **What is the public health impact of different (foodborne) diseases?**
   How do we compare and prioritise diseases?

2. **What causes these problems?**
   How do we identify sources of disease and routes of transmission

3. **What are the options for intervention?**
   Which are more effective?

4. **How do we measure the effect of each intervention?**

EFSA supporting publication 2015:EN-710

EXTERNAL SCIENTIFIC REPORT

CRITICAL REVIEW OF METHODOLOGY AND APPLICATION OF RISK RANKING FOR PRIORITISATION OF FOOD AND FEED RELATED ISSUES, ON THE BASIS OF THE SIZE OF ANTICIPATED HEALTH IMPACT[1]

H.J. van der Fels-Klerx[1], E.D. van Asselt[1], M. Raley[2], M. Poulsen[3], H. Korsgaard[3], L. Bredsdorff[3], M. Nauta[3], V. Flari[4], M. d'Agostino[4], D. Coles[2], L. Frewer[2]

[1]RIKILT, Wageningen University and Research Centre, Akkermaalsbos 2, NL-6708 WB, Wageningen, the Netherlands; [2]University of Newcastle, School of Agriculture, Food and Rural Development, Agriculture Building, Newcastle Upon Tyne NE1 7RU, UK; [3]Technology University of Denmark, National Food Institute, Morkhoj Bygade 19, Soborg, Denmark; [4]Food and Environmental Research Agency, Sand Hutton, York, North Yorkshire, YO41, 1 LZ, UK.

Risk Ranking Methods

This study gives an overview of available risk ranking methods.

Each of the methods was critically reviewed to extract the potentials and limitations.

The study covered toxicological, biological and nutritional health risks of well-known chemical substances, biological agents and nutritional components in food and feed.

An extensive literature search was performed to identify the available methodologies for risk ranking in the fields of feed and food safety and nutritional hazards

Risk Ranking Methods

The various methods for risk ranking included:

- **Risk assessment**
- Comparative risk assessment
- **Risk ratio method**
- Scoring method
- Cost of illness
- **DALY/QALY**
- Willingness to pay
- **Multi criteria decision analysis**
- **Risk matrix**
- Flow charts/decision trees
- **Expert judgment methods**

Risk Ranking Methods

Table 1: Results of the literature search in the two-tier approach

Subject (per partner organization)	**Tier 1: Title, abstract, keywords**			**Tier 2: Full text**	
	Not relevant	Maybe relevant	Relevant	Not relevant	Relevant
Chemical hazards	5769	79	173	5943	101
Microbiological hazards	2601	74	257	2844	110
Nutritional hazards	979	58	12	1045	4
DALY/QALY concept	90	13	9	98	18
Socio-economic methods	3296	47	15	3366	20

A few examples…

Risk Ranking Methods

Risk Assesssment

Strengths:

All scientific and technical information and data, as well as variability and uncertainties, are systematically organized. It is thus a very structured method, providing insights into what is known and the gaps in knowledge

Weaknesses:

A risk assessment for one chemical hazard will need a lot of data, knowledge and resources (manpower, money). Risk ranking of various chemical

hazards in food using outcomes of individual risk assessment will take even more resources.

Uncertainties related to chemical risk assessments are very high because of data limitations. Ranking of chemicals may be difficult, with large and overlapping uncertainty ranges for the risks of the different chemicals.

Risk Ranking Methods

Risk Ratio

Strengths:

Easily applied once concentration data and toxicological reference values are available, and is easy to understand.

A full risk assessment is not necessary, rather an estimate for both amounts of the hazard consumed and the effect of the hazard on human health

Weaknesses:

For emerging chemical hazards, such as nanomaterials, toxicological reference values are usually not available. Furthermore, concentration data are also not always easily available. It may thus be difficult to rank all hazards of interest due to data limitations

Risk Ranking Methods

Risk Matrices

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Severe
Almost certain	M	H	H	E	E
Likely	M	M	H	H	E
Possible	L	M	M	H	E
Unlikely	L	M	M	M	H
Rare	L	L	M	M	H

Risk Ranking Methods

Multi-Criteria Decision Analysis

Strengths:

Allows inputs from stakeholder perception by assigning weights to the various criteria used in the analysis. Furthermore, apart from human health criteria, economic impact or other criteria that are deemed relevant can be included. Broadly applicable allowing risk assessors/managers to determine the impact of various criteria on the overall risk ranking of hazards. This method thus allows to include subjective elements that may also be important for risk managers to include in their decision making process.

Weaknesses:

The outcome is more difficult to communicate than more straightforward methods such as risk matrices or scoring methods as various criteria are included each having different weights. Furthermore, this method needs expert or stakeholder input in order to derive the weights for the criteria.

Swedish (NFA) Risk Thermometer

Ranking of 34 chemicals

severity-adjusted margin of exposure approach (SAMOE)

- HBGVs established by EFSA/WHO/U.S. EPA

- Estimate of Swedish mean dietary exposure

- Selection of severity factor (SF)

- SAMOE = HBGV / (exposure × SF)

Results used as a basis for development of NFA Food Control Program

Currently, the method is applied to ≈ 70 chemicals evaluated by EFSA (Langerholc et al., 2018)

Chemical	SAMOE	Risk class
dioxin	0.14	3
Al	0.17	3
Hg	0.17	3
Pb	0.22	3
Ni	0.45	3
Cd	0.63	3
iAs	1.3	2
3-MCPD	1.6	2
Deoxynivalenol	2.6	2
zearalenone	2.6	2
T2 and H2	3.1	2
glycidol	5.2	2
BDE-99	5.5	2
I-PFOS	7.0	2
fumonisins	8.3	2
I-PFOA	8.9	2
ochratoxin a	15	1
BDE-153	19	1
ndl-PCB	24	1
BDE-47	29	1
PAH4	33	1
BaP	34	1
HCB	74	1
Cu	88	1
Cr III	530	1
DDT	930	1
HBCD	982	1
CP (sum)	2436	1
TCDPP	4743	1
Ag	6182	1
TCEP	13126	1
TPHP	26042	1
BDE-209	26443	1
TCPP	33731	1

Swedish Risk Thermometer

- categorizes the SAMOE values in terms of five health concern levels
-
- Graphical and simplified results for external communication

- Shown on the NFA web page

- Indicates only the “Risk Class”
- Value of continuous ranking metric (SAMOE), and uncertainty (in SAMOE) not shown

Thank you