Methylmercury Exposure of Vulnerable Groups

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Benefits of Fish Consumption

- Fish can include fish and seafood, can be used interchangeably, and can be defined as fin fish (vertebrates: herbivorous, omnivorous, piscivorous) and shellfish (invertebrates), of marine or freshwater origin, farmed or wild.
- Fish and seafood are healthy components of human nutrition
  - Fish is considered as an integral component of a well-balanced diet and provides a healthy source of:
    - Energy,
    - High-quality proteins,
    - Various vitamins (D, A, E and B12),
    - Various essential metals (Se, Mn and Cu),
    - And especially omega-3 fatty acids (also called omega-3 fats and n-3 fats), long-chain n-3 polyunsaturated fatty acids (LCn-3PUFAs), mainly Eicosapentaenoic acid, EPA, 20:5n-3, and Docosahexaenoic acid, DHA, 22:6n-3, play a role in health promotion and disease prevention.

Benefits of Fish Consumption

- LCn-3PUFAs:
  - Play a vital role in human health from conception through every stage of human development, maturation and aging;
  - Reported health benefits include contributing to normal neurodevelopment in children and lowering the risk of cardiovascular heart diseases.
  - Biomedical evidence supports the importance of nutrients in fish in promoting normal nutrition for growth, development, and health maintenance.

Benefits of Fish Consumption

Pregnant and Breastfeeding Women

- Numerous large epidemiological studies have demonstrated that maternal DHA intake from seafood consumption is associated with improved cognitive development: Great Britain, Europe, Republic of the Seychelles, United States and Denmark Strain (2004-2015).
- In those studies it was:
  - Demonstrated that women who eat greater than 12 ounces of fish per week give birth to babies with better cognitive performance, or
  - It correlate fish consumption during pregnancy with cognitive development, or
  - Omega-3 intake from marine sources improved cognitive function in Inuit children whose seafood is known to contain high levels of methyl mercury

References:
Harris MA & Lammi-Keefe CJ (2016) Pregnant Women and Consumption of Fish: Where are We?. In Fish and Fish Oil in Health and Disease Prevention, pp. 49-60 [S Raatz & D Bibus Eds]. Elsevier.

Benefits of Fish Consumption

Concluding Remarks

- There is convincing evidence, from extensive prospective cohort studies and randomized trials in humans, together with supportive retrospective, ecological, metabolic and experimental animal studies, of beneficial health outcomes from fish consumption for:
  - Improved neurodevelopment in infants and young children when fish is consumed by the mother before and during pregnancy.
  - Reduction in risk of coronary heart disease.
- There is emerging possible/probable evidence that fish consumption may reduce the risk of multiple other adverse health outcomes, including ischemic stroke, non-fatal coronary heart disease events, congestive heart failure, atrial fibrillation, cognitive decline, depression, anxiety and inflammatory diseases.
- Eating fish is a part of the cultural traditions of many people/populations, and in some populations fish is a major source of food and essential nutrients in their daily diet.
- In some communities fish can be the primary food source that contributes substantially to food security.

Risks of Fish Consumption

Prenatal exposure

- Depending on the dose and timing of exposure to methylmercury during gestation, the effects may be severe and immediately obvious, or subtle and delayed.
- Effects of prenatal methylmercury exposure, the neurological symptoms include:
  - Mental retardation
  - Ataxia & cerebral palsy
  - Seizures
  - Vision & hearing loss
  - Delayed developmental milestones
  - Language disorders
  - Deficits in fine motor function
  - Visual spatial disabilities
  - Memory problems

Environmental factors

- Metal contaminants* are naturally present in the environment but can be increased through industrial activity and pollution.
- The concentrations and uptake of these metals in (marine) organisms are subject to environmental and species-specific biological factors as well as the chemical and physical state of the metals.
- Different fish species accumulate metals at different rates and to different levels (herbivorous fish, omnivorous, carnivorous fish).
- Different metals accumulate differently within the same fish species.
- One specific metal is accumulated at different levels in different tissues within one fish.


Fish advisories have been developed to balance the presence of chemical contaminants in fish vs. the benefits of fish consumption.

- Driven forces the public health responsibilities and/or growing public concern.
- Based on national/local data and professional knowledge the advisories on the health risks vs. health benefits of fish consumption can be more or less detailed and are country/location specific.
Fish Advisories

- Based on target(group) there will be a different:
  - Format
  - Design
  - Detail
Fish Advisories
The proper design

- The ratio behind it:
  - Identify the population at risk;
  - Minimize the risk in target population;
  - Based on (research) data;
  - Consider a holistic approach;
  - Information exchange and education;
  - Proper risk communication strategies.

Fish Advisories
The proper design

Identification population at risk:
- In recent years, the evolving science and debate concerning the benefits and risks of consuming fish have resulted in confusion as to how much, or even if, fish should be consumed, and by whom.
- International and national food safety agencies have recognized the need to provide useful, clear and relevant information to populations that are concerned about making the healthiest choices when considering whether or not to eat fish.
- The population groups that can be distinguished are: women of reproductive age, pregnant or nursing women, breastfed infants and young children, and high fish consumers.

Fish Advisories
The proper design

Minimize the risk in target population:
- Fish consumption may pose toxicological risks, including neurodevelopmental delay, in fetuses and young children. Notably, these same groups are also sensitive populations for neurodevelopmental risks from not consuming fish.
- The health benefits and risks are likely to vary according to the fish species, fish size, and harvesting and cultivation practices, as well as the amount consumed, which depends on seasonal variations, personal preferences, cultural influences, etc.

Fish Advisories
The proper design

Based on (research) data:
- Several international risk–benefit activities can serve as examples for the kind of framework needed for the quantitative consideration of the risks and benefits of fish consumption.
- Benefit-Risk Analysis of Foods, BRAFO, tiered approach for benefit-risk assessment of foods:
  - Tier 1, each risk or benefit is assessed independently.
  - Tier 2, risks and benefits are compared in a qualitative way.
  - Tier 3, risks and benefits are integrated quantitatively in a common metric by a deterministic approach.
  - Tier 4, risks and benefits are integrated quantitatively in a common metric by a probabilistic approach.

Fish Advisories
The proper design

- Risk–benefit assessment methodology European Union:
  - Benefit-Risk Assessment for Food: An Iterative Value-of-Information Approach (BENERIS) project, a framework for handling complicated benefit risk situations and apply it for the analysis of benefits and risks of certain foods. The first food commodity that was used was fish. Clustered with the Quality of Life – Integrated Benefit and Risk Analysis (QALIBRA) project developed a web-based tool for assessing food safety and health benefits (2006–2009).
  - Scientific Committee of the European Food Safety Authority (EFSA) developed a guidance document for performing risk–benefit assessments of food (2010). It does not address cost-effectiveness or other ethical, social or economic considerations. It is a guidance document similar to the BRAFO methodology. Both methods identify the need for proper problem formulation before the actual assessment is performed, there is overlap between the tiers/steps.
  - Risk-benefit characterization through integration of risks and benefits by expressing them in a common metric, such as the disability adjusted life year (DALY) or quality-adjusted life years (QALYs).
Fish Advisories
The proper design

- In 2006, as a result of conflicting consumer messages and lack of consensus in the scientific community, the National Oceanic and Atmospheric Administration, USA, commissioned a report by the Institute of Medicine of the National Academies, with support from the USFDA, to evaluate the risks and benefits associated with seafood consumption.

- It also made recommendations for consumers in the USA, to create a more comprehensive understanding that would enable consumers to make educated decisions when selecting seafood (Nesheim and Yaktine, 2007).

The Institute of Medicine (IOM) developed a step-by-step decision framework, which evaluated the risks and benefits of seafood consumption based on scientific evidence to examine four population groups:

1. Females who are or may become pregnant or who are breastfeeding,
2. Children up to 12 years of age,
3. Healthy adolescent and adult males and females (who as defined by the IOM report will not become pregnant), and
4. Adult males and females who are at risk of coronary heart disease.

A decision pathway was then created with this information, highlighting the factors for categorizing consumers in specific target groups that face different benefits and risks and that should receive appropriately tailored advice.


The output of the Expert Consultation is a framework for assessing the net health benefits or risks of fish consumption that will provide guidance to national food safety authorities and the Codex Alimentarius Commission in their work on managing risks, taking into account the existing data on the benefits of eating fish.

The risks and benefits of fish consumption: specifically, a comparison of the health benefits of fish consumption with the health risks associated with the contaminants methylmercury and dioxins.

WHO human health risk assessment toolkit: chemical hazards. (IPCS harmonization project document; no.8), WHO/IPCS, 2010

Other international/regional risk–benefit activities as examples for the kind of framework needed for the quantitative consideration of the risks and benefits of fish consumption?
Fish Advisories

The proper design

- Gaps in data:
  - Local food consumption data studies, qualitative and quantitative.
  - Local existing databases on specific nutrients and contaminants, particularly methylmercury, in fish consumed.

Fish Advisories

Information exchange and education:

- To minimize risks in target populations, the Joint FAO/WHO/EC recommendations steps Member States can take to better assess, manage risks, and benefit of fish consumption, and more effectively communicate with their citizens:
  - Acknowledge fish as an important food source of energy, protein and a range of essential nutrients and consumption as part of cultural traditions of many peoples.
  - Emphasize the benefits of fish consumption on reducing mortality from coronary heart disease and the risks of morbidity from coronary heart disease associated with not eating fish for the general adult population.
  - Emphasize the net neurodevelopmental benefits to offspring of women of childbearing age who consume fish, particularly pregnant women and nursing mothers, and the neurodevelopmental risks to offspring of women of childbearing age who do not consume fish.
  - Develop, maintain and improve existing databases on specific nutrients and contaminants, particularly methylmercury, in fish consumed in their region.
  - Develop and evaluate risk management and communication strategies that both minimize risks and maximize benefits from fish consumption.

Fish Advisories

Proper Risk Communication Strategies

- Trust:
  - Is there public trust in the regulator?
  - It can be reallocated, public trust individuals or special interest groups who are perceived not to have vested interest in the subject add hand. These individuals or special interests groups can become rather powerful in setting the regulator agenda.

- Regulator:
  - Inaction against real risks can undermine public trust.
  - Especially if not well represented in areas of the country where it’s an issue of concern because of limited capacity, knowledge, etc.
  - Work together with initiatives and focus on guidance and how?