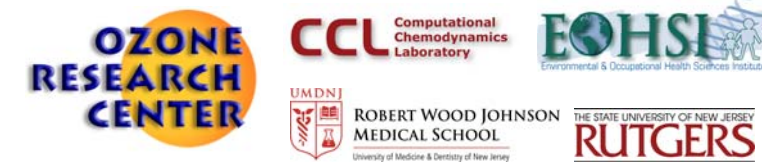


Modeling Cumulative and Aggregate Exposures of Co-occurring Multimedia Contaminants in a Probabilistic Source-to-Dose Framework - Case Study: Hg and MeHg

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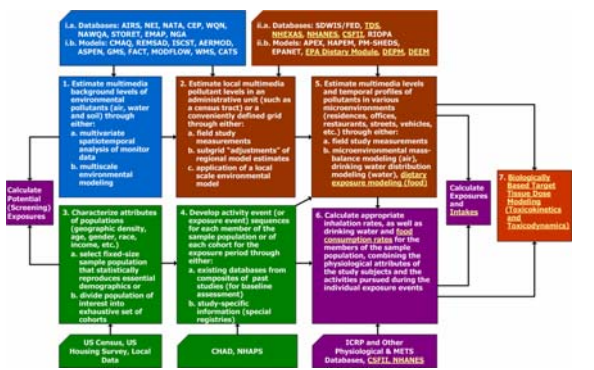


Introduction

MENTOR/SHEDS-4M[®] is a probabilistic framework for source-to-dose exposure and risk assessments. It dynamically links biologically-based modules with environmental, microenvironmental, and human activity modules. This poster presents a case study of human dietary exposure to Hg and MeHg for the general population in Oswego County, NY. Databases for food consumption patterns, food residue and other auxiliary data were used to model short term and long term dietary exposures for the target populations. Physiologically Based Toxicokinetic (PBTK) modeling was used to estimate target tissue mercury concentrations and biomarkers. Results are compared with available biomarker measurements from the NHANES and NHEXAS databases.

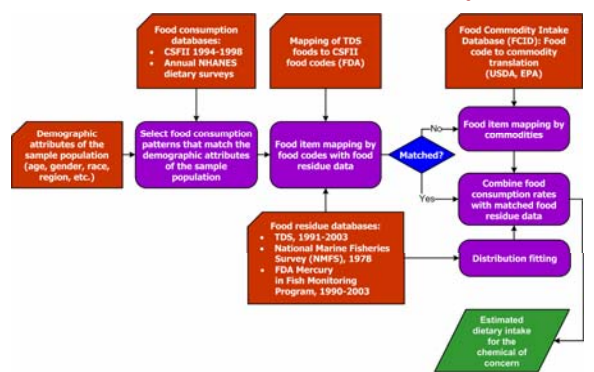
*Modeling Environment for Total Risk studies incorporating the Stochastic Human Exposure and Dose Simulation approach for Multiple co-occurring contaminants and Multimedia, Multipathway, Multiroute exposures (4M)

Generalized 7-Step Flowchart of the MENTOR/SHEDS-4M System

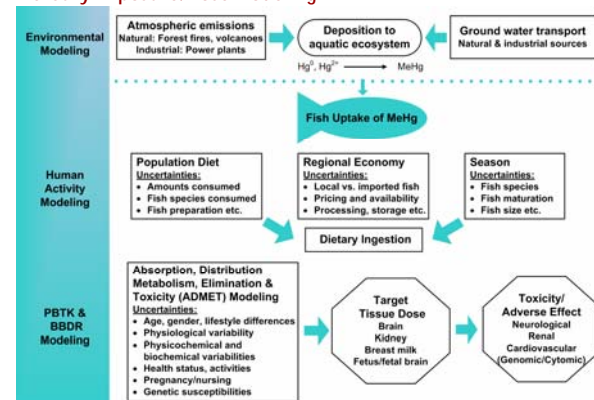


Steps involved in the multiroute application of MENTOR/SHEDS for assessing individual and population exposures and doses to mercury. Dietary pathway components are highlighted in yellow.

Structure of the Probabilistic USEPA-NERL Dietary Module



Some Issues and Uncertainties Related to Dietary Mercury Exposure/Dose Modeling

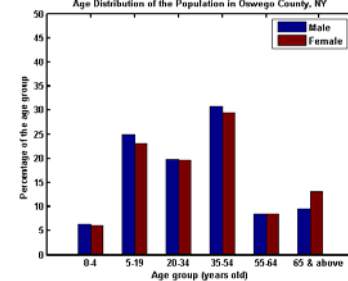
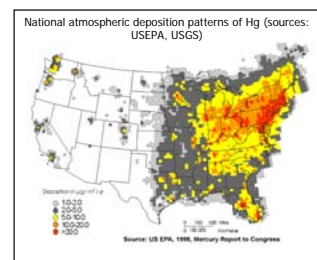


Data Sources Used for Modeling Dietary Exposure to Hg and MeHg

Type of Data	Database	Source
Food Consumption Patterns	Continuing Survey of Food Intakes by Individuals (CSFII) 1994-98	USDA
	National Health & Nutrition Examination Survey (NHANES) Annual Data	CDC
Food Residue	Total Diet Study (TDS) 1991-2003	USFDA
	National Marine Fisheries Survey (NMFS) 1978	NOAA
	Mercury in Fish Monitoring Program 1990-2003	USFDA
	National Listing of Fish Advisories	USEPA
	Great Lakes Fish Consumption Advisories	GLIN (Great Lakes Information Network)
Mapping of Food Consumption to Food Residue	Food Commodity Intake Database (FCID)	USDA, USEPA
	Mapping Profile of TDS Foods to CSFII Food Codes	USFDA

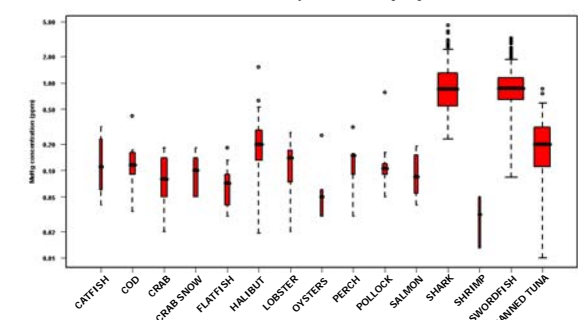
MENTOR/SHEDS-4M Evaluation Case Study

This case study was conducted to simulate human exposure to Hg and MeHg through the dietary pathway for the general population in Oswego County, NY. 10,000 "virtual individuals" were generated to match the demographic characteristics of Oswego County (Data source: US Census Survey 2000).



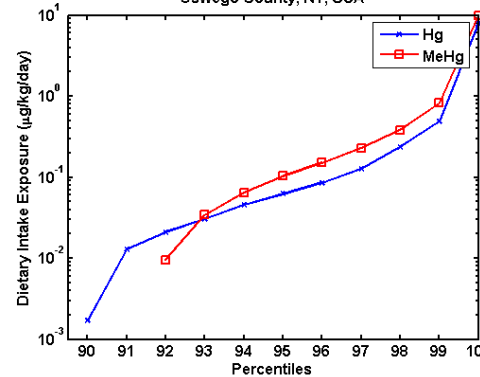
MeHg Concentrations for Selected Species of Fish Most Commonly Consumed in the U.S. Commercial Seafood Market

Data Source: USFDA's Mercury in Fish Monitoring Program (1991-2003)



Short Term Dietary Exposure Modeling (Simulation Period: 1 Day)

Oswego County, NY, USA



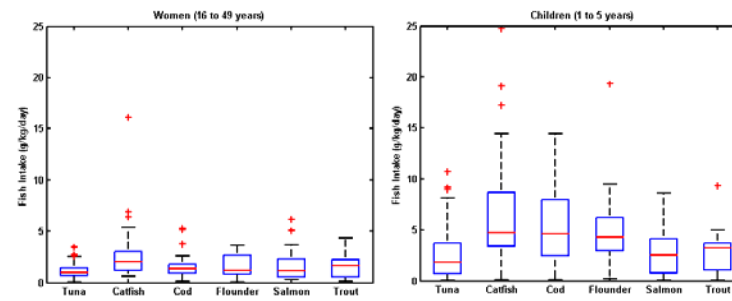
Cumulative Hg and MeHg dietary exposure distributions for the total population of Oswego County, NY, calculated by the MENTOR/SHEDS Population Based Model. Approximately 10% of the population are exposed to Hg and MeHg above the level of 2×10^{-3} µg/kg/day through the dietary pathway.

Long-Term Dietary Exposure Modeling

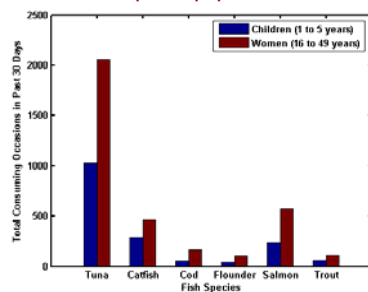
> Food consumption surveys (e.g. CSFII) only provide dietary consumption rates for short-term periods (24-h recall data)
> Food frequency questionnaires (e.g. NHANES data from 1999 onwards) provide eating patterns over a longer time period (such as 30 days), but food consumption details are not collected (e.g., quantity and ingredients)
> The following approach was used to bridge data from above two surveys for estimating longitudinal dietary intake distribution (*Tran et al., 2004):

- (1) mapping 249 CSFII food codes to 31 NHANES fish/shellfish food categories
- (2) estimating distributions of fish/shellfish intake per eating occasion
- (3) estimating month-long (30 day average) daily fish/shellfish intake

Fish intake distributions for selected fish species for two susceptible populations in the U.S.: women 16-49 yrs of age (child-bearing age) and children 1-5 yrs of age (Data Source: USDA's CSFII, 1994-1996, 1998)

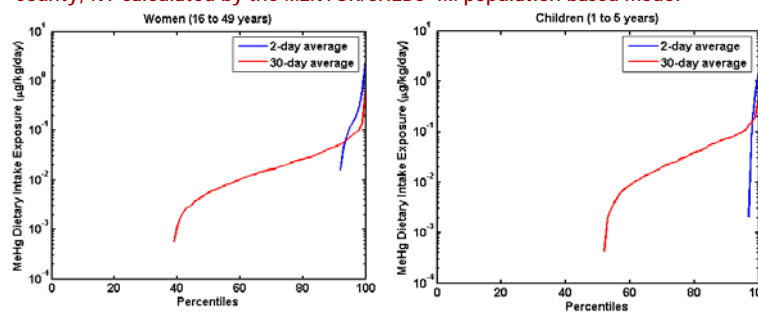


Consumption frequency of selected fish species for two susceptible populations in the U.S.



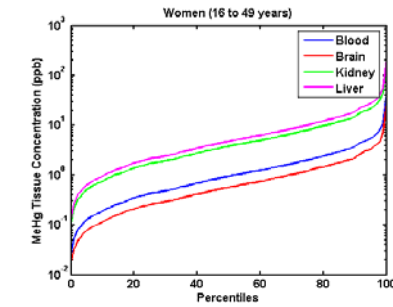
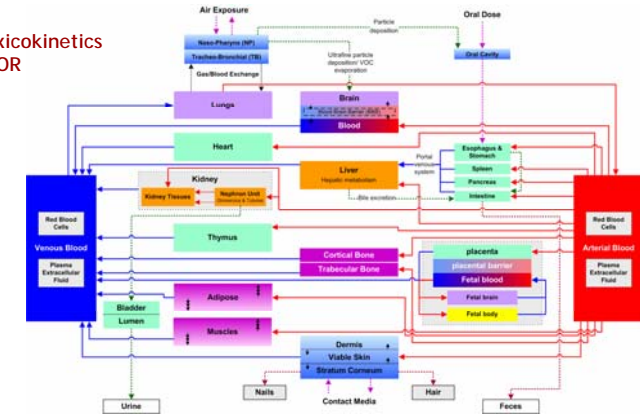
Total number of consuming occasions for selected fish species reported in past 30 days for two susceptible populations in the U.S.: women 16-49 yrs of age (child-bearing age) and children 1-5 yrs of age (Data Source: CDC's NHANES 2001-2002)

Cumulative MeHg dietary exposure distributions for two age groups of Oswego County, NY calculated by the MENTOR/SHEDS-4M population based model



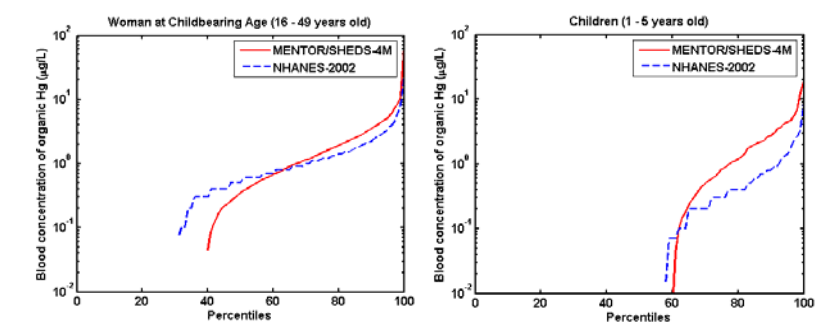
Physiologically-Based Toxicokinetics (PBTK) modules of MENTOR

These modules incorporate age/gender specific parameter distributions and are designed to support probabilistic assessments of cumulative and aggregate exposures/doses

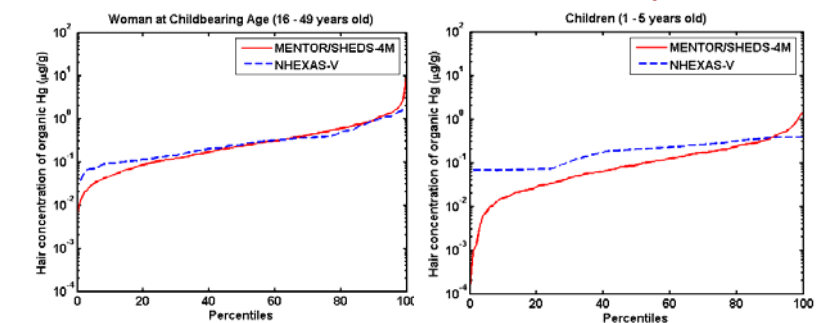


Cumulative distributions of MeHg target tissue concentrations calculated by the MENTOR/SHEDS population based model for the susceptible group of women of childbearing age in Oswego County, NY

Comparison of predicted and observed cumulative distributions of MeHg blood concentrations from MENTOR/SHEDS-4M calculations and NHANES-2002 measurements



Comparison of predicted and observed cumulative distributions of MeHg hair concentrations from MENTOR/SHEDS-4M calculations and NHEXAS-V measurements



Preliminary Conclusions and Discussion

The case study of dietary exposure to Hg and MeHg showed that the major contribution of dietary Hg and MeHg exposure is due to consumption of fish. The one-month simulation can characterize dietary intake distributions above the level of 10^{-3} µg/kg/day for a larger portion of the study population than the one-day simulation. The predicted distributions of MeHg biomarker (blood and hair) concentrations calculated from MENTOR/SHEDS-4M are comparable to the observed concentrations from NHANES-2002 and NHEXAS-V. Future efforts will include assembling/organizing and evaluating available (geo)databases in different scales (from national to regional/local) and performing focused case studies to characterize exposures of the general population and selected subpopulations (e.g. sport and subsistence anglers) and biologically relevant doses.

Acknowledgements

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*Tran, N.L., Barra, L., Smith, K., Javier, A., and Burke, T.A. 2004. Combining food frequency and survey data to quantify long-term dietary exposure: A methyl mercury case study. Risk Analysis 24 (1):19-30.