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while adjusting for covariates. We determine the degree of smoothing (span size) by minimizing the AIC and use a permutation test of the null hypothesis that the map is flat.

Methods: We used synthetic data generated under the null to evaluate the type I error rates of hypothesis tests. We examined several variations of the GAM approach: the χ^2 test provided by R or Splus, a conditional permutation test (using the span of the observed data for all permutations), a fixed-span permutation test (using multiple span sizes selected a priori with a Bonferroni-like correction), and an unconditional permutation test (recomputing the optimal span for each permutation). We compared the methods under 3 alternative hypotheses: a circular area of elevated risk (hot spot); a point source where risk decreases with distance; and a line source where risk decreases with distance. The theoretical power for each hypothesis was computed.

Results: SatScan and the fixed-span and unconditional permutation tests had appropriate type I error rates. The type I error rates for the conditional and χ^2 tests were elevated. We proposed a simple correction for the former. SaTScan had better power than the GAM methods for the hot spot (SaTScan is designed to find the most likely circular cluster). The GAM methods had superior power to SaTScan for other alternative hypotheses. The unconditional permutation test had reduced power when it was examined and was computationally intensive.

Conclusion: The relative power of the methods depended on the alternative hypothesis under consideration. SaTScan performed better for the circular hot spot; GAM performed better for the other hypotheses.

EXPOSURE ASSESSMENT BY VARIOUS MEDIA AND PATHWAYS

O-30A6-2

Retrospective Exposure Estimation for Perfluorooctanoic Acid (PFOA) for Participants in the C8 Health Project

Hyeong-Moo Shin,[1] Verónica Vieira,[2] P. Barry Ryan,[3] Russell Detwiler,[1] Brett Sanders,[1] Kyle Steenland,[3,4] and Scott Bartell[1] *[1]University of California, Irvine, CA; [2]Boston University, Boston, MA; [3]Emory University, Atlanta, GA; and [4]C8 Science Panel, Atlanta, GA.*

Background/Aims: The primary source of PFOA in the environment of eastern Ohio and western West Virginia is believed to be the Washington Works facility. Percolation of deposited PFOA through the soil and pumping by industrial and municipal wells near the contaminated Ohio River is thought to explain elevated well water concentrations and human serum concentrations measured in recent years. Our objective is to estimate historical PFOA exposures and serum concentrations experienced by each of about 45,276 non-occupationally exposed participants in the C8 Health Project, based on their residential histories.

Methods: We linked several environmental fate and transport models including AERMOD, PRZM3, BREZO, MODFLOW, and MT3D to simultaneously model PFOA air dispersion, transit through the unsaturated soil zone, surface water transport, and groundwater flow and transport. Annual PFOA exposure rates were estimated for each individual based on predicted calibrated water concentrations and predicted air concentrations, and default assumptions from the EPA Exposure Factors Handbook. Self-reported municipal water sources were verified using geocoded addresses and historical water distribution network maps for 6 municipal water districts. Individual exposure estimates were coupled with a one-compartment pharmacokinetic model to estimate annual serum PFOA concentrations.

Results: Predicted water concentrations were within 2.3 times the observed mean water concentrations for all 6 municipal water districts. Predicted and observed median serum concentrations in 2005–2006 are 28.2 and 24.3 ppb, respectively (Spearman's rho = 0.66). Stratified by municipal water source at the time of the serum sample, Spearman rho ranges from 0.19 to 0.34.

Conclusion: State-of-the-art fate and transport models provide the most defensible retrospective exposure estimates for epidemiologic studies when historical environmental measurements are lacking but source emissions rates are known. Our models predict recently observed municipal water PFOA concentrations and human serum PFOA concentrations surprisingly well, and will be used in a variety of epidemiologic studies being conducted in this region.

O-30A6-3

Dietary Exposure Assessment of the 18-month-old Guadeloupian Toddlers to Chlordecone

Sophie Seurin,[1] Florence Rouget,[2] Jean-Charles Leblanc,[1] and Fanny Héraud[1] *[1]AFSSA, French Food Safety Agency, Maisons-Alfort, France; and [2]INSERM U625, National Institut of Health and Medical Research, Rennes, France.*

Background/Aims: Chlordecone is an organochlorine insecticide used in the banana culture of the French West Indies until 1993. Previous studies revealed its wide presence in water and soils. Consumption of contaminated food is a source of exposure. Because of physiological and behavioral differences, toddlers are expected to be differently exposed than children and adults. The aim of the study is to assess the dietary exposure to chlordecone of 18-month-old Guadeloupian toddlers.

Methods: Dietary exposure of chlordecone is estimated through models using consumption and contamination data. Consumption data derive from a dietary survey joined to the epidemiological mother-child cohort TIMOUN conducted between 2005 and 2008 and focused on 240 children aged 18 months. Food contamination data come from the RESO study performed in Guadeloupe during years 2005–2006. Different scenarios are studied depending on whether the subjects live on a soil-contaminated place or not and on their supply habits.

Results: Mean dietary exposure of chlordecone is estimated in a range of 0.02–0.04 μg/kg bw/d (P95: 0.04–0.11) for toddlers living in a noncontaminated area while it is estimated between 0.04 and 0.07 μg/kg bw/d (P95: 0.08–0.13) for toddlers living in a contaminated area. Whatever the dietary exposure scenario considered, the probability of exceeding the chronic health-based guidance value of 0.5 μg/kg bw/d is null.

Conclusion: The study shows that 18-month-old toddlers appear to be less exposed than older population subgroup. This is explained by consumption pattern mostly based on milk and fruits, which are not highly contaminated. Fish products and tropical roots, which are the main contributors to the food exposure of the older people, have not been yet introduced in the diet or are not consumed in important quantities by toddlers. These dietary exposure estimates have now to be associated to the developmental milestones measured in the TIMOUN cohort.

O-30A6-4

Total-body Exposure to Metal Sensitizers: Inhalation, Ingestion, and Skin Contact

Aleksandr Stefaniak, M. Abbas Virji, and Gregory Day *National Institute for Occupational Safety and Health, Morgantown, WV.*

Background/Aims: Exposures to sensitizing metals are a significant public and occupational health problem. Once sensitized, a person must avoid repeated exposures to specific metal(s) to prevent elicitation of adverse responses. Exposures may occur via inhalation, ingestion, and skin contact, with each pathway contributing to the total-body insult. The purpose of this study was to evaluate the solubility and absorption potential of 2 model metal allergens, cobalt, and beryllium, in the lung, gastrointestinal, and skin compartments.

Methods: Solubility of cobalt and beryllium metal particles was evaluated using 1 or more biologically relevant artificial solvents: lung airway lining

fluid, lung alveolar macrophage phagolysosomal fluid, gastrointestinal fluid, and skin sweat. Solubility tests provided estimates of bioaccessibility (amount available for absorption). Absorption across biological barriers was estimated using published human and animal toxicology literature.

Results: Dissolution rates for cobalt metal particles, in units of g/(cm^2 × day), were fastest in gastrointestinal fluid (3.7 ± 1.6 × 10 − 4) and slower in skin sweat (4.4 ± 0.4 × 10 − 5), lung alveolar macrophage phagolysosomal fluid (2.8 ± 0.8 × 10 − 5), and airway lining fluid (1.0 ± 0.3 × 10 − 5). For beryllium metal particles, dissolution rates were fastest in gastrointestinal fluid (4.1 ± 0.2 × 10 − 7) and slower in phagolysosomal fluid (1.1 ± 1.4 × 10 − 7), skin sweat (1.7 ± 0.6 × 10 − 8), and airway lining fluid (1.5 ± 0.8 × 10 − 9). Literature indicates the absorption of particulate cobalt compounds is 30% via inhalation, 3% to 50% via ingestion, and 0.024% and 3.6% via intact and abraded skin, respectively. Absorption of particulate beryllium compounds is <1% via ingestion. In the absence of inhalation and skin absorption values for particulate beryllium, levels were assumed to be similar to divalent cations such as cobalt.

Conclusion: Cobalt and beryllium metal particles are soluble in biological fluids and may be absorbed via multiple exposure pathways. Based on the range of absorption values among biological compartments, systemic dose may be limited by dissolution rates.

O-30A6-5

A Case Study for the Validation of the Framework of the Aggregate Exposure Assessment—Phthalates

Jong-Hyeon Lee,[1] Chan-Kook Kim,[1,2] Jung-Suk Lee,[1] and Kun-Ho Park[1]
[1]NeoEnbiz Co., Bucheon, Republic of Korea; and [2]Seoul National University, Seoul, Republic of Korea.

Background/Aims: The framework for the human exposure assessment was firstly formulized by NRC (1991). The main idea of the framework is to apply and combine 3 different approaches such as the scenario evaluation approach, the point-of-contact approach, and dose-reconstruction approach. After then, several types of technical documents for the human exposure assessment were applied to the human risk assessment. However, there was seldom validation study for the framework covering the all of media including air, water, soil/dust, food, and consumer product. Recently, a validation study based on \'Scenario-based Population Exposure Assessment\' was published by a research group in ETH/Zurich. They successfully calculated aggregated exposure rates for phthalates from all of human exposure media and compared with the total exposure rates reconstructed from urinary biomarker level. They used a huge database for food, consumer product, soil, and dust in the scale of EU to estimate the aggregated exposure level.

Methods: Here is another type of case study for phthalates, which is a panel study with 90 volunteers in Korea. In this study, the aggregated exposure levels was calculated from multi-media including microenvironment in the individual basis, and then was compared with the total exposure level back-calculated from urinary metabolites level in the same person.

Results: After including the exposure from consumer product, the aggregated exposure for DEHP was in the same range of the total exposure. In contrast to DEHP, the aggregated exposures for DBP and BBP were 5∼100 times lower than the back-calculated values. These results mean that some important exposure scenarios for consumer products are skipped.

Conclusion: From this case study, it is evident that the individual exposure assessment approach in a panel study can take a role of redefining the exposure scenario for the population exposure assessment, which is the only way to assess the population at risk.

O-30A6-6

Probabilistic Modeling of Dietary Permethrin Exposure Using 1999–2006 Nhanes Data, and Evaluation of Model Results With Duplicate Diet Data

Jianping Xue and Valerie Zartarian *EPA, NC.*

Background/Aims: Dietary permethrin exposure has not been well studied, and estimates are needed to help address the Food Quality Protection Act for pyrethroid pesticides.

Methods: This modeling assessment was designed to: quantify dietary permethrin exposure in the general US population; analyze the major contributors; evaluate model predictions; and compare CDC's 1999–2006 National Health and Nutrition Examination Survey (NHANES) and USDA's 1994–1996, 1998 Continuing Survey of Food Intakes by Individuals (CSFII) consumption data for use in dietary exposure assessments. The SHEDS-Dietary model was applied, using residue data from USDA's pesticide database program and NHANES consumption data. Model estimates were compared with measured duplicate diet data from USEPA's The Children's Total Exposure to Persistent Pesticides and Other Persistent Organic Pollutants study. The importance of food consumption data was analyzed using a bootstrap method, and comparing food intake and exposure results using NHANES and CSFII.

Results: The mean modeled dietary permethrin exposure ranged from 0.44 to 2.2 μg/d; as age increases, exposure increases. By body weight, young children and adults over 50 years have the highest exposures. Results are similar for cis- and transpermethrin. Three major food contributors were spinach, lettuce, and cabbage. For the upper tails, lettuce was more important; removing lettuce alone reduced modeled exposures by 50% for the 95th and 99th percentiles. The exposure results using NHANES versus CSFII were very comparable (relative error percentage <5% for 95th percentile), and modeled estimates matched well against duplicate diet measurements.

Conclusion: The model evaluation results provide more confidence in SHEDS-Dietary, which is useful for identifying factors of dietary exposure. Uncertainty analyses showed the importance of dietary consumption data. These data and analyses can support critical decisions about the use of the dietary exposure route in the assessment of aggregate exposure and health risks from permethrin.

O-30B6-1

Health Risk Assessment of Organophosphate Pesticides Exposure for Chilli-growing Farmers in Ubon Ratchathani Province, Northeastern, Thailand

Wattasit Siriwong,[1,2] Nutta Taneepanichskul,[1] Saowanee Norkaew,[1] Sumana Siripattanakul,[3] Srilert Chotpantarat,[4] and Mark Robson[†¶‖]
[1]College of Public Health Sciences, Chulalongkorn University, Bangkok, Thailand; [2]Thai Fogarty ITREOH Center, Chulalongkorn University, Bangkok, Thailand; [3]Ubon Ratchathani University, Ubon Ratchathani, Thailand; [4]Chulalongkorn University, Bangkok, Thailand; [5]School of Environmental and Biological Sciences, Rutgers University, New Brunswick, NJ; and [6]UMDNJ-School of Public Health, Piscataway, NJ.

Background/Aims: Health risk assessment of organophosphate pesticides exposure associated with dermal exposure in chilli-growing farmers was conducted during growing season from December 2009 to January 2010 at one of the biggest area for chilli farm in Thailand located at Ubon Ratchathani province, Northeastern, Thailand.

Methods: From 330 chilli-growing farmers interviewed, organophosphate insecticides, that is, profenofos and chlorpyrifos were commonly used in this area. These wide-spectrum insecticides are used to control insect pests. Profenofos and chlorpyrifos residues on chilli-growing farmers' hand after spraying were collected using hand-wiping technique. Liquid-liquid extraction technique was used and then analyzed by gas