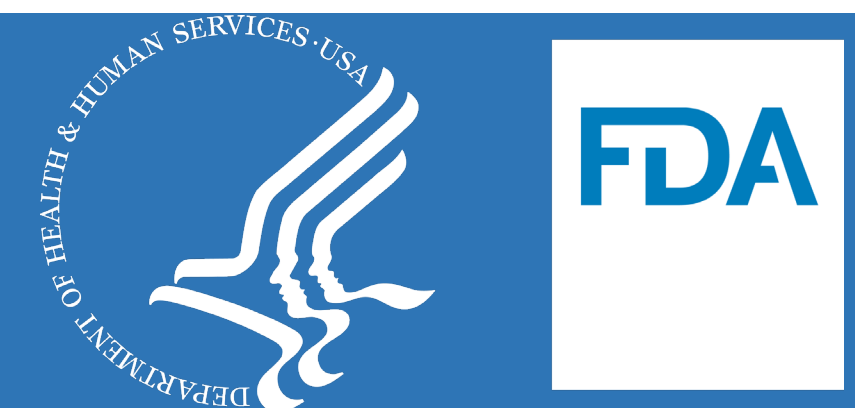


Implementing a framework to evaluate the impact of food intake shifts on risk of illness using a case study with infant cereal

Sofia M. Santillana Farakos¹, Régis Pouillot², Judith Spungen¹, Brenna Flannery¹, Laurie Dolan¹, Jane Van Doren¹

¹Center for Food Safety and Applied Nutrition, U.S. Food and Drug Administration, College Park, MD, USA, ²Independent Consultant



ABSTRACT

Objectives Developing a framework to provide decision makers with a multi-faceted evaluation of the impact of dietary shifts on risk of illness in the U.S. population.

Methods We collected representative data on prevalence and concentration of inorganic arsenic and aflatoxin in infant rice and oat cereal. Exposure to these contaminants through consumption and risk of illness from cancer were assessed per consumer based on data from the National Health and Nutrition Examination Survey and published dose-response and related data. The expected number of additional cases of illness and disability-adjusted life years (DALYs) for the U.S. population were estimated. The public health impact of shifts in consumption from one product to the other considered marginal and joint consumption and characterized uncertainty arising from estimates of contaminant concentrations, bioavailability and dose-response models. Monte Carlo simulations were developed in R and a R Shiny app was created.

Results Based on current consumption of infant rice and oat cereal and preliminary data on the arsenic contamination in infant rice cereal, the estimated additional DALY for the total US population from inorganic arsenic and aflatoxin is 4,600 (CI 90% [370; 8,400]). If all consumers shift their consumption (maintaining equivalent servings) to only infant rice or only infant oat cereal, the estimated DALY increases to by a factor of 1.4 and decreases by a factor of 0.4 relative to the baseline, respectively. Changes in contaminant concentrations or percent consumers also significantly impact risk. Uncertainty in risk estimates is primarily driven by the dose-response models for this case study.

Conclusions The current risk-risk framework can provide decision makers with a nuanced understanding of the impact of consumption shifts on public health and reveal parameters that drive predicted changes in public health. The framework showcased in this case study is applicable to food safety and nutrition questions. The Shiny app provides a real-time visualization tool to facilitate understanding and allow direct query by decision makers.

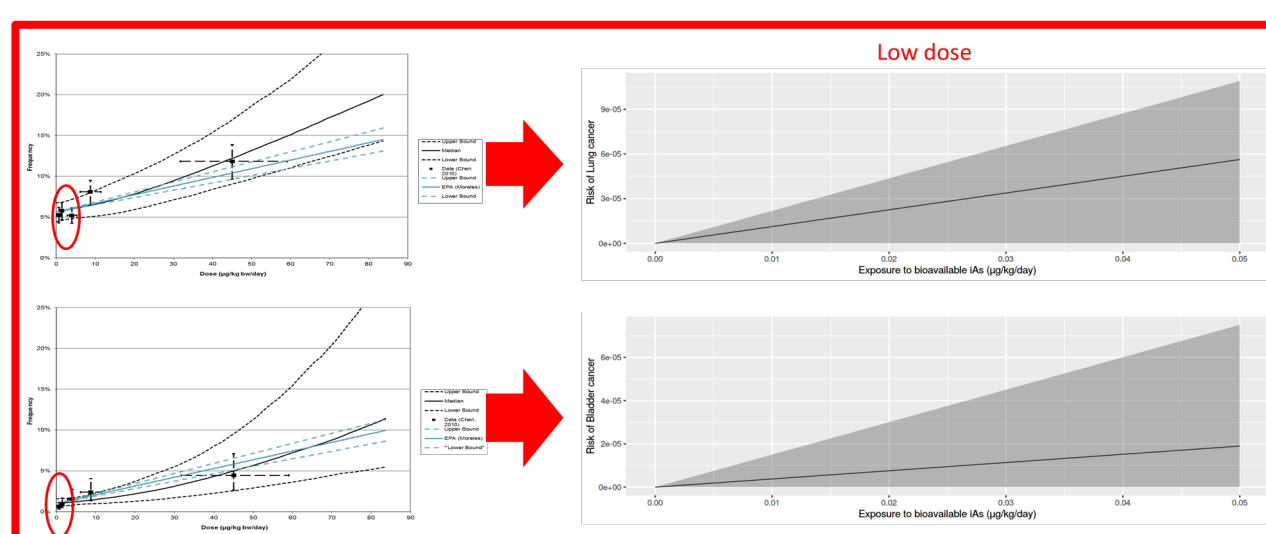
OBJECTIVE

Implement a quantitative risk-risk modeling framework to provide decision makers with a multi-faceted evaluation of the impact of dietary shifts on risk of illness in the U.S. population. We developed a case study on consumption of infant rice and oat cereal and cancer risk from inorganic arsenic (iAs) and aflatoxins.

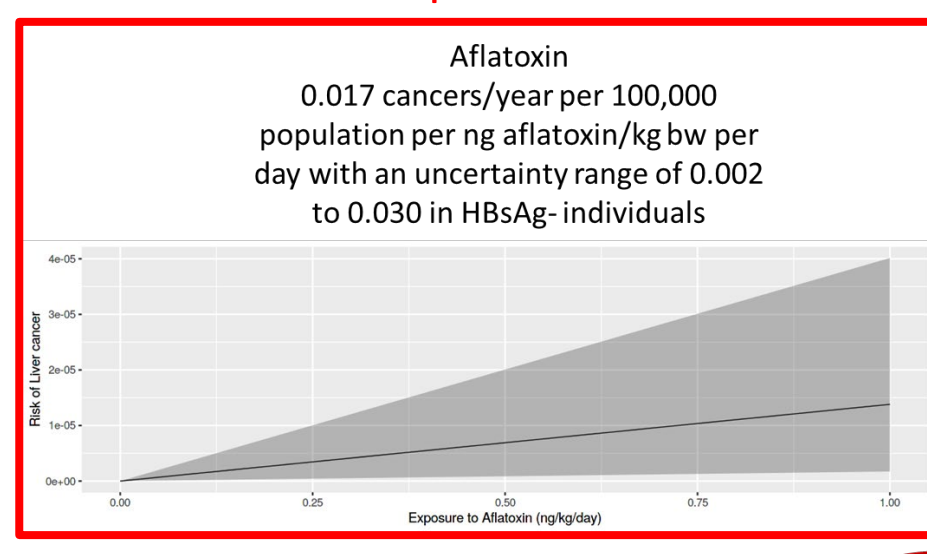
MATERIALS AND METHODS

Exposure & Dose Response → Number of illnesses & DALY

Inorganic Arsenic Dose-Response Model



Aflatoxin Dose-Response Model



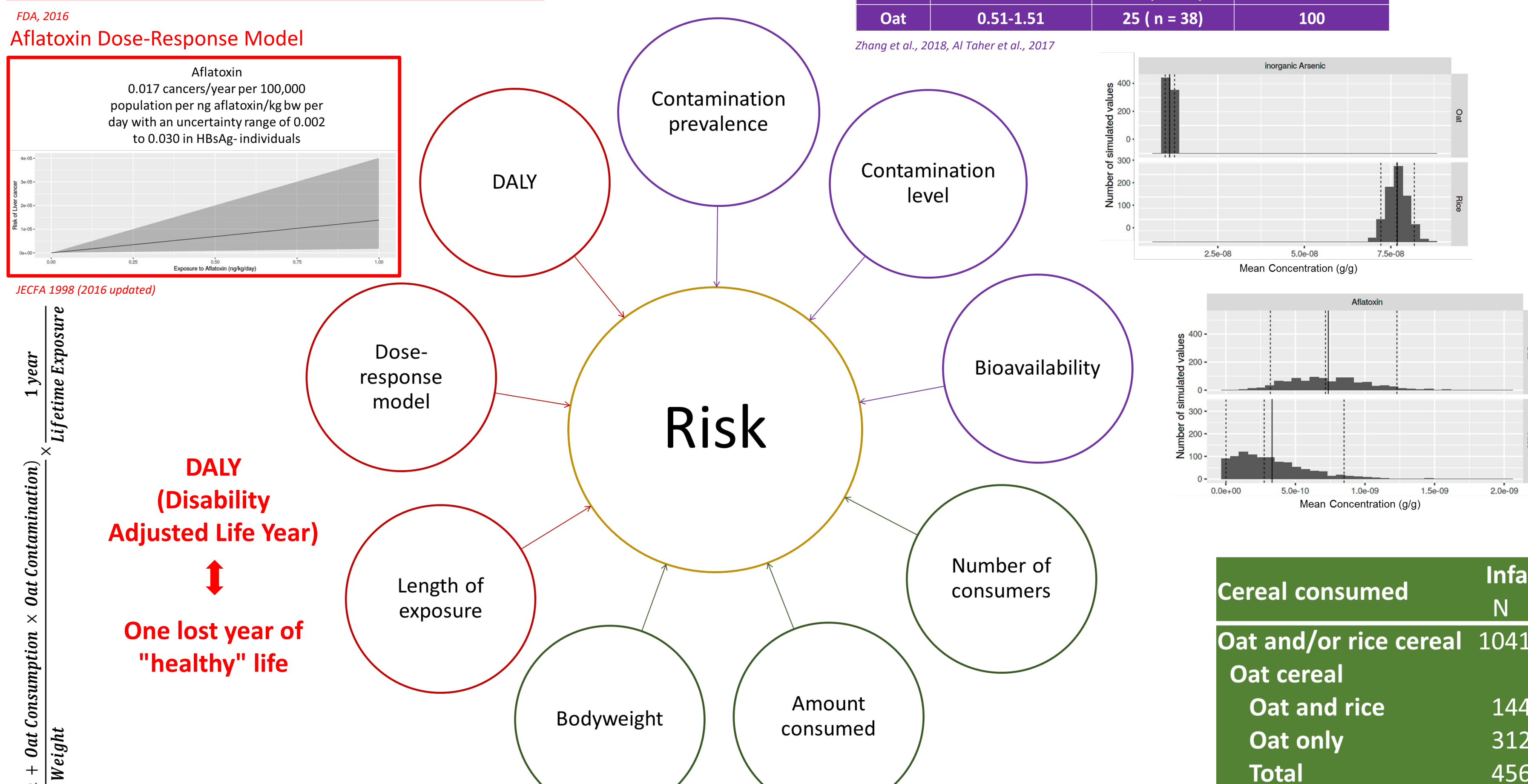
Preliminary Data

Infant Cereal	Mean iAs Concentration (µg/kg)	% Prevalence (# of samples)	Bioavailability (%)
Rice	76.7	100 (n = 12)	70-90
Oat	11.1	100 (n = 19)	70-90

FDA, 2019. Preliminary data.

Infant Cereal	Aflatoxin Concentration LB-UB (µg/kg)	% Prevalence (# of samples)	Bioavailability (%)
Rice	0.3-1.01	9.3 (n = 37)	100
Oat	0.51-1.51	25 (n = 38)	100

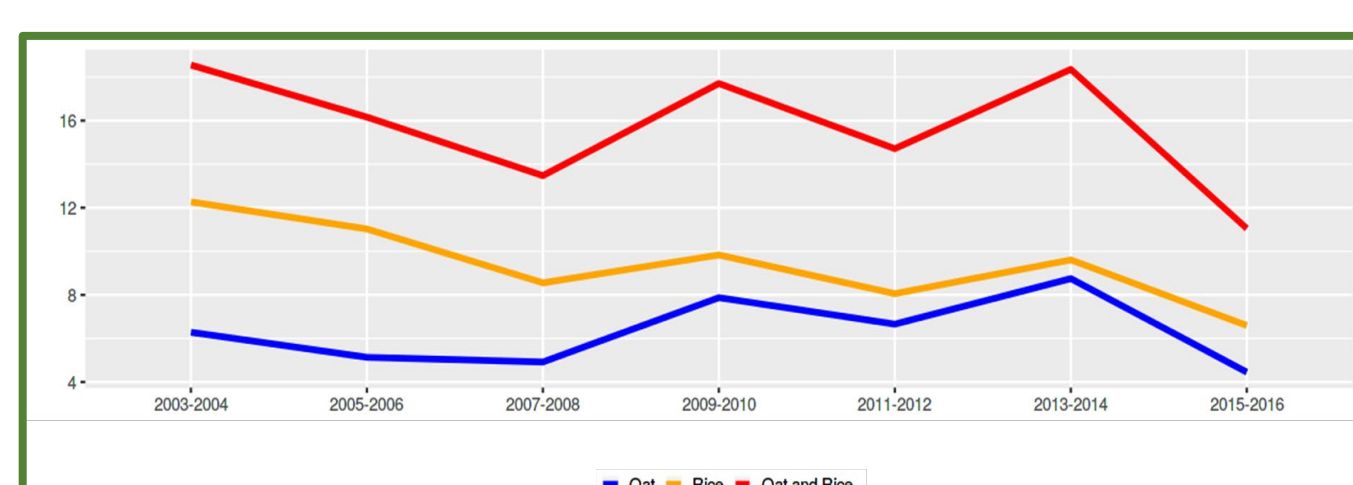
Zhang et al., 2018, Al Toher et al., 2017



Contaminant	Cancer type	DALY	Reference
Inorganic arsenic	Lung	14.4	
Inorganic arsenic	Bladder	4.22	FDAiRISK 4.0
Aflatoxin	Liver	19.4	

Contaminant	Lifetime exposure (years)	Reference
Inorganic arsenic	51	U.S. FDA, 2016
Aflatoxin	78.69	World Bank, 2019

Infant Cereal Consumption (g/day) 2003-2016 (WWEIA/NHANES)



What We Eat In America (WWEIA)/NHANES, 2003-2016. Infants (0-11 m) consuming oat and rice cereals, two 24-hour recalls

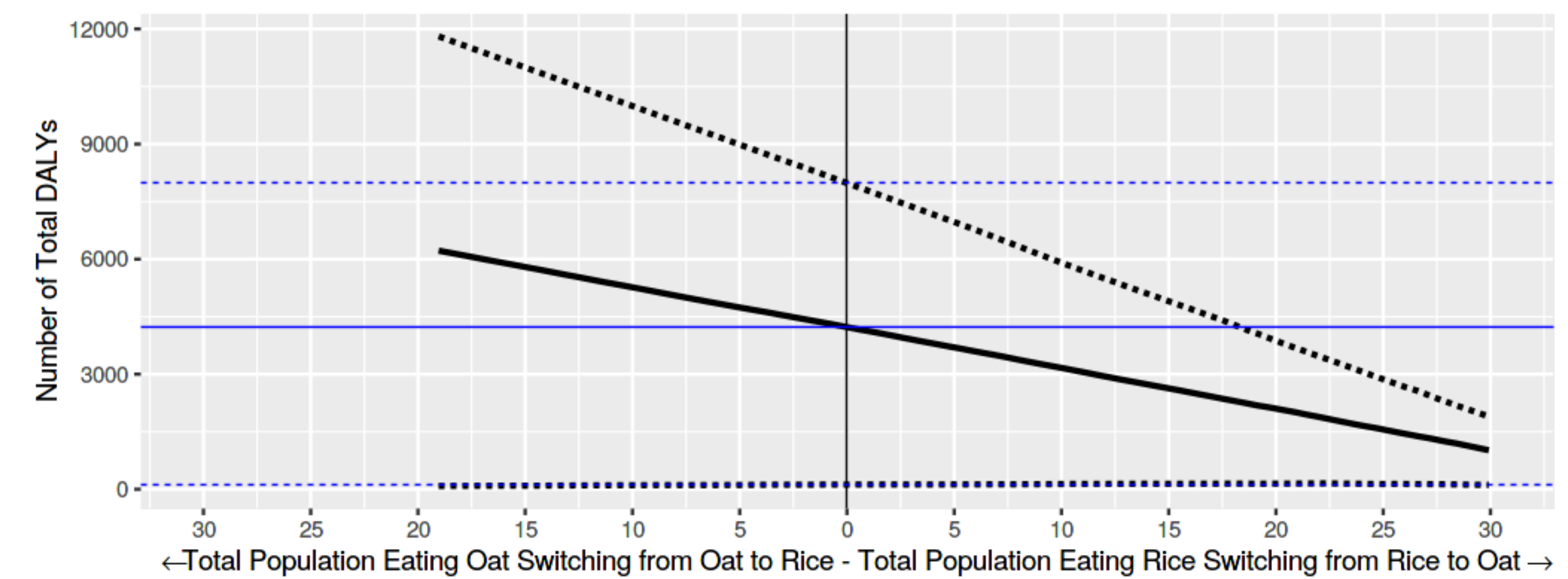
Cereal consumed	Infants N	%
Oat and/or rice cereal	1041	42
Oat cereal		
Oat and rice	144	7
Oat only	312	12
Total	456	19
Rice cereal		
Oat and rice	144	7
Rice only	585	23
Total	729	30
Neither oat nor rice	1493	58
Total	2534	100

RESULTS

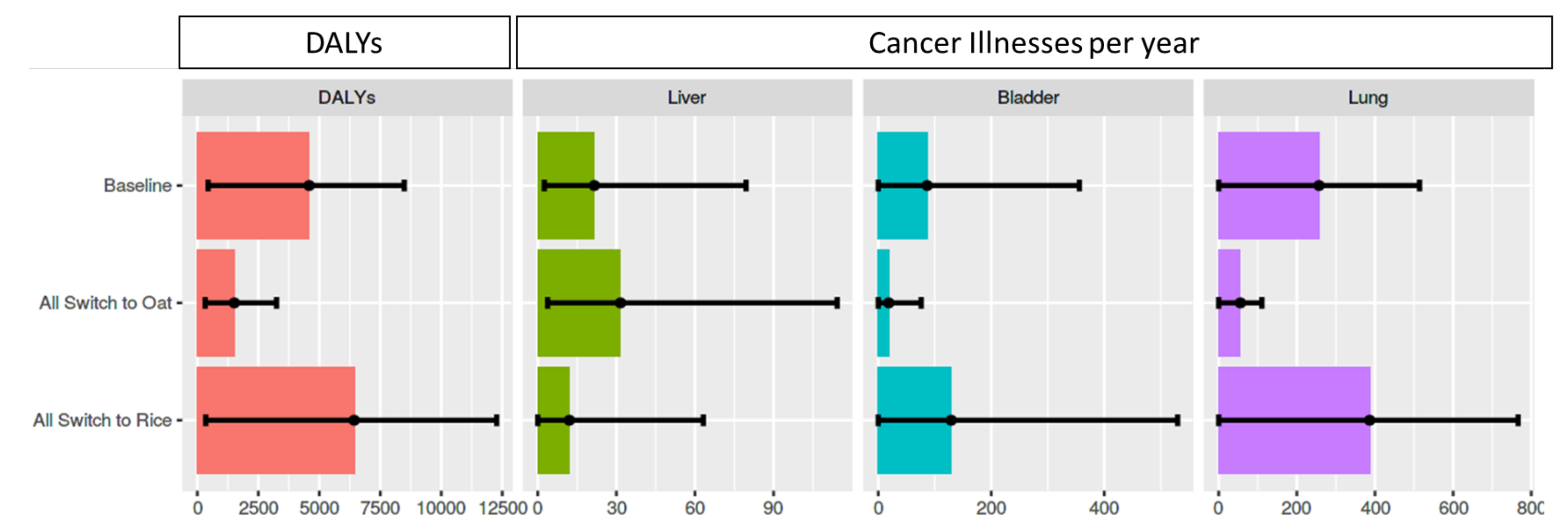
BASELINE

Based on current consumption of infant rice and oat cereal and preliminary data on the arsenic contamination in infant rice cereal, the estimated additional DALY for the total US population from iAs and aflatoxin is 4,600 (CI 90% [370; 8,400]) and the additional number of cancer illnesses is 370 (CI90% [29, 743]).

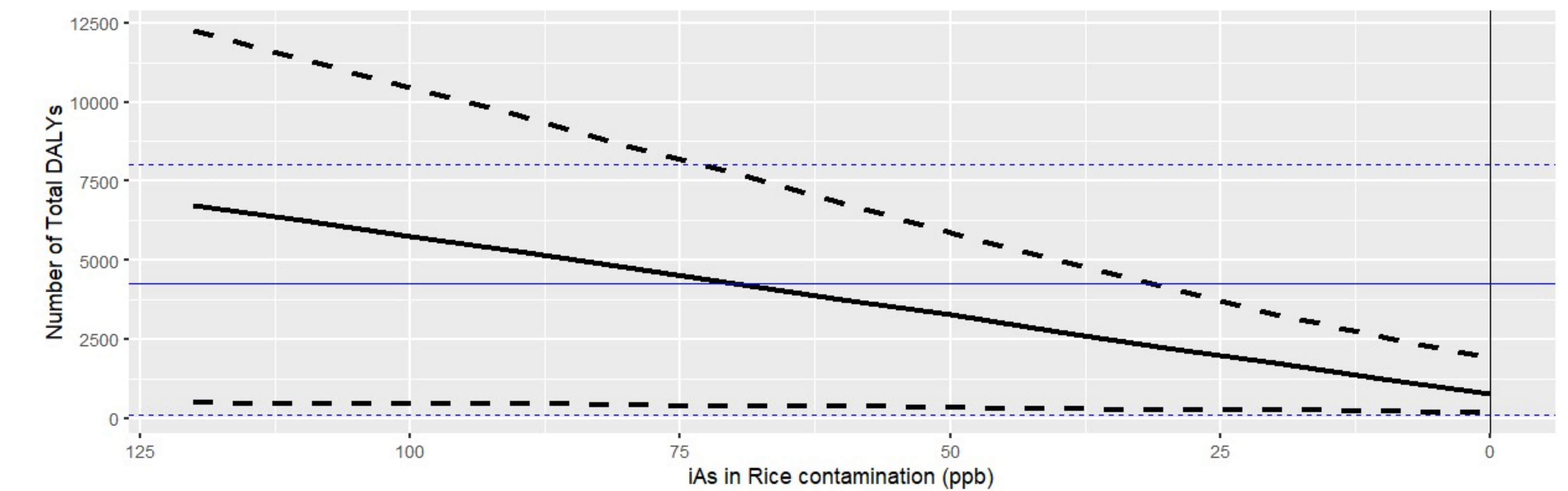
WHAT IF THERE IS A POPULATION SHIFT IN CONSUMPTION?



— Baseline Value — Estimated Value --- CI90%



WHAT IF THERE IS A SHIFT IN CONTAMINATION LEVEL?



— Baseline value — Estimated value --- CI90%

CONCLUSIONS

- The current case study illustrates how modeling can be used to quantitatively assess the potential impact of policy on consumer behavior and resulting health outcomes for food safety and nutrition questions.
- These preliminary results provide insight into the impact of the recommendations to vary grain intake for infants who might otherwise consume only rice. These results can be updated when new data become available.
- The risk-risk framework developed in this case study can provide decision makers with a nuanced understanding of the impact of consumption shifts on public health and reveals parameters that drive predicted changes in public health.

ACKNOWLEDGEMENTS

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