Presenter Disclosure

Richard Mattes

Board Member/Advisory Panel:	Grain Food Foundation Mars Foods General Mills, Bell Institute of Health and Nutrition
Consulting Agreement:	Bright Seed Calorie Control Council
Research Support:	Eli Lilly Almond Board of California Grain Food Foundation

Food Processing and Nutrition Policy

Richard Mattes
Purdue University

PURDUE UNIVERSITY IBRC Ingestive Behavior Research Center

Historical Transition of Nutritional Guidance

Nutrients ⇨ Foods ⇨ Food Groups ⇨ Diet Patterns ⇨ Processed Foods

Associations between Ultra-Processed Food Intake and Selected Health Outcomes PREDIMED-PLUS Cohort (N=7,447)

Subject agreement and concordance between classification systems

		Overall	Q1	Q5
NOVA	IARC	28.0	7.2	7.8
NOVA	IFIC	32.3	8.8	8.9
NOVA	UNC	30.0	8.3	7.4
IARC	IFIC	38.4	9.8	12.3
IARC	UNC	38.4	9.4	12.1
IFIC	UNC	48.6	10.8	15.2

	NOVA	IFIC	UNC	IARC
BMI	+			
Total-Cholesterol		+	+	+
HbA1c				+
Blood Pressure			+	

IFIC – International Food information Council;
UNC – University of North Carolina;
IARC (EPIC) – International Agency for Cancer Research

Martinez-Perez etal., Nutrients Vol. 13, Iss. 7, (2021): 2471. DOI:10.3390/nu13072471

NOVA Classification

"The most important factor now, when considering food, nutrition and public health, is not nutrients, and is not foods, so much as what is done to foodstuffs and the nutrients originally contained in them, before they are purchased and consumed. That is to say, the issue is food processing – or, to be more precise, the nature, extent and purpose of processing, and what happens to food and to us as a result of processing."

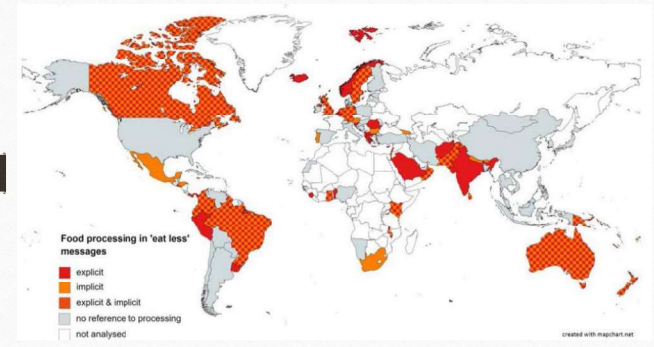
Monteiro et al., Publ Hlth Nutr 2018;21:5-17

Processed Foods

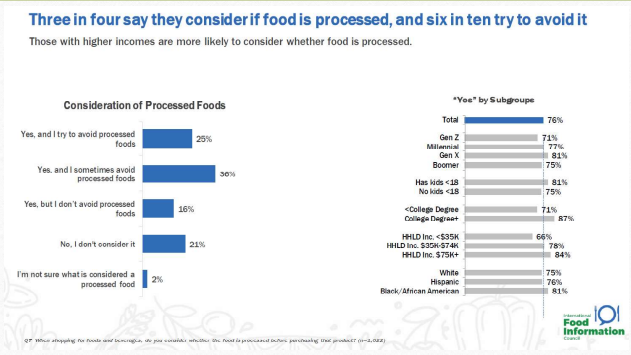
Processes that modify food structure → **Formulation** → **Unintentional Contaminants** → **Resource Management**

NOVA Classification

- Group 1 – Processing used to preserve foods and to make them suitable for storage, facilitate their culinary preparation, enhance their nutritional quality, and often to make them more enjoyable to eat and easier to digest
- Group 2 – Processed culinary ingredients that are highly durable but usually not consumed by themselves.
- Group 3 - Ready-to-consume products; eaten by themselves or in combinations
- Group 4 - Typically formulated to be convenient, intensely palatable and highly profitable. They are formulations of industrial ingredients and substances derived from foods or else created in laboratories, and typically contain little or even no whole foods.



Koios etal., Intl J Hlth Policy Manag 2022;11:2588-2599



Koios etal., Intl J Hlth Policy Manag 2022;11:2588-2599

Ideally, public health and clinical recommendations are based on the convergence of:

1. Epidemiological data,
2. Controlled clinical trial data,
3. Mechanistic data

Processed Foods

Epidemiology

Meta-Analysis of Observational Studies

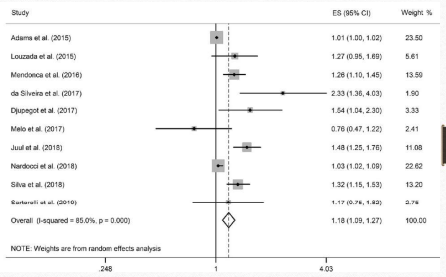
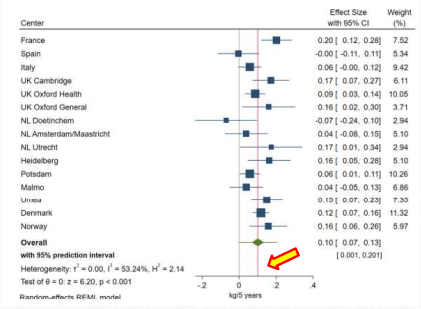


Fig. 2 Forest plot of the association between Ultra-processed food consumption and overweight using a random-effects model. Forest plot demonstrating meta-analysis of studies investigating the association between ultra-processed food consumption and overweight (ES and 95% CIs) using a random-effects model. ES, effect size; CI, confidence interval.

"Participants with higher intake of ultra-processed foods experienced two percent higher odds of excess body weight (pooled effect size 1.02; 95% CI 1.01 – 1.03), p <0.001"

Askari et al., Intl J Obes 2020;44:2080-2091.

UPF Consumption and Weight Gain – EPIC Study (N=348,748)



Cordova et al., Clin Nutr 2021;40:5079-5088

Meta-Analysis of Observational Studies

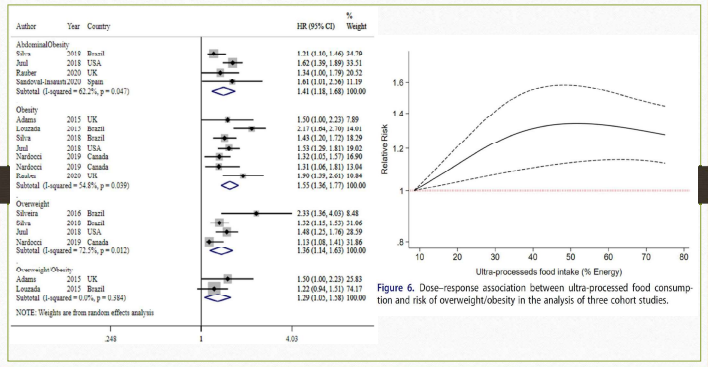
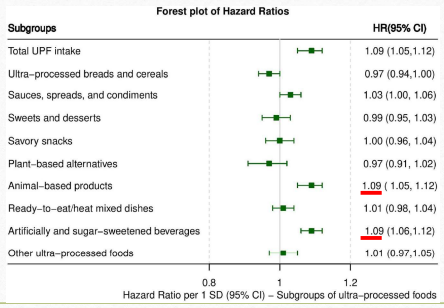


Figure 6. Dose–response association between ultra-processed food consumption and risk of overweight/obesity in the analysis of three cohort studies.

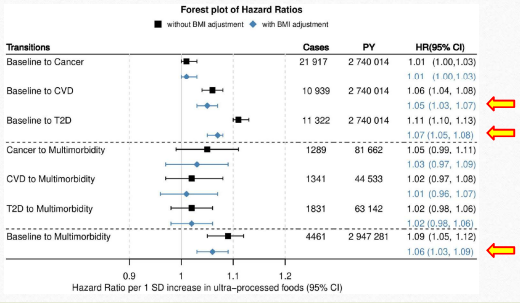
Moradi et al., Crit Rev in Food Sci Nutr https://doi.org/10.1080/10408398.2021.1946005

Risk of Cancer-Cardiometabolic Multimorbidity (N=266,666)



Cordova et al., The Lancet 2023 doi.org/10.1016/Janepa.2023.100771

UPF Consumption and Selected Health Risks (N=266,666)



Cordova et al., The Lancet 2023 doi.org/10.1016/Janepa.2023.100771

Magnitude of Effect

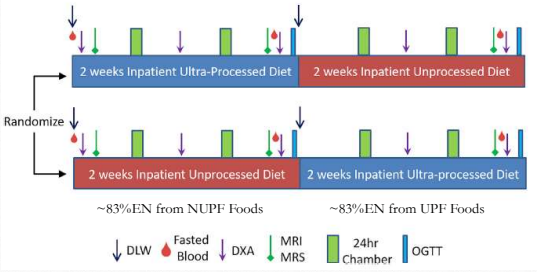
- **Meta-analyses odds ratios – 1.02 – 1.55**
- **Comparable to estimates of:**
  - **Education**
  - **Economic status**
  - **Sleep duration**
  - **Anxiety**
  - **Physical activity**
  - **Television viewing**

Clinical Trials

N=1

N=20

Research Design



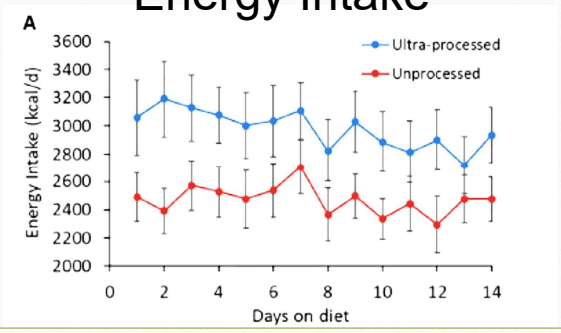
Hall et al., Cell Metab 2019;30:67-77

Table 1. ***Continued***

	Ultra-Processed Diet	Unprocessed Diet
Energy from unprocessed (%)[a]	4.6	88.1
Energy from ultra-processed (%)[a]	81.3	0

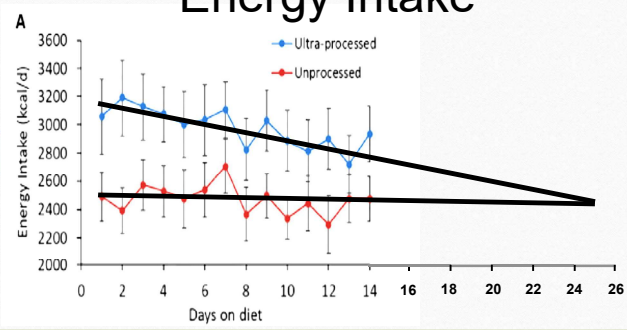
[a]The calculated energy percentages refer to the fraction of diet calories contributed from groups 1 and 4 of the NOVA classification system: (1) unprocessed or minimally processed, (2) processed culinary ingredients, (3) processed foods, and (4) ultra-processed foods

Energy Intake

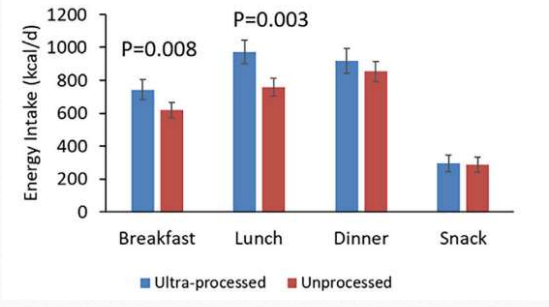


Hall et al., Cell Metab 2019;30:67-77

Energy Intake

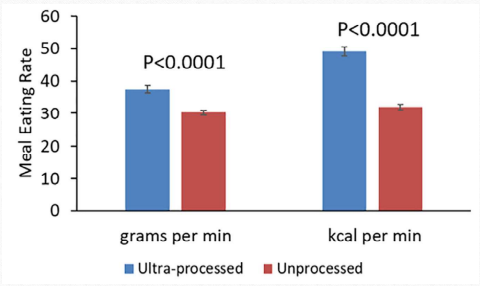


Hall et al., Cell Metab 2019;30:67-77



Hall et al., Cell Metab 2019;30:67-77

Eating Rate



Hall et al., Cell Metab 2019;30:67-77

Day 2

UPF

Non-UPF

Hall et al., Cell Metab 2019;30:67-77

Mechanistic Studies

N=0

Mechanisms

Food Choice	Food Composition	Digestive Processes
Hyper-palatability	Energy density	Microbiome
Appetite modulation	Low calorie sweeteners	Eating rate
Low Cost	Added sugar, salt, fat	Oral processing effort
Shelf-life	Food texture	Gastric emptying
Food packaging	Macronutrients	GI transit time
	Additives	

Valicente et al., Advances in Nutrition, https://doi.org/10.1016/j.advnut.2023.04.006

Mechanisms

Food Choice	Food Composition	Digestive Processes
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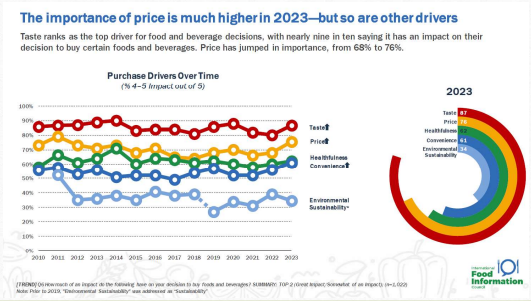
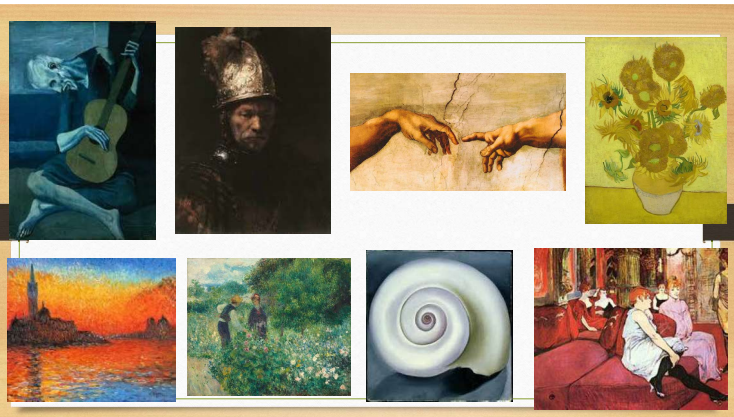
Valicente et al., Advances in Nutrition, https://doi.org/10.1016/j.advnut.2023.04.006

Hyper-Palatability

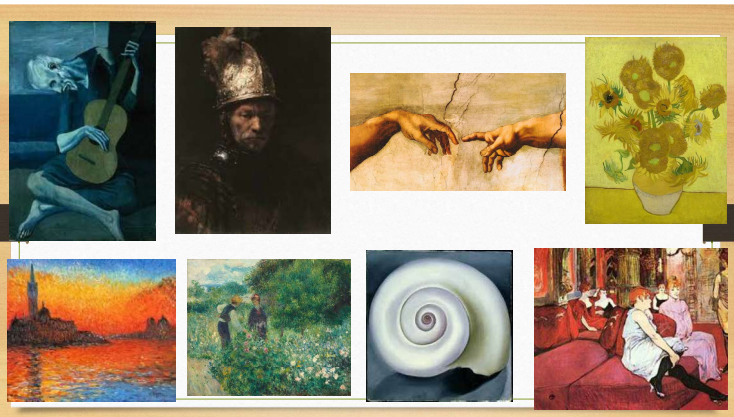


However

- Single components do not dictate overall impressions



What is your Favorite Color?



However

Single components do not dictate overall impressions

Liking does not grow monotonically

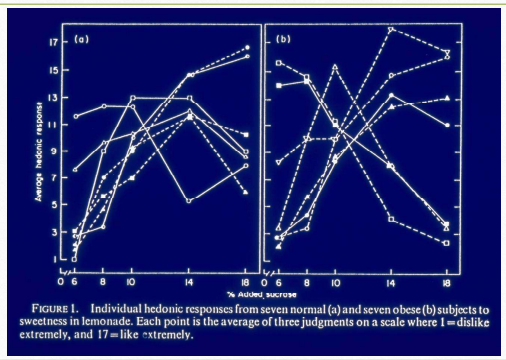
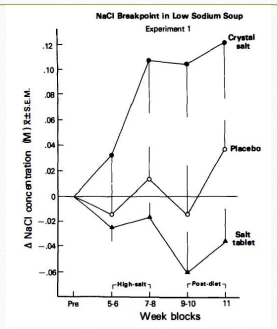


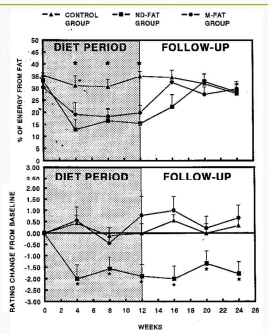
FIGURE 1. Individual hedonic responses from seven normal (a) and seven obese (b) subjects to sweetness in lemonade. Each point is the average of three judgments on a scale where 1 = dislike extremely, and 17 = like extremely.

Pangborn & Giovanni Appetite 1984;5:317-327

However

- Single components do not dictate overall impressions
- Liking does not grow monotonically
- Preferred flavor principles vary widely cross-culturally
- Preferred sensory qualities change with age
- Hedonic impressions are driven by frequency of exposure



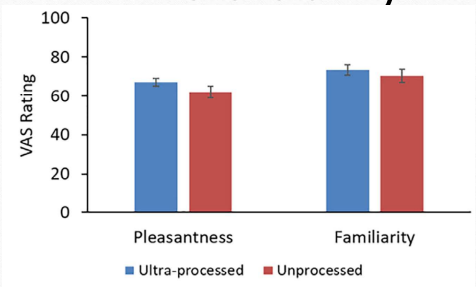


Kurt Lewin – We like what we eat more than we eat what we like

Bertino M, Beauchamp GK, Engelman K. Physiol & Behav 1986;38:203-213.

Mattes, AJCN 1993;57:373-381.

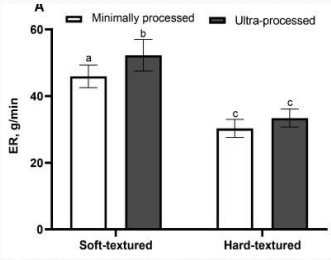
Palatability



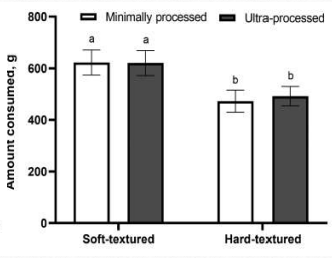
Hall et al., Cell Metab 2019;30:67-77

Food Texture/Eating Rate

Eating Rate



Intake (grams)



Teo et al., AJCN 2022;116:244-254

Microbiome

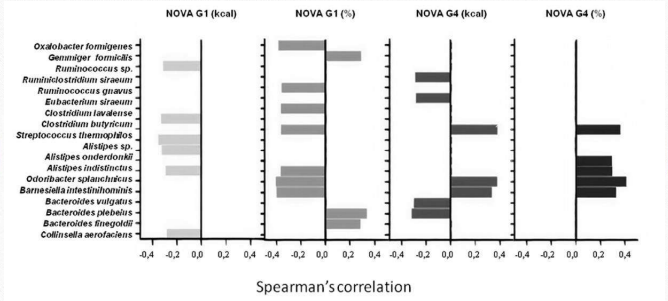


Figure 1 Species correlated with unprocessed or minimally-processed food consumption (NOVA G1) and with UPF consumption (NOVA G4).

Fernandes et al., Nutr Metb & Cardiovasc Dis 2023;33:84-89

"Food consumption assessed by processing level was not correlated with the diversity or phyla of the microbiota."

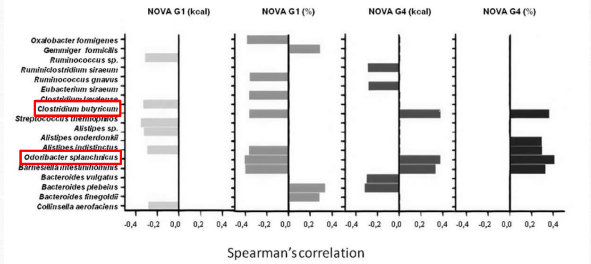


Figure 1 Species correlated with unprocessed or minimally-processed food consumption (NOVA G1) and with UPF consumption (NOVA G4).

Fernandes et al., Nutr Metb & Cardiovasc Dis 2023;33:84-89

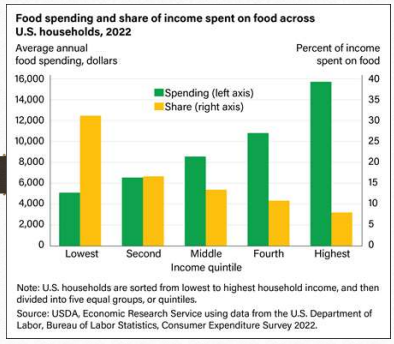
Is there a risk of moving forward now?

Inefficient,
Ineffectual,
Harmful

- **Diet Quality**
- **Food safety**
- **Health Disparities**

Ethical Issues

- **Cost**
- Convenience
- Diet Quality
- Food Waste
- Food Safety



As their incomes rise, U.S. households spend more money on food but it represents a smaller share of their income. In 2022, households in the lowest income quintile spent an average of $5,090 on food (representing 31.2 percent of income), while households in the highest income quintile spent an average of $15,713 on food (representing 8.0 percent of income).

https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=58372

Ethical Issues

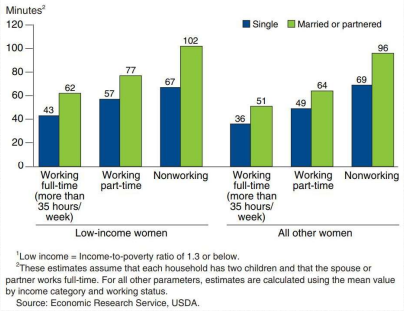
- Cost
- **Convenience**
- Diet Quality
- Food Waste
- Food Safety

Predicted mean cooking and eating behaviors by household income, Home Cooking Survey, 2015 (N = 1112).

	Household income					
	< $25,000		$25,000–$59,000		≥ $60,000	
	Mean	(SEM)	Mean	(SEM)	Mean	(SEM)
Average time spent cooking[§]						
Weekday	44.87	3.11	58.63*	2.27	53.11*	1.83
Weekend	44.55	3.16	56.72*	2.39	53.53*	1.85

Wolfson et al., Prev Med Rep 2019;13:298-305

Daily Food Preparation Time



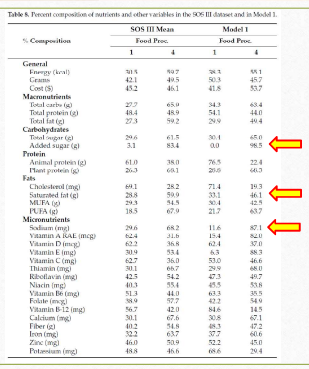
[1]Low income = Income-to-poverty ratio of 1.3 or below.
[2]These estimates assume that each household has two children and that the spouse or partner works full-time. For all other parameters, estimates are calculated using the mean value by income category and working status.
Source: Economic Research Service, USDA.

~30% of American families with children under 18y/o are single –parent families

Mancino Res Rep, Econ Res Serv, USDA, Wash, DC 2007

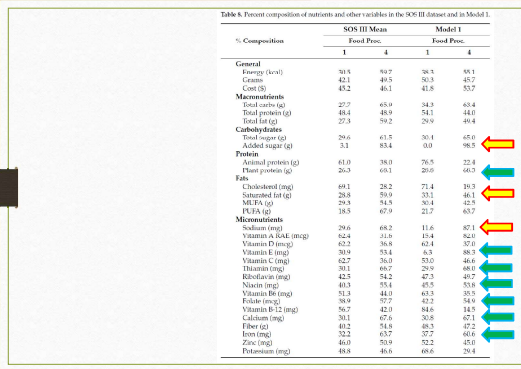
Ethical Issues

- Cost
- Convenience
- **Diet Quality**
- Food Waste
- Food Safety



Hallinan et al., Nutrients 2021, doi.org/10.3390/nu13113838

Seattle Obesity Study (N=857)



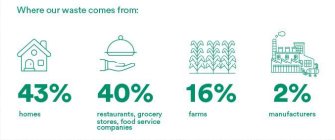
Hallinan et al., Nutrients 2021, doi.org/10.3390/nu13113838

Ethical Issues

- Cost
- Convenience
- Diet Quality
- **Food Waste**
- Food Safety

Food waste:

Contributes ~8% of green house gasses
Contributes ~22% of solid waste in landfills
Accounts for ~21% of agricultural water (EPA)



Fruits and Vegetables
5 of top10 wasted foods
28% Consumers (NRDC)

~14.5% of Americans are food insecure or have very low food security

Ethical Issues

- Cost
- Convenience
- Diet Quality
- Food Waste
- **Food Safety**

Who is at highest risk for foodborne illness?

- **Infants and very young children,**
- **The elderly,**
- **Pregnant women and.**
- **Individuals with weakened immune systems**

(USDA)

But if remove preservatives and limit other methods to control foodborne pathogens

People with limited means who rely heavily on processed foods, will be at increased risk

Workshop

Supported by USDA, National Institute of Food and Agriculture
March 1-2, 2023

- **Hot Springs, Arkansas**
-

Worksite	N
Academia	16
Government	10
Private Sector	6

- **Goal: Develop a Research Roadmap**
- **Focused on NOVA Food Classification System**

The 6 Research Questions were:

1) **What objective methods or measures could further categorize UPFs, considering food processing, formulation, and the interaction of the two?**
2) **How can we improve exposure assessment of UPF intake?**
3) **Does UPF intake influence risk for obesity or CMDs, independent of diet quality?**
4) **What, if any, attributes of UPFs influence ingestive behavior and contribute to excess energy intake?**
5) **What, if any, attributes of UPFs contribute to clinically meaningful metabolic responses?**
6) **What, if any, external environmental factors lead people to consume high amounts of UPFs?**

Adversarial Collaboration