

Ultra-Processed Foods, Human Health, and Policy

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A National Nutrition Crisis

- **More U.S. adults sick than healthy:**
  - **1 in 2** have diabetes or prediabetes
  - **3 in 4** have overweight or obesity
  - **14 in 15** have suboptimal cardiometabolic health
- **Sick American teenagers:**
  - **1 in 3** have prediabetes
  - **1 in 4** have overweight or obesity
  - **1 in 4** have fatty liver disease
- **Poor nutrition each year:**
  - Kills **500,000 Americans (16% of total deaths)**
  - Causes **800,000 new cases of diabetes (70% of total cases)**
  - Causes **80,000 new cancers**
- **An economic crisis:**
  - **$2 trillion each year** in healthcare spending and lost productivity
  - Strained **federal and state budgets**
  - Less competitive **U.S. businesses**
  - Reduced **military readiness**

U.S. Burden of Disease Collaborators, JAMA 2018; O'Hearn et al., JACC 2022; Zhang et al., JNCI Cancer Spectr 2019; O'Hearn et al., Nature Med 2023; Centers for Disease Control and Prevention; Rockefeller Foundation, *True Cost of Food*, 2021 (adjusted to 2026)

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A 20th Century Food System, with 21st Century Problems



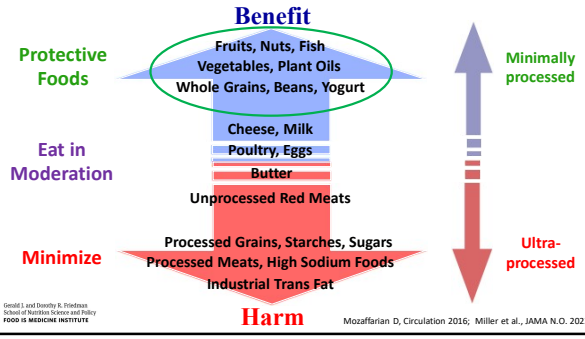


Mozaffarian D. *Food is Medicine*. 2026 Holt (MacMillan): New York

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Science-Based Priorities: Healthy Foods



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Mozaffarian D, Circulation 2016; Miller et al., JAMA N.O. 2022

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Rise of Ultra-Processed Food (UPF)

1980 Low-Fat Guidelines



Tobacco Giants Consolidation of Big Food



Philip Morris



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Defining Ultraprocessed Foods: The "Nova" System



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Processed Food Categories

Nova 1 **Nova 2** **Nova 3** **Nova 4**






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Processed Food Categories

Nova 1 **Nova 2** **Nova 3** **Nova 4**





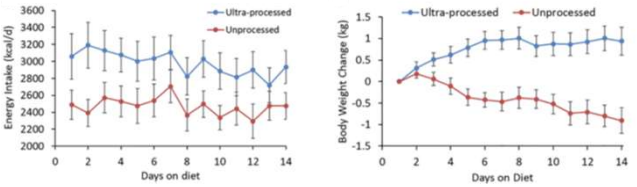



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Ultraprocessed Foods: U.S. Trial

Diets matched in available calories, fat, sugar, salt, carb, protein, fiber, and energy density.
No perceived differences in taste, satisfaction, hunger, or fullness.



Ultraprocessed foods altered blood insulin, PYY, leptin, and adiponectin

Hall et al., Cell Metab 2019

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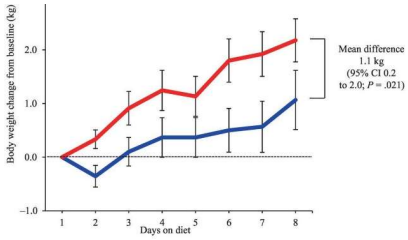
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Ultraprocessed Foods: Japan Trial

Meals matched in available calories, carbohydrate, protein, and fat
No perceived differences in taste, satisfaction, hunger, fullness

Average calorie difference:
800 calories per day

Consumed nearly
20 more calories per minute of eating



Hamano et al., Diab Obes Metab 2024

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Ultraprocessed Foods

Fried rice (7-Eleven)
Shrimp dumpling (Ajinomoto)
Mango pudding (Megmilk Snow)



Rice with dried salted-seaweeds
Ginger grilled pork
Mixed salad with olive oil, vinegar, salt, sugar
Sliced avocado and tomato
Walnuts



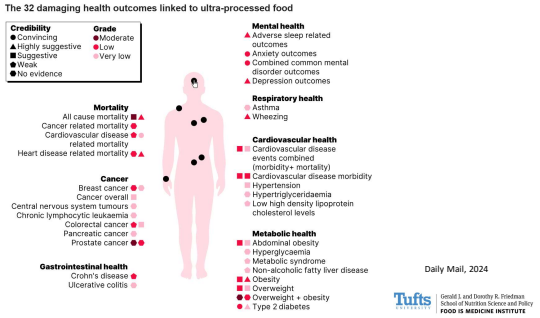
Hamano et al., Diab Obes Metab 2024

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Ultraprocessed Foods and Health

The 32 damaging health outcomes linked to ultra-processed food

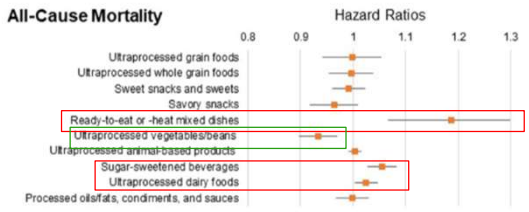


Daily Mail, 2024

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Ultraprocessed Foods & Mortality: Heterogeneity



Wang et al., J Acad Nutr Diet 2025

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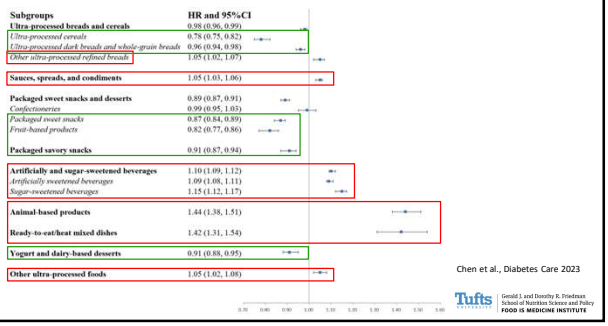
Ultraprocessed Foods & Mortality: Heterogeneity

	Multivariable RR (95% CI) Comparing Q4 vs. Q1
Total mortality	
Ultra-processed breads and breakfast foods	1.03 (1.01 to 1.06)
Fats, condiments, and sauces	1.00 (0.98 to 1.03)
Packaged sweet snacks and desserts	0.98 (0.96 to 1.01)
Sugar and artificially sweetened beverages	1.09 (1.06 to 1.12)
Ready-to-eat/heat mixed dishes	1.03 (1.00 to 1.06)
Meat/poultry/seafood based ready-to-eat products	1.13 (1.10 to 1.16)
Packaged savory snacks	0.99 (0.97 to 1.02)
Dairy based desserts	1.06 (1.03 to 1.08)
Other	1.04 (1.03 to 1.06)

Fang et al., BMJ 2024

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Ultraprocessed Foods & Diabetes: Heterogeneity



Chen et al., Diabetes Care 2023

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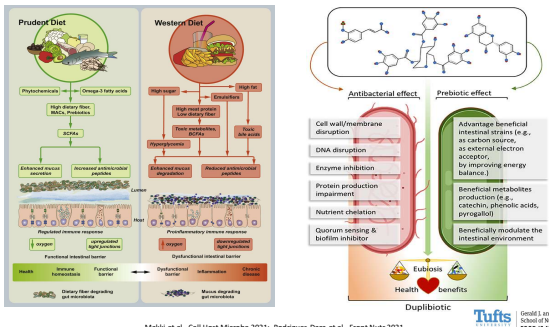
Ultraprocessed Foods & Health: Just Nutrients ?

- Among 48,000 U.S. adults, each 10% of energy from UPFs was associated with:
  - Higher BMI, HbA1c, BP, and TC:HDL-C
  - Greater prevalence of metabolic syndrome, diabetes, and cancer
  - Greater all-cause mortality
- Adjusting for major food ingredients, nutrients, fiber, vitamins, minerals, and other nutritional factors, these associations were ~50% attenuated, but remained significant.
- In contrast, adjusting for saturated fat, added sugar, or sodium had little effect.
- UPF consumption is associated with adverse risk factors, disease conditions, and all-cause mortality, only partly explained by nutritional quality

Hatta-Langedyk et al., AJPH 2026

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Ultra-Processing: Loss of Phytonutrients and Prebiotics



Makki et al., Cell Host Microbe 2021; Rodrigues-Daza et al., Front Nutr 2021

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Ultra-Processing: Industrial Additives, Contaminants

- **Industrial additives**: e.g., sweeteners, colors, preservatives, emulsifiers, stabilizers, thickeners
- **Agricultural contaminants:** e.g., pesticides, herbicides
- **Packaging contaminants**, e.g., endocrine disrupters like BPA, PFAS, phthalates

Touvier et al., BMJ 2024

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UPF Mechanisms: Food – Microbiome Interactions

Diet is the top driver of gut microbiome composition and function, shaping:

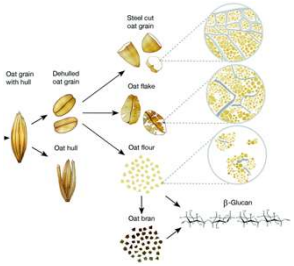
- Digestive efficiency and flux, including the location, rate, and completeness of nutrient digestion
- Relative (host vs. microbiome) nutrient utilization
- Metabolic expenditure
- White, brown, and beige adipocyte function

Riedl et al., Curr Hypertens Rep 2017
Armstrong et al., Nutr Res Rev 2019

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Ultraprocessed Foods: Acellular Nutrition



- **Acellular flours and sugars: highly refined, no intact cellular structure**
- **Rapidly digested in the stomach and small intestine**
- **Toxic "triple hit":**
  - **Burst of glucose into the bloodstream**
  - **Loss of prebiotics for the microbiome**
  - **More calories shunted to the body**

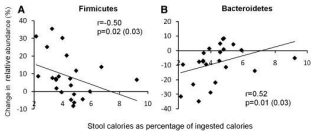
Spreadbury I, Diabetes Metab Syndr Obes 2012; Zinocker & Lindseth, Nutrients 2018; Popa et al., Trends in Wheat and Bread Making 2021

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Host-Microbiome Energy Sharing

Digestive Efficiency



Energy Sharing

- Gut microbiota: an anaerobic, thermogenic biomass
- May digest between **2 to 15%** of ingested calories

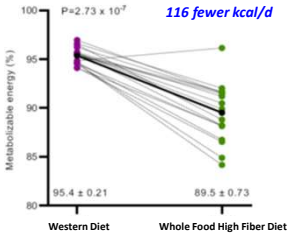
Jumpertz et al., AJCN 2011
Riedel et al., Curr Hypertens Rep 2017

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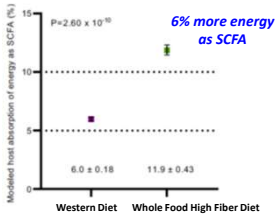
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Host-Microbiome Energy Sharing

% of Energy Metabolized



% of Host Energy as Short-Chain Fatty Acids



Randomized cross-over feeding study

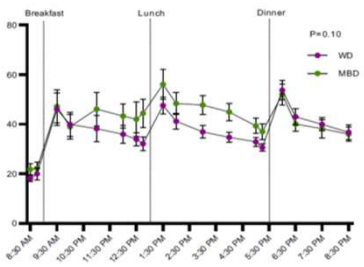
Corbin et al., PNAS 2023; Corbin et al., Nutr Rev 2025

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Fewer Calories – But Higher GLP-1

GLP-1 levels



Randomized cross-over feeding study

Corbin et al., PNAS 2023; Corbin et al., Nutr Rev 2025

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Ultraprocessed Foods: Additives, Contaminants

- Artificial sweeteners, low calorie sweeteners
- Salt, other preservatives
- Artificial colors
- Emulsifiers
- Phthalates, PFAS, BPA, furans, heterocyclic amines, PAH, acrolein, AGEs, acrylamide, microplastics

Obesogens

Endocrine Disrupters

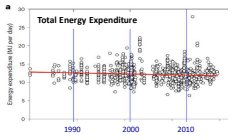
Jumpertz, AJCN 2011; Spreadbury I, Diabetes Metab Syndr Obes 2012; Riedel, Curr Hypertens Rep 2017; Zinocker, Nutrients 2018; Franzago, Epigenetics 2018; Popa, Trends in Wheat and Bread Making 2021; Brandao, Int J Mol Sci 2021; Noriega, Nutrients 2023

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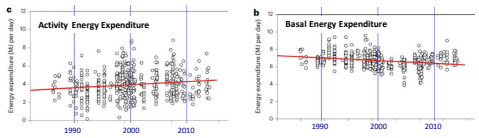
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Declining Basal Metabolic Rate Over Time

~ 5,000 USA and UK adults, with energy measured using doubly labeled water



- 222 kcal/day

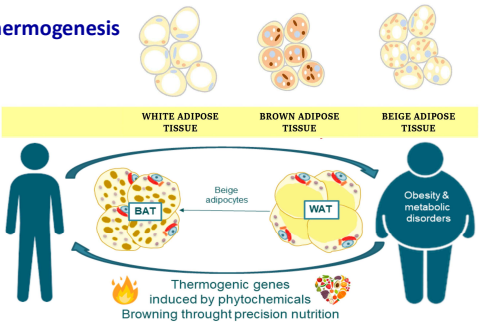


Speakman et al., Nature Metab 2023

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Thermogenesis



Polyphenols: Berries, grapes, cocoa, green tea

Omega-3 fats: Fish, walnuts, flaxseed

Capsaicin: Chili peppers

Curcumin: Tumeric

***Many* microbiome metabolites**

Hadi et al., Front Physiol 2019

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Ultra-Processed Foods: Mechanisms for Harm

- Loss of intact natural structure (acellular nutrition)
- Loss of phytonutrients and prebiotics
- Refined starch, sugar, salt
- Marketing and packaging
- Addictive formulations and hyperpalatability
- Harmful additives
- Agricultural and packaging contaminants

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Ultra-Processed Foods: Accelerating Policy Attention

- 40 states have passed or pending bills for warning labels or bans on specific additives, reducing UPF in schools
- California has defined UPF and passed a non-UPF label
- 2025 Dietary Guidelines for Americans recommend avoiding highly processed foods, ready-to-eat foods, refined grains, SSBs, processed meats
- New FDA rule to close the GRAS loophole
- New proposed federal definition of UPF, potential front-of-pack labeling

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Policy and Regulatory Actions to Address Ultraprocessed Food.[a]

Policy Area	Action	Examples
Taxation	Federal, state, or local excise taxes levied on the manufacturing, distribution, or sale of UPF; revenue can be general or earmarked for specific purposes, such as healthy food programs, to reduce regressiveness	Taxes on SSBs in multiple U.S. localities and more than 50 countries Taxes on candy in 19 U.S. states Taxes on junk food in Hungary and Mexico
Labeling	Front-of-package icons or warning labels denoting UPF or the presence of certain additives	Black-box warning labels for artificial sweeteners in Mexico and Argentina Front-of-package icons describing added sugar or sodium content or warning labels indicating high levels of added sugar or sodium in multiple countries
Dietary guidelines	Introduction of national guidelines recommending choosing fewer highly processed foods or UPFs and choosing more unprocessed, minimally processed, or fresh, homemade foods	Guidelines in Belgium, Brazil, Brunei, Canada, Ecuador, France, Israel, Maldives, Peru, Qatar, and Uruguay
School meals	Implementation of nutrition standards limiting the serving of certain types of UPF or food containing certain additives	New York City school meal standards eliminating partially hydrogenated oils and processed meats Texas bill to ban specific food additives in school meals
Federal nutrition programs	Removal of eligibility for certain types of UPF or food containing certain additives	Arizona bill preventing use of SNAP benefits for purchasing SSBs, drinks with artificial sweeteners, or candy Texas bill preventing use of SNAP benefits for purchasing SSBs, candy, potato chips, or cookies
Food procurement	Elimination of certain types of UPF or food containing certain additives in cafeterias, vending machines, or other food services Elimination of certain types of UPF or food containing certain additives in procurement, such as food for the military or prisons	U.S. Food Service Guidelines for Federal Facilities requiring fruits and yogurt options with no added sugar and limiting sodium levels in food options
Food safety	Requirement for strong evidence of safety, review, and public comment for any new substances added to foods Rigorous postmarketing surveillance to support removal of additives linked to harm	European Union, Canadian, and U.K. regulations requiring safety review of food additives and banning many additives California law banning specific additives in food FDA review in progress to revise existing policy that permits companies to add new substances to foods with little or no oversight, review, or public reporting
Food marketing	Elimination of health claims on UPF packages Restrictions on marketing of UPF to children	Prohibition on products high in certain nutrients or with artificial sweeteners from any marketing strategies directed toward children in Mexico Prohibition on advertising or sponsorship of products high in certain nutrients or containing artificial sweeteners in schools in Argentina

Ultra-Processed Food: Needed Policies

Mozaffarian D, NEJM 2025

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Simple Rules to Identify More Optimal Processing

- **Fewer cosmetic additives**
- **More intact cellular structure**
- **Fermentable dietary fiber**
- **Preserved polyphenols and other probiotics**
- **Less salt, sweeteners, emulsifiers**
- **Avoid: SSBs, processed meats, UPF breads and cereals, ready-to-eat/heat meals, UPF dairy**

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GLP-1s and Ultraprocessed Foods

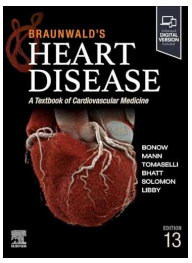
- He took us straight past the Doritos, without a side glance at the Oreos or the Cheetos. We rushed past the Pop-Tarts and Hershey's Kisses, the Lucky Charms and Lay's. [We arrived at] his happy place: the produce section. "I eat a lot of pineapple, cucumber, ginger."
- His daughter fed him some candy. "I just couldn't," he said. "It was so sweet it choked me."
- My "whole life was fast foods." Now, "the first place I hit when I get to the store is produce. My favorite is Mount Rainier cherries, apples, peaches, pears."
- "Celery tastes like celery, and carrot tastes like carrot. Strawberry tastes like strawberry." Since taking a GLP-1, she said, "I just started to realize that they taste wonderful by themselves."
- A Hostess HoHo no longer seems like food, she said. "It tastes plasticky—Feels plasticky in my mouth."

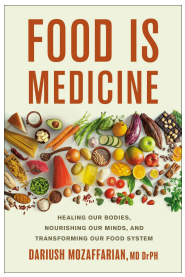
New York Times Magazine, Nov 19, 2024

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Further Reading





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