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Food for Thought  
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# Ultra-processed foods and cardiometabolic health

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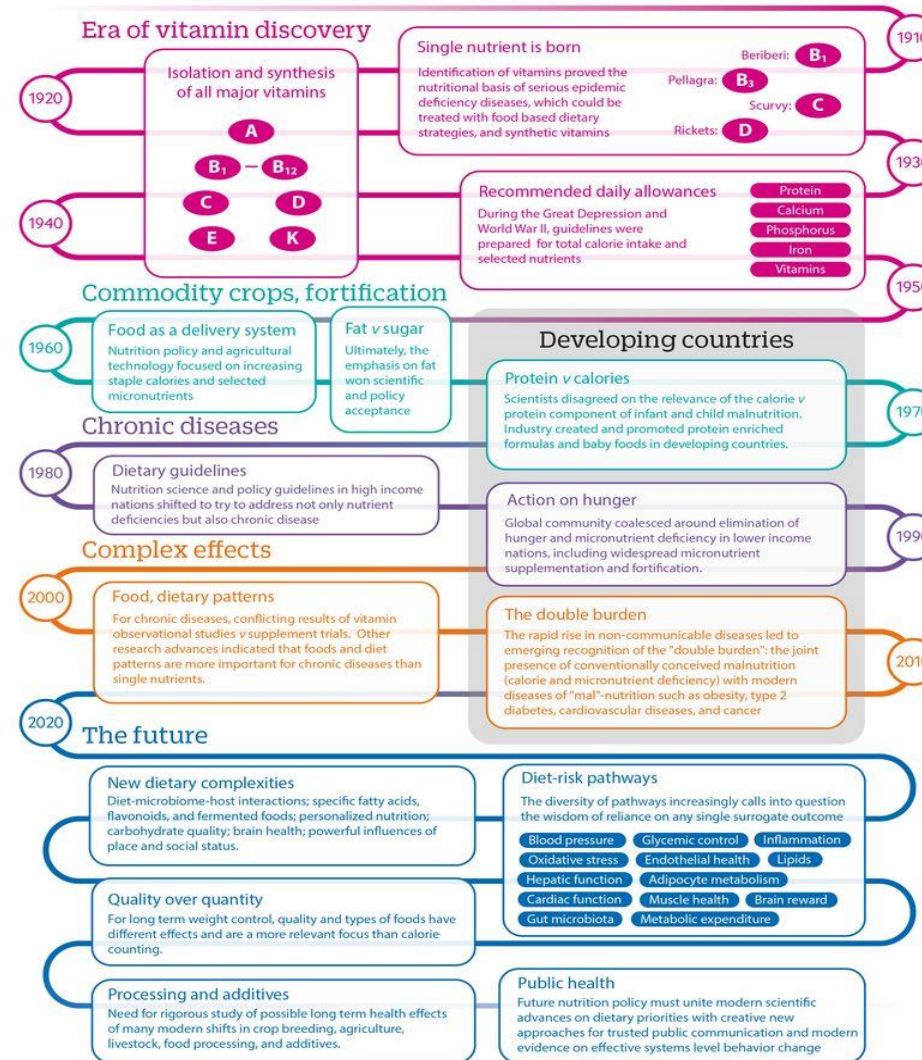


# Impact of food (ultra) processing on health: a recent and dynamic research area

thebmj Visual summary

## A timeline of nutrition research

While food and nutrition have been studied for centuries, modern nutritional science is surprisingly young. This timeline shows how developments in the early 20th Century have persistently shaped our understanding of the field, at times limiting our knowledge of the complex links between dietary patterns and health.



History of modern nutrition science—implications for current research, dietary guidelines, and food policy  
<https://www.bmj.com/content/361/bmj.k2392>  
 Mozaffarian et al. 2018  
 BMJ Food for thought 2018



**NOVA 1**

**Unprocessed or minimally processed foods**

Fresh, dried, grounded, chilled, frozen, pasteurized or fermented staple foods such as fruits, vegetables, pulses, rice, pasta, eggs, meat, fish or milk.



**NOVA 2**

**Processed culinary ingredients**

Substances usually extracted from foods, not to be solely consumed, used in kitchens to transform unprocessed or minimally processed foods into culinary preparations such as salt, vegetable oils, butter, and sugar.



**NOVA 3**

**Processed foods**

Canned vegetables with added salt, meat and fish products only preserved by salting, cheeses and freshly made unpackaged breads, sugar-coated dry fruits, and other products manufactured with the addition of salt, sugar or other substances of Group 2 ingredients to Group 1 foods.



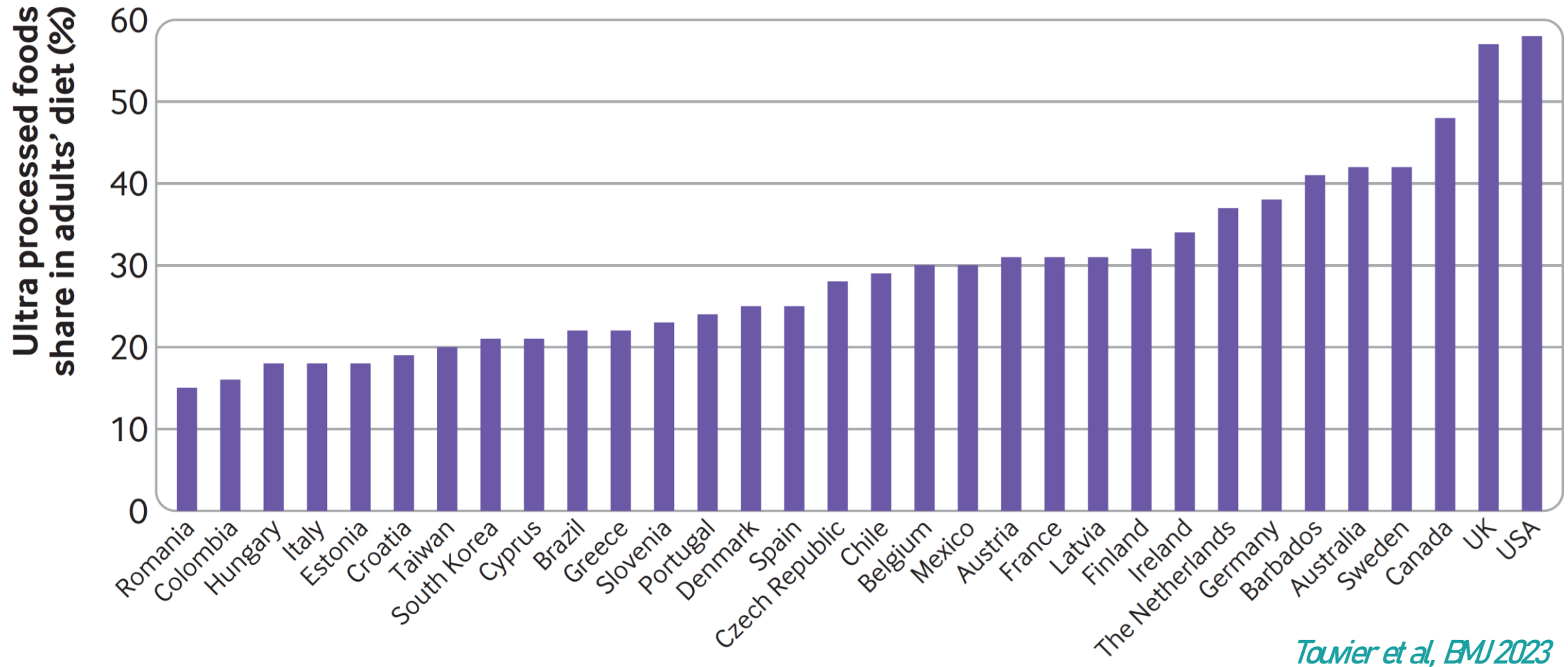
**NOVA 4**

**Ultra-processed foods**

- Foods made by intense industrial physical chemical or biological processes (e.g. hydrogenation, moulding, extruding, pre-processing by frying)
- And/or containing industrial substances not usually found in domestic kitchens (e.g. cosmetic additives, maltodextrin, hydrogenated oils, flavouring agents).
- E.g. sodas, chocolate and energy bars, instant noodles and dehydrated soups, fish and chicken nuggets, 'slimming' products, powdered or 'fortified' meals, vegetable patties (meat substitutes) containing substances such as protein isolates and/or additives that modify colour and flavours.

- Convenient, ready-to-eat
- Generally affordable
- Generally highly palatable, with added salt, sugar, flavours, taste and texture-enhancers
- Intensive appealing marketing and advertisement

## The ultra-processed foods epidemic: how countries differ?



- Since the 1990s sales of UPF increased in most countries (mainly in LMC) or stayed high
- Share of energy intake brought by UPF varies greatly among countries (highest =USA, 58%)
- Reflects ≠ economic, sociocultural, politico-legal, and commercial factors throughout food systems

## UPF: Evidence on cardiometabolic effects

Starting in 2015: >70 prospective studies consistently showed associations between consumption of UPF and adverse health outcomes  
(*Srouf et al, The Lancet Gastroenterology and hepatology, 2022*)

Meta-analyses reporting associations between ultra-processed food consumption and cardiometabolic outcomes\*

Study	Risk increase (highest versus lowest exposure categories)
Chen et al (2023)	Type 2 diabetes (40% higher risk)
Yuan et al (2023)	Cardiovascular events (35% higher risk)
Wang et al (2022)	Hypertension (23% higher risk)
Taneri et al (2022)	All-cause mortality (29% higher risk)
Moradi et al (2021)	Abdominal obesity (41% higher risk) Overweight (36% higher risk), Obesity (55% higher risk)
Lane et al (2021)	Metabolic syndrome (81% higher odds)
Suksatan et al (2021)	Cardiovascular mortality (50% higher risk) Cardiac mortality (66% higher risk)

\*Most recent and complete selected for each outcome

*Touvier et al, BMJ 2023*

- + Cohorts associating UPF with risks of cancers (e.g. *Fiolet, BMJ 2018*), IBD (e.g. *Narula, Clin Gastroenterol Hepatol 2023*), depression (e.g. *Gómez-Donoso, Eur J Nutr 2020*), gestational diabetes (e.g. *Leone, Nutrients 2021*), chronic kidney disease (e.g. *Du, Am J Kidney Dis 2022*)
- + UPF meeting the criteria to be labelled as addictive substances using the standards set for tobacco products? (*Gearhardt, Addiction 2023*)

# Geographical location and methods of prospective studies on UPF and health outcomes

## Adults

- 67 studies based on NOVA: 48 (70%) included >10 000 participants, 17 (25%) >100 000 participants
- 34 in Europe, 15 in USA and Canada, 9 in Latin America, 5 in Asia, 4 in other geographical regions
- Primary exposure: 43 used the % of UPF in the diet by weight or energy, others used servings or g/d
- Assessment by FFQ (43), 24h records or recalls (15), or structured dietary history questionnaire (9)
- All adjusted for socioeconomic and demographic factors; 57 also adjusted for total energy intake and 42 for dietary content of key nutrients or diet quality indexes
- 52 out of 58 studies that explored outcomes beyond obesity also accounted for BMI
- Consistent associations with adverse outcomes (previous slide)



## Children and pregnant women

- 9 studies in children or adolescents and 6 in pregnant women
- 9 in Latin America, 3 in Europe, 3 in United States
- UPF during childhood associated with higher levels of total and LDL cholesterol, adiposity
- UPF during pregnancy associated with increased gestational weight gain and blood glucose levels



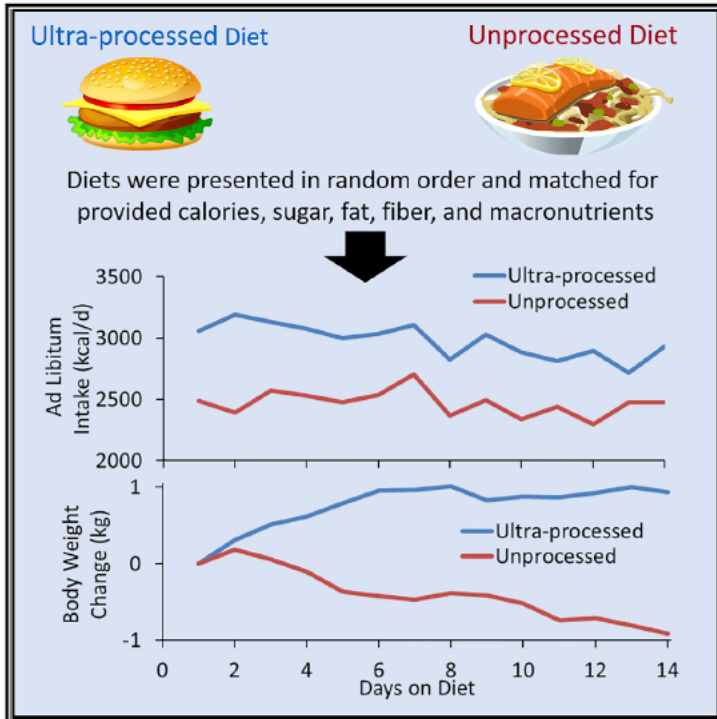
# UPF Randomized controlled trials

## Cell Metabolism

Clinical and Translational Report

### Ultra-Processed Diets Cause Excess Calorie Intake and Weight Gain: An Inpatient Randomized Controlled Trial of *Ad Libitum* Food Intake

#### Graphical Abstract



#### Authors

Kevin D. Hall, Alexis Ayuketah, Robert Brychta, ..., Peter J. Walter, Shanna Yang, Megan Zhou

#### Correspondence

kevinh@nih.gov

#### In Brief

Hall et al. investigated 20 inpatient adults who were exposed to ultra-processed versus unprocessed diets for 14 days each, in random order. The ultra-processed diet caused increased *ad libitum* energy intake and weight gain despite being matched to the unprocessed diet for presented calories, sugar, fat, sodium, fiber, and macronutrients.

*Hall et al, Cell Metabolism 2019*

European Journal of Nutrition (2023) 62:443–454  
<https://doi.org/10.1007/s00394-022-02995-9>

ORIGINAL CONTRIBUTION



Effectiveness of a minimally processed food-based nutritional counselling intervention on weight gain in overweight pregnant women: a randomized controlled trial

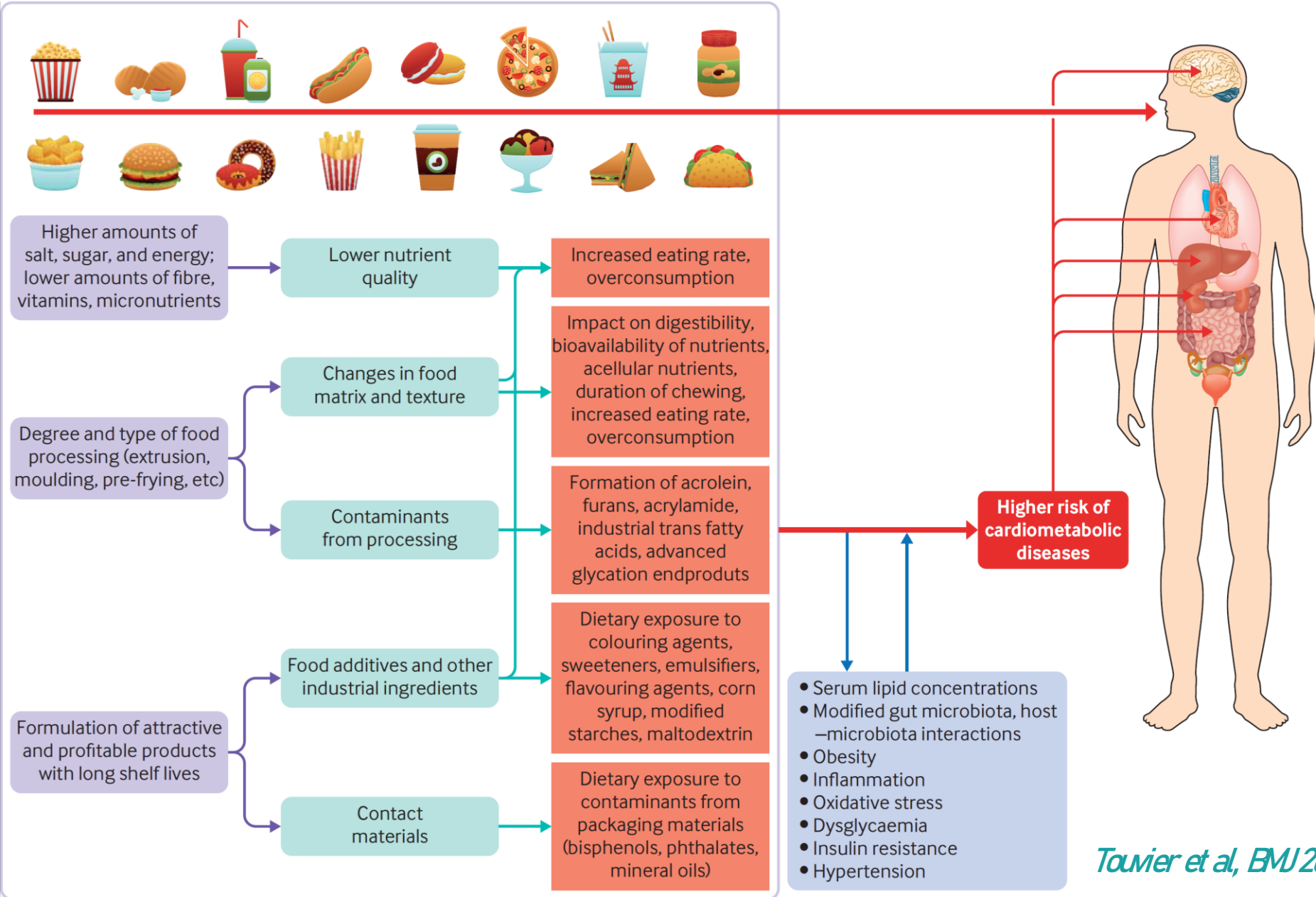
Daniela Saes Sartorelli<sup>1</sup> · Lívia Castro Crivellenti<sup>2</sup> · Naiara Franco Baroni<sup>2</sup> · Daniela Elias Goulart de Andrade Miranda<sup>3</sup> · Izabela da Silva Santos<sup>4</sup> · Mariana Rinaldi Carvalho<sup>2</sup> · Maria Carolina de Lima<sup>2</sup> · Natália Posses Carreira<sup>2</sup> · Ana Vitória Lanzoni Chaves<sup>2</sup> · Marina Garcia Manochio-Pina<sup>5</sup> · Laércio Joel Franco<sup>1</sup> · Rosa Wanda Diez-García<sup>6</sup>

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*Sartorelli et al, Eur J Nutr 2023*

+ RCTs on some additives emblematic of UPF  
(e.g. *Chassaing Gastroenterology 2022; Suez Cell 2022*)

# UPF impact on health: multifaceted mechanisms beyond nutrient profile







# NutriNet-Santé cohort: interdisciplinary nutrition research (n=174,000 ; 2009-ongoing)

[www.etude-nutrinet-sante.fr](http://www.etude-nutrinet-sante.fr) / PI: Dr Mathilde Touvier



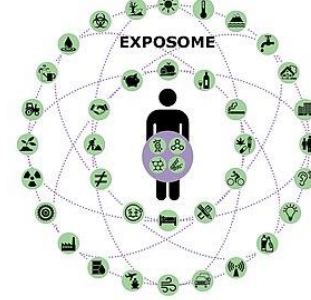
Food labeling, Food policy



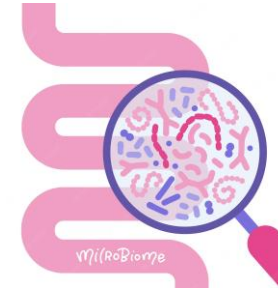
Food processing  
Food formulation  
Food packaging



Organic food, pesticides  
Environmental impact  
Sustainability



Exposome



Mechanisms,  
gut microbiota



Psychological and  
geographical determinants,  
built environment, geolocation



Sugar, glycaemic index  
and associated exposures



Cancer, cardiometabolic  
health...and other pathologies  
(mental and respiratory health,  
IBD, etc.)



Nutrition  
and immunity



Circadian nutritional  
rhythms



Participatory  
research  
on student's diet



Dietary  
supplements



Connected sensors for  
research in nutrition  
and physical activity



# UPF impact on health: the food additives trail

Very detailed assessment of dietary exposure: repeated 24h records including brands of industrial products + scan of bar codes



## Food additive nitrites / nitrates

- Cancer risk: *Chazelas et al, Int J Epidemiol, 2022*
- Type 2 diabetes risk: *Srouf et al, Plos Medicine, 2022*
- Risk of hypertension: *Srouf et al, JAMA 2023*



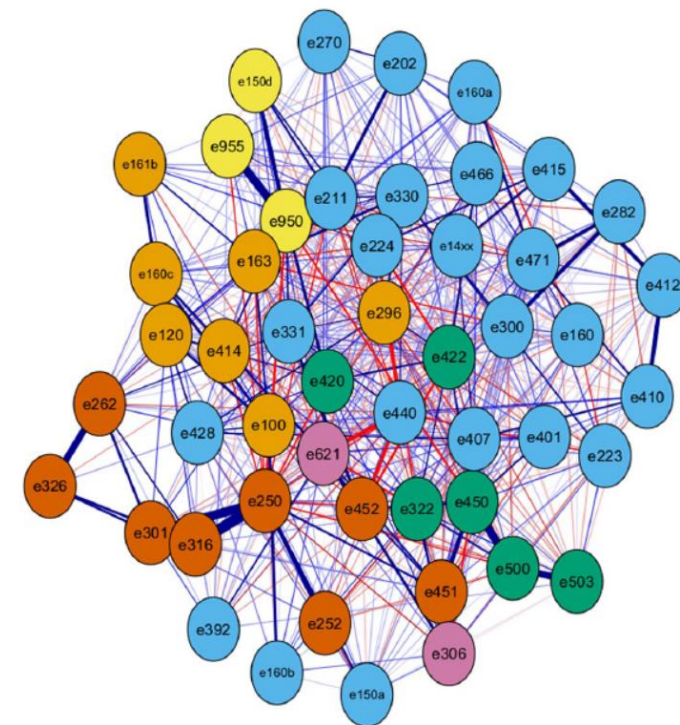
## Artificial sweeteners

- Cancer risk: *Debras et al, Plos Medicine, 2022*
- Cardiovascular disease risk: *Debras et al, BMJ 2022*
- Type 2 diabetes risk: *Debras et al, Diabetes Care, 2023*



## Food additive emulsifiers

- Cardiovascular disease risk: *Sellem et al, BMJ 2023*
- Cancer risk: *Sellem & Srouf et al, under review*
- Type 2 diabetes risk: *Salame et al, submitted*



Mixtures → cocktail effects?

*Chazelas et al, Scientific Reports, 2021*



ADDITIVES project (PI M Touvier):



# Do we have enough evidence justifying to take action to limit UPF exposure?

Economic stakes -> Some big food companies advocate for no public action, arguing for “no consensus” about health impacts of UPF (*Food Drink Europe 2023*)

## Challenges and points of discussion:

- UPF category: broad and heterogeneous + risk of misclassification in epidemiological studies
- Components of ultra-processed foods (eg, aspartame, carboxymethylcellulose) previously assessed and authorized by health authorities, considered as safe at current consumption levels
- Observational studies → residual confounding; Randomized Controlled Trials (RCT) for causality

## Do we have enough evidence justifying to take action to limit UPF exposure?

- Empirical validation by the consistency of the numerous epidemiological studies (*Monteiro Am J Clin Nutr 2022*), some of which with very precise dietary assessment (e.g. NutriNet-Santé, *Srour BMJ 2019 & JAMA Intern Med 2020*)
- Development of new tools (*Menichetti Nat Commun 2023*), guide on best practices to apply NOVA in epidemiological studies (*Martinez-Steele Nat Food 2023*) and dietary assessment methods specifically designed to assess UPF exposure (*Martinez-Perez IJBNPA 2022, Sarbagili-Shabat EJCN 2020*)
- Previous food additive assessments based on focused toxicological metrics (eg, cytotoxicity, genotoxicity), with no consideration of the latest epidemiological results or experimental data on metabolic or microbiota perturbations (*Chassaing Gastroenterology 2022, Suez Cell 2022*) nor potential cocktail effects  
-> need for reevaluation of controversial “cosmetic” additives, as done recently for TiO<sub>2</sub> (*Bettini Sci Rep 2017*) and aspartame (*IARC Lancet Oncol 2023*)
- Long-term RCTs on "hard endpoints" not feasible for suspected deleterious exposures (ethics !)
- Triangulation of study designs to show causality: consistency of results across large observational and mechanistic epidemiological studies on long term outcomes, carefully controlling for potential confounders + short term RCT on intermediate endpoints + in vivo and in vitro experimental studies.

# What's next?



**Research**



**Public health policies**

# Health impact of UPF: need for publically funded interdisciplinary research

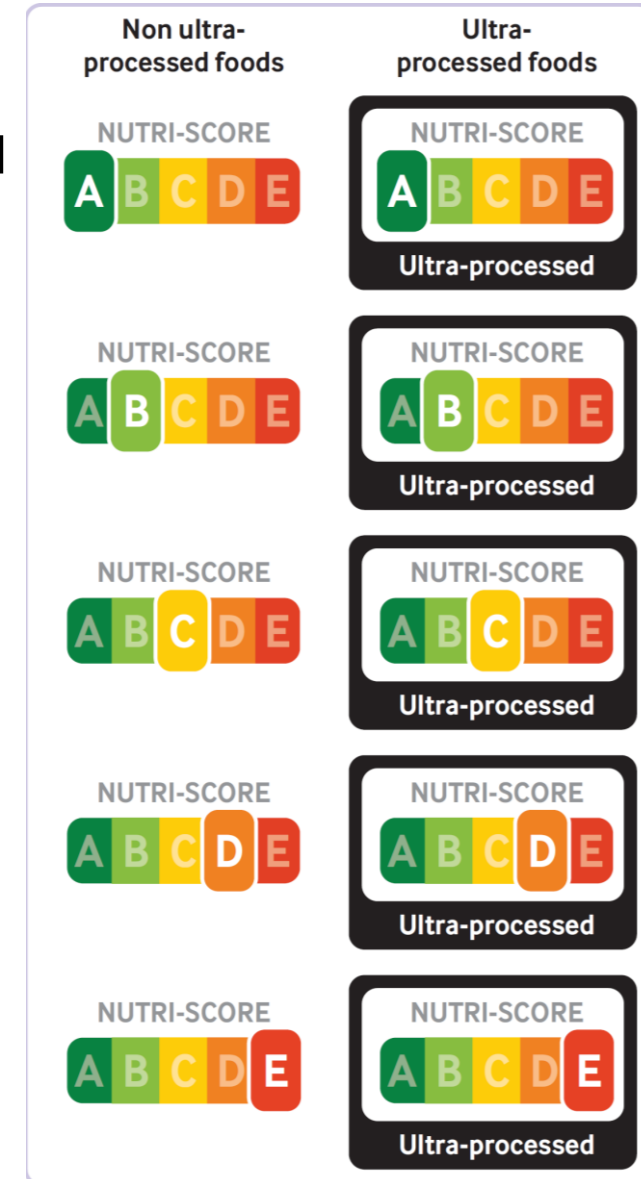


- To better identify the specific processes and substances (additives, other industrial ingredients, contaminants from processing or packaging) that contribute to the adverse cardiometabolic (and other) effects of UPF
- Interdisciplinary research combining epidemiology, data science, high quality dietary data collection, toxicology, experimental and interventional research, food technology, public policy, food systems and social marketing research.
- Publicly funded research, independent from the food industry

# Appropriate food policies: information and education at the individual level to better identify UPF

- Need for an operational definition for regulatory purposes, e.g. derived from NOVA and specifying an official positive list of processes and ingredients defining UPF
- Collective expertise by public health authorities, independent academic experts
- Front-of-pack labels or rating systems to facilitate consumer identification of UPF in supermarkets and online retailing.  
Several initiatives: “warnings” in Latin America (*Popkin Lancet Diabetes Endocrinol 2021*); FoodCompass in the USA (*Mozaffarian Nat Food 2021, O’Hearn Nat Commun 2022*); Nutri-Score with a black UPF banner (*Sraor BMJ Nutr Prev Health 2023*)
- Food profiling smartphone apps (barcode scanning), e.g. Open Food Facts (<https://world.openfoodfacts.org>)
- If not already the case, countries should include promotion of non/minimally processed foods in their official dietary guidelines → communication campaigns

→ Empowering people with better information



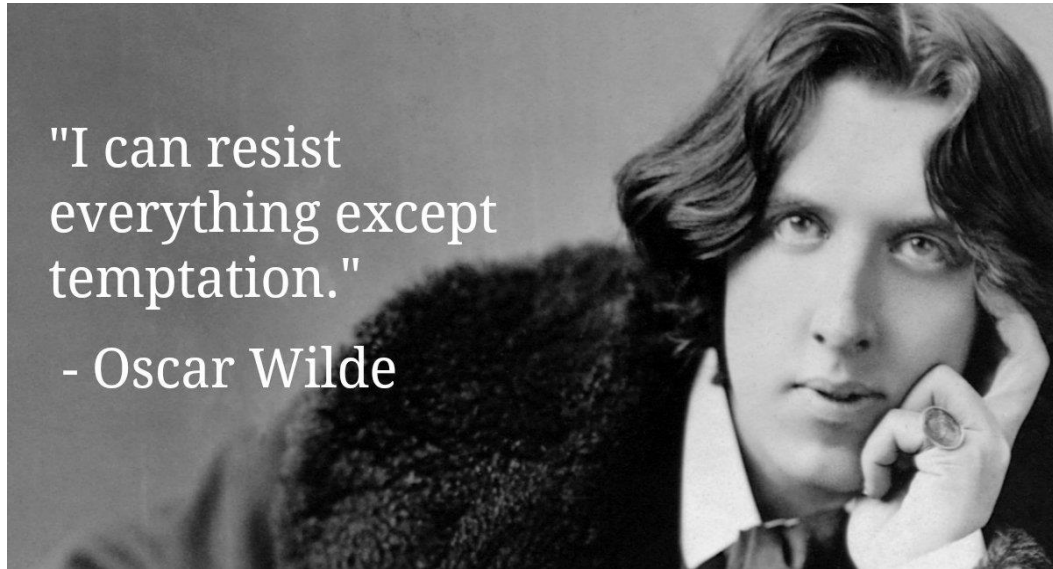
*Touvier et al, BMJ 2023*

RCT: *Sraor BMJ Nutr Prev Health 2023*

# Appropriate food policies: need to go beyond the individual level

"I can resist everything except temptation."

- Oscar Wilde



**Individual and collective determinants of physical activity and food choices**

*Source: Fitzgerald & Spaccarotella 2009*



## Appropriate food policies: deep change in food systems

- Need to change the environment in which people live and the food supply to which they have access to limit exposure to UPF and support informed decision making
  - Policy measures that work ecologically throughout food systems (*Popkin, Lancet Diabetes Endocrinol 2021, Northcott Agric Hum Values 2023*):
    - Law and regulation to reduce UPF marketing
    - Protection of schools and other learning environments,
    - Government policies and rewards to increase availability, accessibility, and affordability of nutritious minimally processed foods
    - Fiscal interventions that target deeper structural and commercial drivers of production, distribution, and promotion of UPF
    - Reevaluation of industrial food additives
  - By funding nutrition research and government lobbying, UPF companies often influence dietary recommendations and food policies, and avoid regulation (*Swinburn Lancet 2019; Chartres JAMA Intern Med 2016; Monteiro BMJ Glob Health 2021*)
- All decisions should be made free from commercial conflicts of interests (*Gilmore Lancet 2023*)



# Are minimally-processed diets achievable and affordable?

- Lower cost per calorie for UPF; Difficulty to achieve healthy and sustainable diets with minimal amounts of UPF at reasonable costs in some countries where they are ubiquitous ([Herforth FAQ 2020](#))
- But several countries of various socioeconomic background manage to maintain low levels of UPF
- And many (Brazil, Ecuador, Peru, Uruguay, Chile, Mexico, France, Belgium, Cataluña, Israel, Malaysia, Zambia, Sri Lanka, Canada) officially started to promote healthy, seasonal and affordable non-UPF diets in their official food policies, with concrete tools for citizens (e.g. meal simulation website [Mangerbouger.fr](#)).



# We need food processing...but not ultra-processing!



## Processed



## Ultra-processed

Not all “industrial foods” are “ultra-processed” foods

Many benefits of food processing (incl. industrial):

- Greater shelf stability
- Microbiological safety
- Affordability
- Functional and taste properties
- Convenience, time saving

## Conclusion: Public health policies to reduce UPF intake cannot wait

- Food processing is essential to sustainable food systems and food security.
- But mounting evidence from epidemiological and experimental studies links consumption of UPF to poorer cardiometabolic health.
- Factors at play (eg, food ingredient profiles, additive mixtures, process or packaging-related contaminants) and causal mechanisms are not yet fully understood, but evidence is accumulating beyond nutrient pathways
- Multidisciplinary research, independent of industry is needed to re-evaluate the safety of food additives and industrially processed ingredients as well as process-related contaminants
- Existing evidence is sufficiently strong to warrant immediate public health actions to help citizens identify UPF and limit their exposure by fiscal, marketing, and labelling regulations deeply transforming current food systems: healthy, sustainable minimally processed foods should become the easiest choice.





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# Thank you for your attention

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