Décrypter les comportements alimentaires à l'ère du numérique

Apports de la web-cohorte NutriNet-Santé à la recherche en e-épidémiologie nutritionnelle et l'appui aux politiques publiques

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Inserm / Inrae / Cnam / Université Sorbonne Paris Nord / Université Paris Cité

PI of the NutriNet-Santé Cohort

CRESS-EREN : Nutritional Epidemiology Research Team

Physio-pathological mecanisms


Inflammation, Oxidation, Dysbiosis, Endocrine and metabolic disturbances, Genetics/epigenetics

Determinants of nutritional behaviours

Socio-demographic, Economic (social inequalities), Psychological, Geographic, Genetic, Cultural, Health information and literacy

Dietary exposures and physical activity

Nutritional and non-nutritional exposures (contaminants linked to production methods [pesticides], the environment, food processing, packaging, food additives...), Nutrition-related behaviours, Dietary patterns, Physical activity, Dietary exposome, Alcohol, Dietary supplements, Nutritional status...

Human health

Chronic diseases (cardiovascular, diabetes, obesity, hypertension, cancers), Cognition, Mental, Respiratory, and Reproductive health, Mortality, Multimorbidity, IBD, Covid-19, Quality of life, Microbiota health

Planetary health

Sustainability, One Health, Environmental impact, Biodiversity

Public health policies and tools

Individual- and society-level policies, Food labeling, Recommendations, Pricing policies, Advertising regulation, Urban policies, Digital tools and applications

Targeted populations

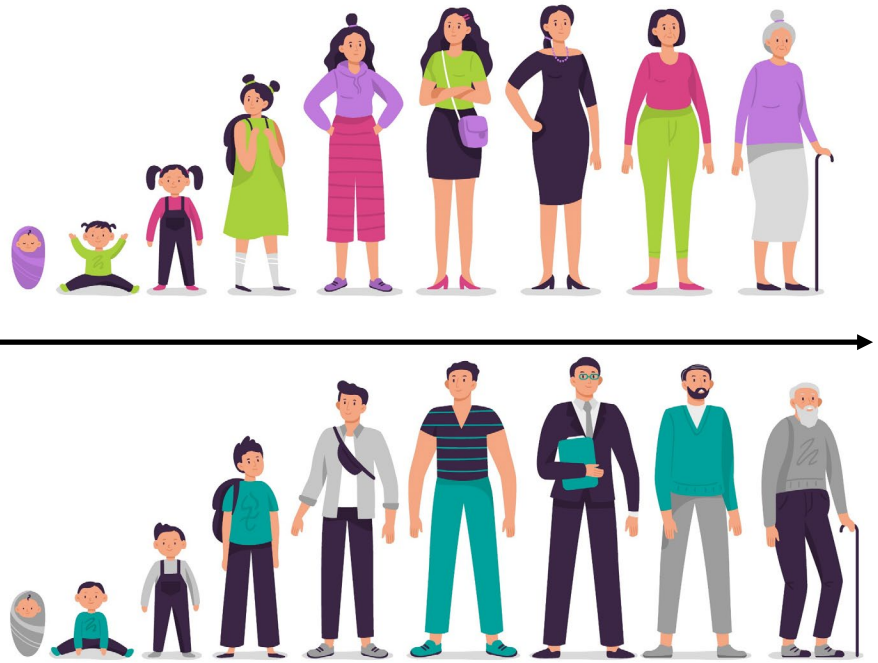
General population (primary prevention), Patients (secondary/tertiary prevention), Disadvantaged populations, Adolescents -> Seniors, Students, Pregnant women, Vegetarians...

Methodological approaches

Etiological epidemiology, Real-life interventions anchored in the Seine Saint Denis territory, Digital interventions, Surveillance, Modeling, Biomarkers, Trajectories, Interdisciplinarity, Innovative digital tools for measuring nutritional exposure, Participatory research

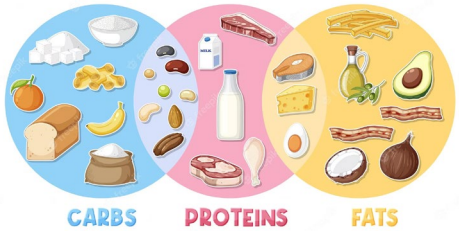
Diet in the life course

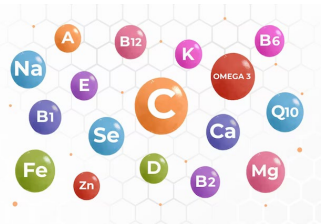
On average, in a lifetime, in France:

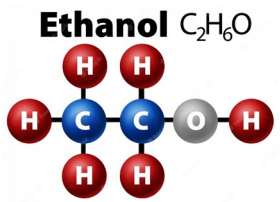


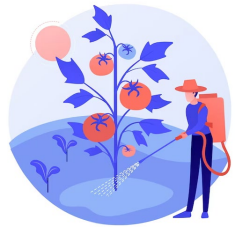
30 tons
Of foods

50 000 litres
of beverages





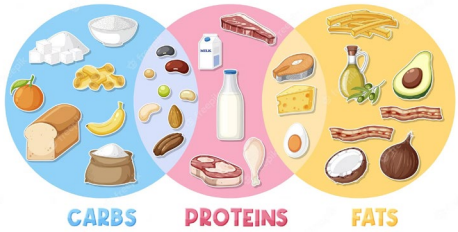


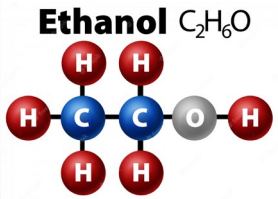


...

Estimates based on representative national food consumption surveys in France, Esteban Santé Publique France 2015; INCA3 ANSES 2015

Complexity of nutritional exposure -> limits of traditional methods and tools for data collection

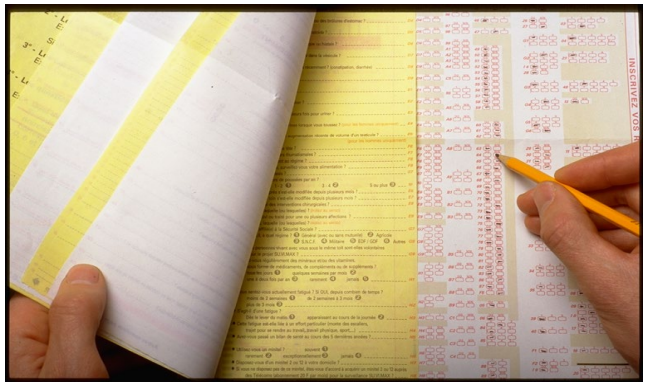


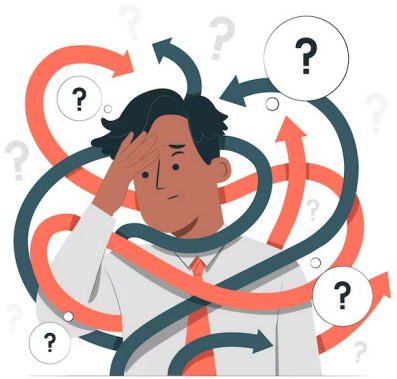


- High level of detail to accurately characterize nutritional exposures
- Prospective studies
- Very large samples
- Need to control for many potential confounders -> extensive information to be collected

Complexity, costs, logistics with traditional data collection tools ++++++

(postal mailings, data entry, verifications, correspondence with participants, cohort retention, etc.)





NutriNet-Santé: a unique infrastructure for interdisciplinary nutrition research

Launching May 11th 2009 in France: 1st **web-cohort** of this size worldwide

NutriNet-Santé: a unique infrastructure for interdisciplinary nutrition research

Launched in **2009** in France, 1st **web-cohort** of this size worldwide

So far: >183,000 participants aged 15+ / recruitment still ongoing

- **Very detailed assessment of dietary exposures and emerging nutritional behaviours**
  - ✓ 3 validated repeated 24h dietary records every 6 months, incl. >3500 generic food items + commercial names/brands of industrial products
  - ✓ Numerous complementary online questionnaires → characterization of the "exposome" of participants

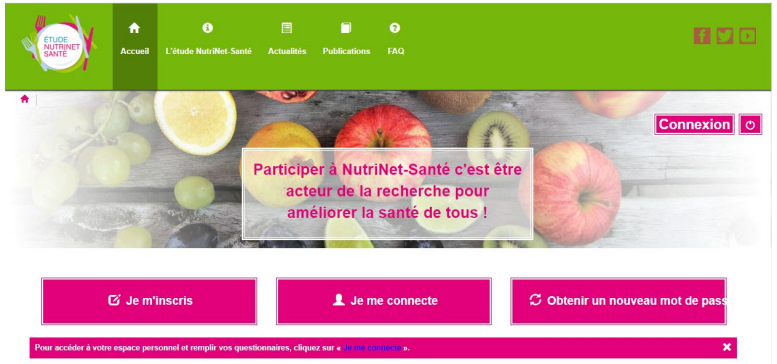
  Food packaging, cooking practices, mode of production, physical activity, tobacco, drugs, environmental, domestic, professional exposures…

- **Biobank:** n=20,000 (fasting serum, plasma, buffy-coat, urine) + stool collection ongoing for n≈10 000 (**NutriGut -> microbiota**)

- **Health events:** validation by medical committee + linked to National health insurance and mortality databases (SNIIRAM, CépiDC -> SNDS)

2009 — Ongoing, **already >15-year follow-up** and >6400 incident cancers, 4900 cardiovascular diseases, 4800 deaths — 2026…

- **Academic collaborations welcome**
- **Multidisciplinary** & **participatory** research
- **International expansion** (Belgium + partners for know-how transfer to Canada, Brazil)



www.etude-nutrinet-sante.fr / https://info.etude-nutrinet-sante.fr/ PI : M Touvier

Interface accessible on computers, tablets, and smartphones

www.etude-nutrinet-sante.fr

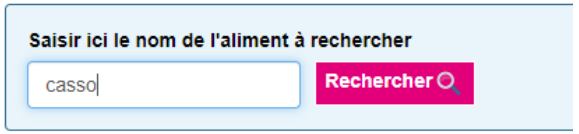
Annual set of questionnaires + flexibility to add new questionnaires at any time

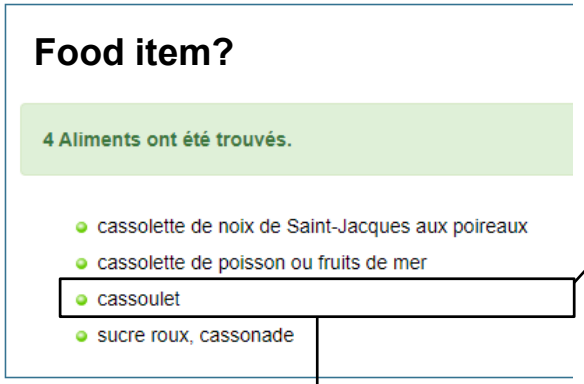
- Baseline set:

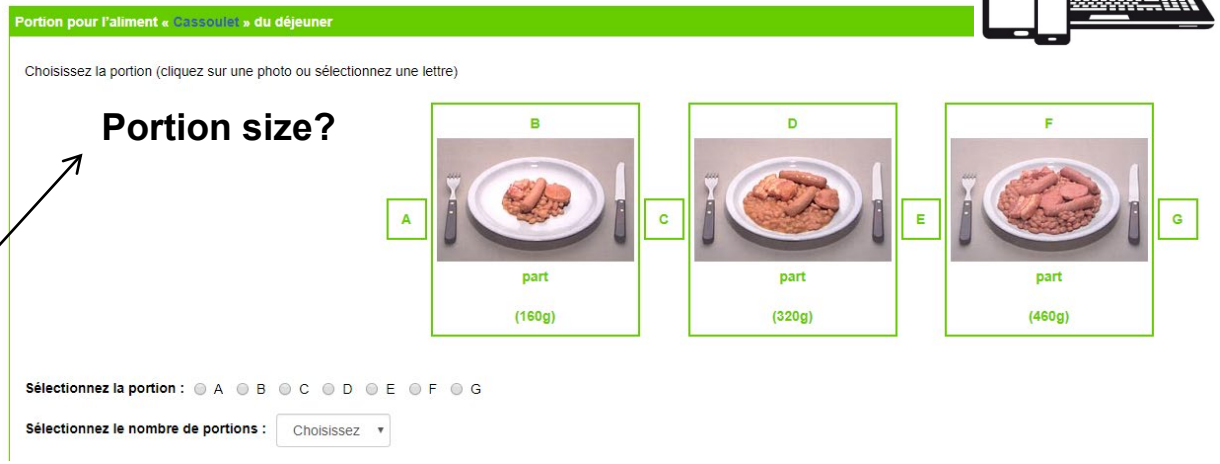
Socio-demographic and lifestyle questionnaire	15 mn
Dietary questionnaire *(3 24-hour records: 2 weekdays + 1 weekend day)*	25 mn x 3
Physical activity questionnaire (IPAQ 7 days)	10 mn
Anthropometric questionnaire	10 mn
Health questionnaire	15 mn

- Baseline set repeated every year / twice a year for dietary, health and weight status questionnaires
- Maximum 1 additional questionnaire per month, less than 20 minutes: consumption of organic products, dietary supplements, nutritional knowledge, tastes and aversions, sun exposure, occupational exposure, food packaging, memory and mood, use of apps, food waste, etc.-> list and PDF: *https://info.etude-nutrinet-sante.fr/siteinfo/Ancillary protocols on sub-cohorts*
- Monitoring of health events: validation by physicians based on medical records + link to health insurance databases and the mortality register
- Regular publication of cohort results (summaries in French: *https://etude-nutrinet-sante.fr/link/zone/43-PublicationsPress coverage*) and media coverage (*https://etude-nutrinet-sante.fr/link/zone/42-Dans%20les%20m%C3%A9dias*)

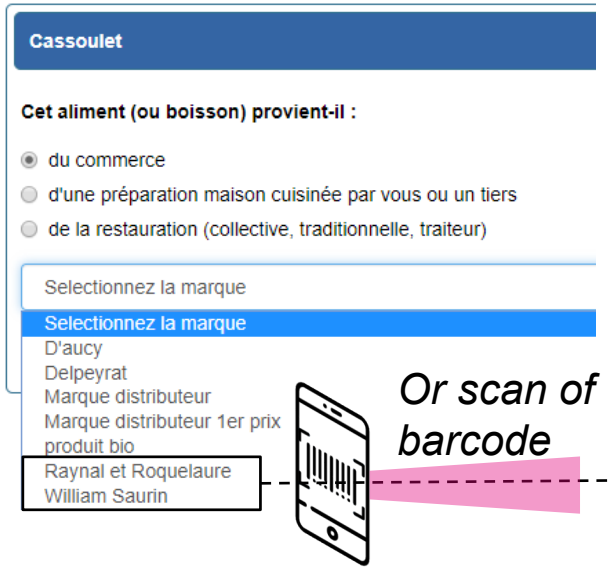
NutriNet-Santé : Online interactive dietary records

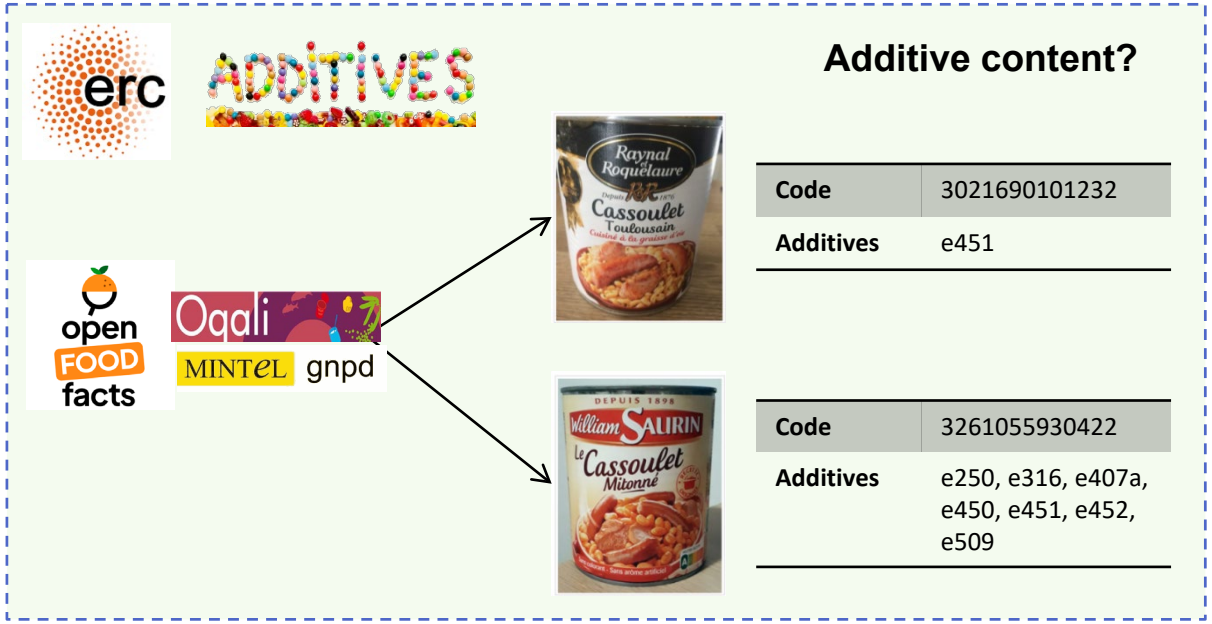






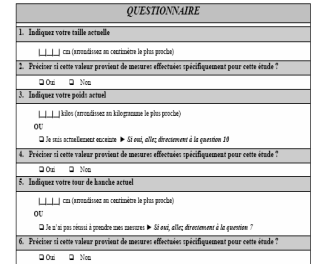
Industrial product?
→Brand?





Methodological work in e-epidemiology: pre-testing of the NutriNet-Santé cohort

Web questionnaires	Traditional method
Sociodemographic	Self-administered paper questionnaire
Health	Self-administered paper questionnaire
Anthropometric	Self-administered paper questionnaire
Physical	Interview by a dietitian
Diet (1 24-hour record)	Interview with a dietitian (1 reminder over 24 hours)


QUESTIONNAIRE

1. Indiquez votre taille actuelle

|_|_|_| cm (arrondissez au centimètre le plus proche)

2. Préciser si cette valeur provient de mesures effectuées spécifiquement pour cette étude ?

❑ Oui ❑ Non

3. Indiquez votre poids actuel

|_|_|_| kilos (arrondissez au kilogramme le plus proche)

OU

❑ Je suis actuellement enceinte ▶ *Si oui, allez directement à la question 10*

4. Préciser si cette valeur provient de mesures effectuées spécifiquement pour cette étude ?

❑ Oui ❑ Non

5. Indiquez votre tour de hanche actuel

|_|_|_| cm (arrondissez au centimètre le plus proche)

OU

❑ Je n'ai pas retrouvé à prendre mes mesures ▶ *Si oui, allez directement à la question 7*

6. Préciser si cette valeur provient de mesures effectuées spécifiquement pour cette étude ?

❑ Oui ❑ Non

- High concordance between the two methods (assessed by ICC and Kappa)
- Numerous errors avoided in the online version (data entry errors, missing values, outliers) thanks to built-in checks, elimination of the data entry step and reduction of social desirability bias
- Web version: user-friendly and highly appreciated (92-94% of participants preferred web questionnaires to paper questionnaires), simplified logistics, reduced costs.

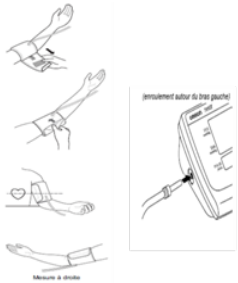
Touvier M, et al. Eur J Epidemiol. 2010; Touvier M et al. Br J Nutr. 2011; Vergnaud AC et al. Int J Public Health. 2011

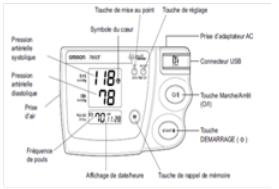
Validation studies of 24-hour dietary records collected online versus blood and urine biomarkers

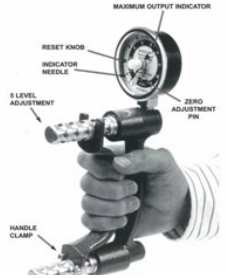
- Protein, potassium and sodium intake compared to urinary biomarkers over 24 hours (n=199 adults) *(Lassale et al, Br J Nutr. 2015)*

- Fish, fruit and vegetable consumption and micronutrient intake compared to plasma biomarker concentrations: β-carotene, vitamin C and n-3 polyunsaturated fatty acids (n=198 adults) *(Lassale et al, J Acad Nutr Diet. 2016)*

Biobank and clinical examination







- 2011-2014: Clinical examination + biobanking: n=20,000
  - Blood pressure
  - Anthropometric measurements
  - Grip test
  - Body composition
  - Fasting serum, plasma, buffy-coat, urine

- 2020-2022: n=26,000 dry blood spot

- 2024-2025: stool collection for n≈10 000

Les centres de prélèvement NutriNet

Région parisienne

80 centers

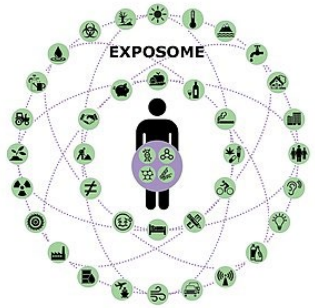
NutriNet-Santé: a unique infrastructure for interdisciplinary nutrition research (n=183,000 ; 2009-ongoing)

www.etude-nutrinet-sante.fr / PI: Dr Mathilde Touvier

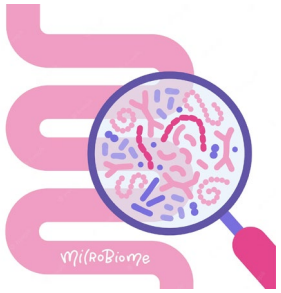
Food labeling, Food policy

Food processing
Food formulation
Food packaging

Organic food, pesticides
Environemental impact
Sustainability



Exposome

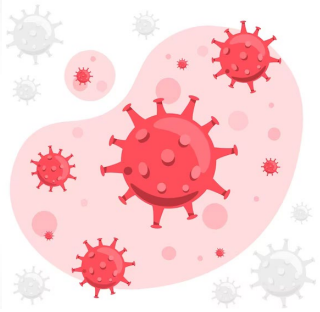


Mechanisms,
gut microbiota

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

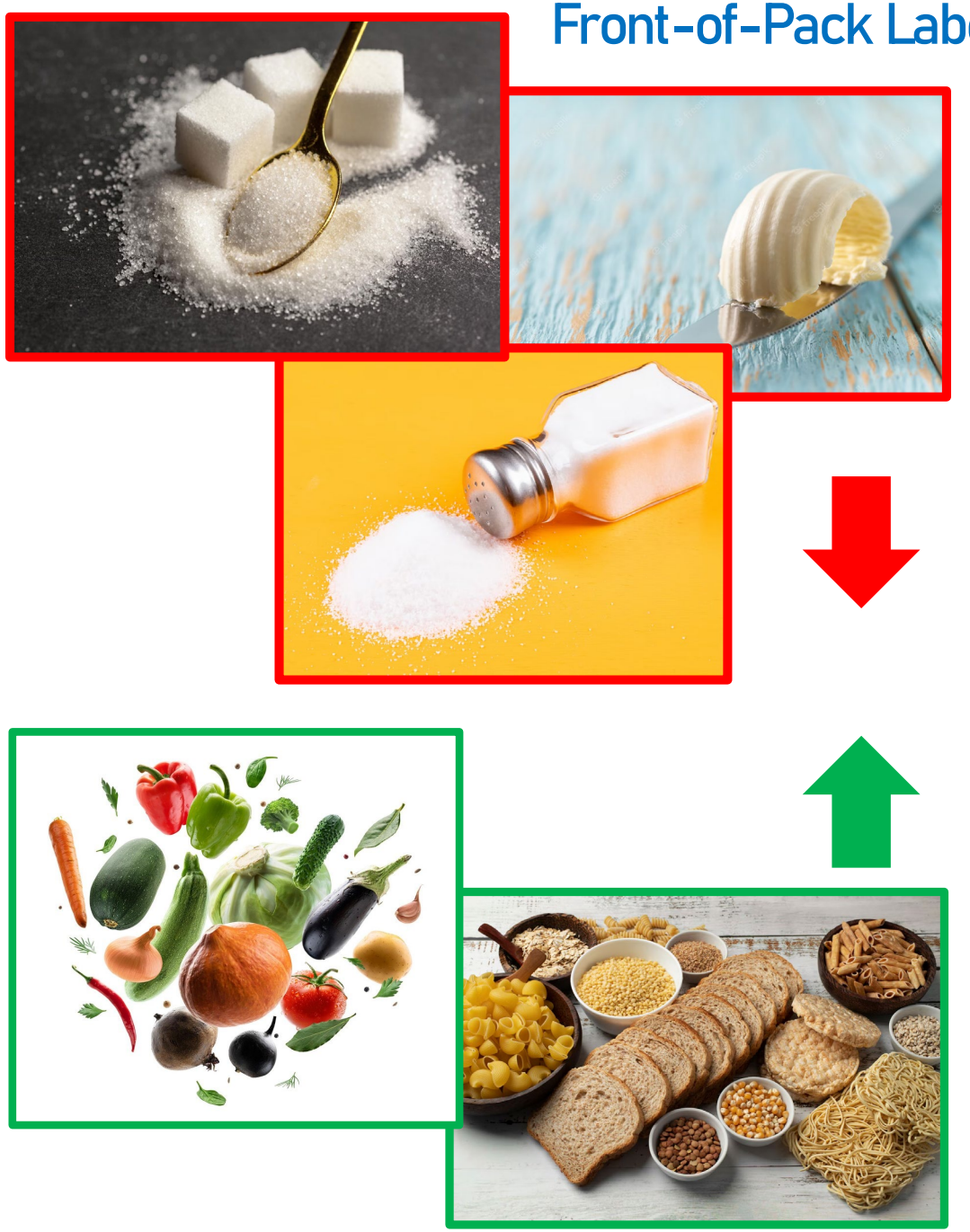
Circadian nutritional
rhythms

Participatory
research
on student's diet

Dietary
supplements

Connected sensors for
research in nutrition
and physical activity

Front-of-Pack Labeling as a Public Health Tool: The Nutri-Score Example



Which food has the best nutritional quality?

Información nutricional/Valores nutricionais médios/Gemiddelde voedingswaarde/ Valeurs nutritionnelles moyennes/Nährwerte/Valori nutrizionali medi	e/100g	e/300g
Valor energético/Energia/Energie/ Energie/Energie/Energia	885 kJ/ 210 kcal	2656 kJ/ 630 kcal
Grasas/Lípidos/Vetten/Matières grasses/Fett/Grassi	5,3g	15,9g
de las cuales, saturadas/dos quais saturados/ waarvan verzadigde vetzuren/dont acides gras saturés/ davon gesättigte Fettsäuren/di cui acidi grassi saturi	2,4g	7,2g
Hidratos de carbono/Hidratos de carbono/Koolhydraten/ Glucides/Kohlenhydrate/Carboidrati	30,6g	91,8g
de los cuales, azúcares/dos quais açúcares/waarvan suikers/ dont sucres/davon Zucker/di cui zuccheri	3,9g	11,7g
Proteínas/Proteínas/Eiwitten/Protéines/Eiweiss/Proteine	8,9g	26,7g
Sal/Sal/Zout/Sel/Salz/Sale	0,90g	2,70g

Valeurs nutritionnelles	Pour 100 g	1 portion - 200 g	% des AQR* par portion
Énergie	829 kJ - 197 kcal	1658 kJ - 394 kcal	20 %
Matières grasses	4,7 g	9,4 g	13 %
Dont acides gras saturés	2,9 g	5,8 g	29 %
Glucides	25 g	51 g	20 %
Dont sucres	2,1 g	4,2 g	5 %
Fibres alimentaires	4,1 g	8,2 g	–
Protéines	11 g	22 g	45 %
Sel	1,5 g	3 g	49 %

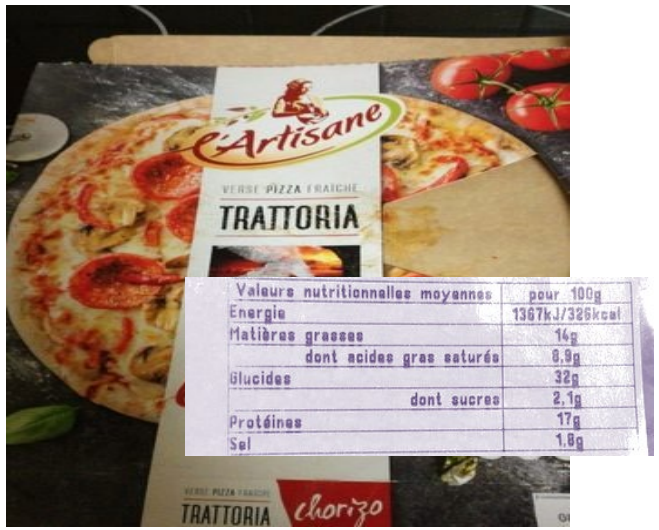
*Apport Quotidien de Référence pour un adulte-type (8 400 kJ/ 2 000 kcal)

DECLARATION NUTRITIONNELLE	Pour 100g	Pour 1/4 de pizza (143g)	% AR* pour 143g
Energie	970 kJ 231 kcal	1384 kJ 330 kcal	17%
Matières grasses dont acides gras saturés	10,1g 4,1g	14,5g 5,9g	21% 30%
Glucides dont sucres	25,4g 4,1g	36,3g 5,8g	14% 6%
Fibres alimentaires	1,7g	2,4g	
Protéines	8,7g	12,4g	25%
Sel	1,3g	1,9g	31%

?

INFORMATIONS NUTRITIONNELLES	Pour 100 g	Pour 1/3 de pizza (123 g)	% AR* pour 123 g
Energie	895 kJ 213 kcal	1103 kJ 263 kcal	13%
Matières grasses dont acides gras saturés	7,7 g 3,6 g	9,5 g 4,5 g	14% 23%
Glucides dont sucres	24 g 4,1 g	30 g 5,1 g	12% 6%
Fibres alimentaires	1,7 g	2,1 g	
Protéines	11 g	13 g	26%
Sel	1,4 g	1,7 g	28%

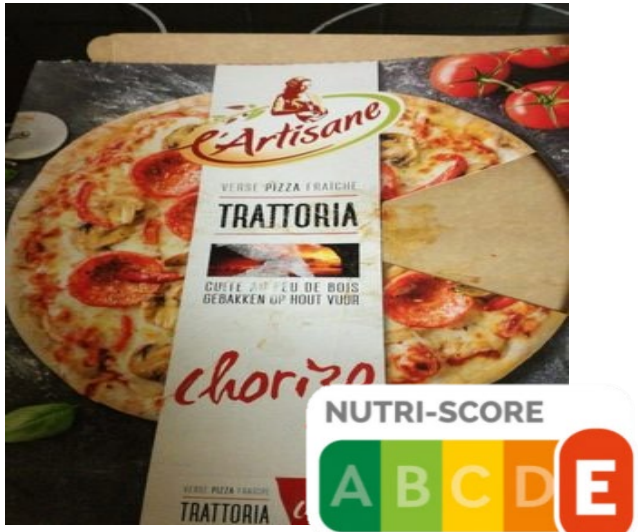
*Apport de référence pour un adulte-type (8 400 kJ/2 000 kcal). Contient 3 portions adulte.



Valeurs nutritionnelles moyennes	pour 100g
Energie	1367kJ/326kcal
Matières grasses	14g
dont acides gras saturés	8,9g
Glucides	32g
dont sucres	2,1g
Protéines	17g
Sel	1,8g

Valeurs nutritionnelles moyennes	pour 100 g	par portion de 157 g
Energie	1034 kJ/247 kcal	1623 kJ/388 kcal
Matières grasses	10,6 g	16,6 g
dont acides gras saturés	5,6 g	8,8 g
Glucides	25,5 g	40,0 g
dont sucres	3,3 g	5,2 g
Protéines	11,3 g	17,7 g
Sel	1,44 g	2,26 g
RI (reference intake) = Apport de Réf		

Which food has the best nutritional quality?

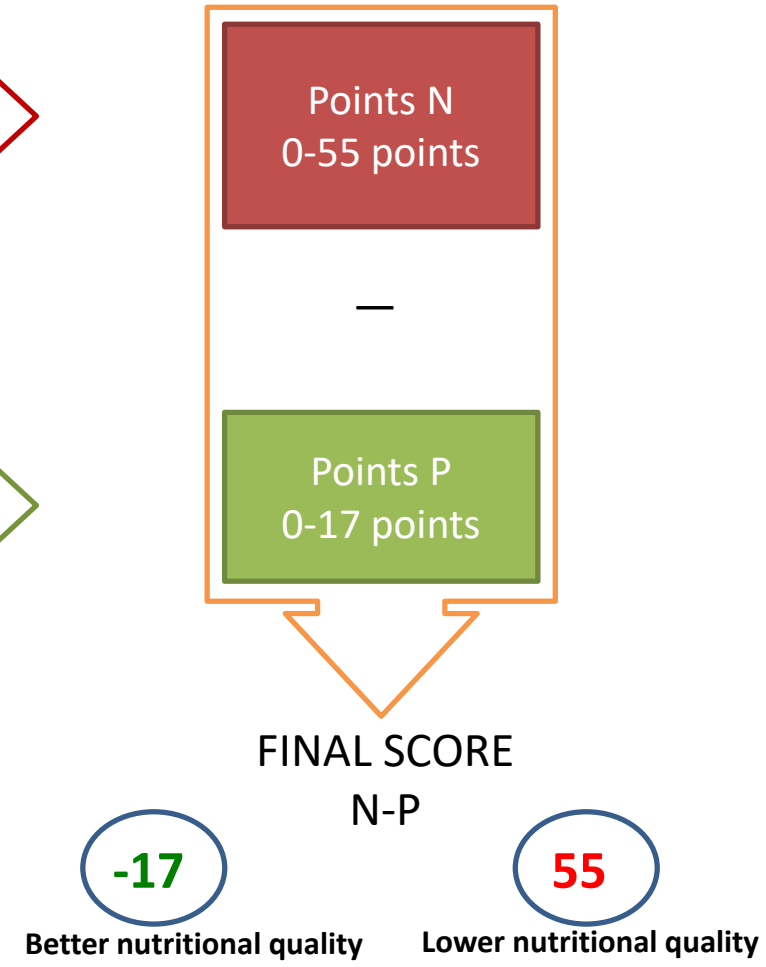


Nutri-Score algorithm

DATA AVAILABLE ON PACKAGING

Nutrients /100g	Points
Energy (KJ)	0-10
Sugar(g)	0-15
Saturated fat (g)	0-10
Salt (g)	0-20

Element /100g	Points
Fruits, vegetables, pulses (%)	0-5
Fibers (g)	0-5
Proteins (g)**	0-7



*** 0-2 for red meat*

For beverages with intense sweeteners, + 4 negative points

* updated in 2023, International Scientific Committee

https://www.santepubliquefrance.fr/determinants-de-sante/nutrition-et-activite-physique/articles/nutri-score

Nutri-Score helps consumers quickly identify the overall nutritional quality of foods at the point of purchase

Foods from different categories but intended for the same use, e.g. eaten for breakfast: bread, rusks, breakfast cereals, biscuits, pastries, etc.

Foods in the same category (e.g. breakfast cereals)

The same food (with the same name) from different brands (e.g. Crispy muesli with chocolate chips)

Nutri-Score : a science-based public health tool

- Cohorts (SUVI.MAX, NutriNet-Santé, EPIC..)
- Online experimental supermarket -> RCT
- Experimental shops
- Study in real-life setting
- International study (18 countries)

2018 2018 2019 2019 2020 2020

Bulk products, collective catering...

Decree 31 October 2017

EREN scientific publications

Public health law January 2016

EREN scientific publications

Report for the French Minister of Health (Hercberg 2014)

EREN scientific publications

NUTRI-SCORE A B C D E

France

2026: >1500 brands

>150 scientific publications:

- validation of the algorithm
- validation of the graphical design and impact

Dozens of hearings in the National Assembly, the Senate, and other institutions

8 countries: France, Belgium, Germany, Luxembourg, Spain, Netherlands, Switzerland, Romania

Nutri-Score and chronic diseases

→ SU.VI.MAX cohort
n=6,435, 13 years of follow-up

+ cancers
+ cardiovascular diseases
+ obesity (in men) + weight gain (in both sexes)
+ metabolic syndrome

→ NutriNet-Santé cohort
n= 46,864, 6 years of follow-up

+ cardiovascular diseases
+ breast cancer
+ asthma

→ SUN cohort
n=20,053, 10.9 years of follow-up

+ overall mortality
+ cancer mortality

→ ENRICA cohort
n=2,054, 9 years of follow-up

+ overall mortality

→ EPIC cohort (10 European countries)
n=501,594, 17 years of follow-up

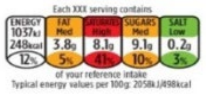
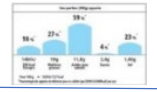
+ all-site cancers
+ colorectal cancers, upper aerodigestive tract cancers, stomach, lung (for men), and liver and breast (postmenopausal) for women
+ total mortality and mortality from cancer, diseases of the circulatory, respiratory, and digestive systems
+ Crohn's disease

https://nutriscore.blog/2022/09/23/bibliography-references/
https://nutriscore-europe.com/wp-content/uploads/2023/01/NS_rapport-EU-V10_230202.pdf

Impact of Nutri-Score on the nutritional quality of the shopping basket (in real-life settings)

In-store experiment

691 participants; 5 logos tested

		nutritional quality of the shopping cart	
		General population	Households <€2,000/month
Nutri-Score		+9.3%	+9.4%
Health Star Rating (HSR)		+6.6%	+6.5%
Multiple Traffic Lights (MTL)		+4.8%	+3.6%
SENS		+3.6%	+2.1%
GDA/RI		+2.9%	+2.2%
No label		-0.2%	-0.2%

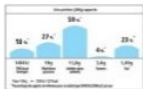
Field trial in actual supermarkets

60 supermarkets, 4 regions in France
Data collected: purchase receipts (1,748,000 products)
4 logos tested


+4.5%


+3.9%

+3.3%


0%

→ Nutri-Score is the logo associated with the best overall nutritional quality of the shopping basket (+4.5% to 9.4%)

→ Nutri-Score has the greatest impact among lower-income consumers

Randomised controlled trial in an experimental online supermarket testing the effects of front-of-pack nutrition labelling on food purchasing intentions in a low-income population

Manon Egnell [1], Isabelle Boutron [2], Sandrine Péneau [1], Pauline Ducrot [3], Mathilde Touvier [1], Pilar Galan [1], Camille Buscail [1], Raphaël Porcher [2], Philippe Ravaud [2], Serge Hercberg [1, 4], Emmanuelle Kesse-Guyot [1], Chantal Julia [1, 4]
Correspondence to Dr Manon Egnell; m.egnell@eren.smbh.univ-paris13.fr

European Review of Agricultural Economics pp. 1–34
doi:10.1093/erae/jbz037

Nutritional and economic impact of five alternative front-of-pack nutritional labels: experimental evidence

Paolo Crosetto*, Anne Lacroix, Laurent Muller and Bernard Ruffieux

Journal of the Academy of Marketing Science
https://doi.org/10.1007/s11747-020-00723-5

ORIGINAL EMPIRICAL RESEARCH

Effects of front-of-pack labels on the nutritional quality of supermarket food purchases: evidence from a large-scale randomized controlled trial

Pierre Dubois [1] · Paulo Albuquerque [2] · Olivier Allais [3] · Céline Bonnet [1] · Patrice Bertail [4] · Pierre Combris [3] · Saadi Lahlou [5] · Natalie Rigal [6] · Bernard Ruffieux [6] · Pierre Chandon [2]

OECD recently published projection figures for the period 2023-2050:

- 2M cases of NCDs avoided in Europe thanks to the Nutri-Score.
- Significant reduction in healthcare expenditure of -0.05%/year attributable to the Nutri-Score
- Accompanied by an improvement in productivity at work due to the reduction in cases of NCDs: 10.6 full-time equivalents per 100,000 individuals / year less absenteeism

OECD. *Healthy Eating and Active Lifestyles: Best Practices in Public Health*. (OECD, 2022). doi:10.1787/40f65568-en.

Strong support from the international scientific community and learned societies

IARC Evidence Summary Brief No. 2

Association between nutritional profiles of foods underlying Nutri-Score front-of-pack labels and mortality: EPIC cohort study in 10 European countries. Deschasaux M, Huybrechts I, Julia C, Hercberg S, ...Gunter MJ, Touvier M. **BMJ**. 2020 Sep 16;370:m3173. doi: 10.1136/bmj.m3173. PMID: 32938660

Nutritional quality of food as represented by the FSAm-NPS nutrient profiling system underlying the Nutri-Score label and cancer risk in Europe: Results from the EPIC prospective cohort study. Deschasaux M, Huybrechts I, ...Gunter MJ, Touvier M. **PLoS Med**. 2018 Sep 18;15(9):e1002651. doi: 10.1371/journal.pmed.1002651. eCollection 2018 Sep. PMID: 30226842

Nutritional quality of diet characterized by the Nutri-Score profiling system and cardiovascular disease risk: a prospective study in 7 European countries. Deschasaux-Tanguy M, ,,, Touvier M. **Lancet Reg Health Eur**. 2024 Sep 10;46:101006. doi: 10.1016/j.lanepe.2024.101006

News and Views

The Nutri-Score nutrition label

A public health tool based on rigorous scientific evidence aiming to improve the nutritional status of the population

Serge Hercberg[1], Mathilde Touvier[1], Jordi Salas-Salvado[2], on behalf of the Group of European scientists supporting the implementation of Nutri-Score in Europe[3]

décembre 2021

1034 professionnels de santé et scientifiques se mobilisent en France pour défendre Nutri-Score face aux nouvelles attaques des lobbys économiques et politiques

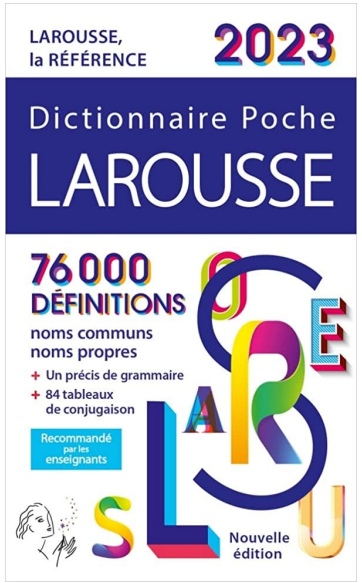
Depuis plusieurs semaines on assiste à une violente offensive anti Nutri-Score menée en France par les secteurs des fromages et des charcuteries qui se disent «pénalisés» par la notation de leurs produits. C'est le projet de la Commission Européenne de proposer fin 2022 un logo nutritionnel obligatoire pour l'Europe qui mobilise ces secteurs agricoles de grandes multinationales qui font de la résistance

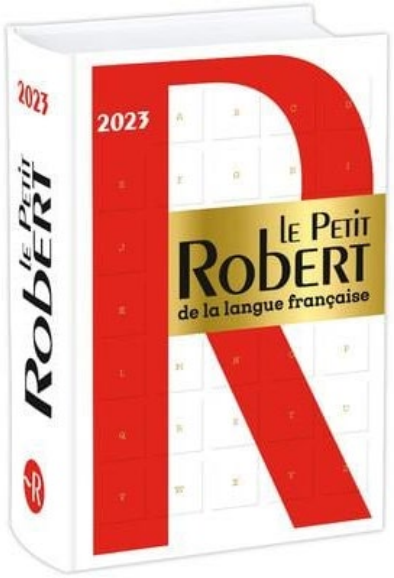
The Nutri-Score nutrition label : justifications, scientific basis, user guide, benefits, limitations, deployment and update

SOMMAIRE

https://nutriscore.blog

Nutri-Score: a public health tool understood and widely acclaimed by the public

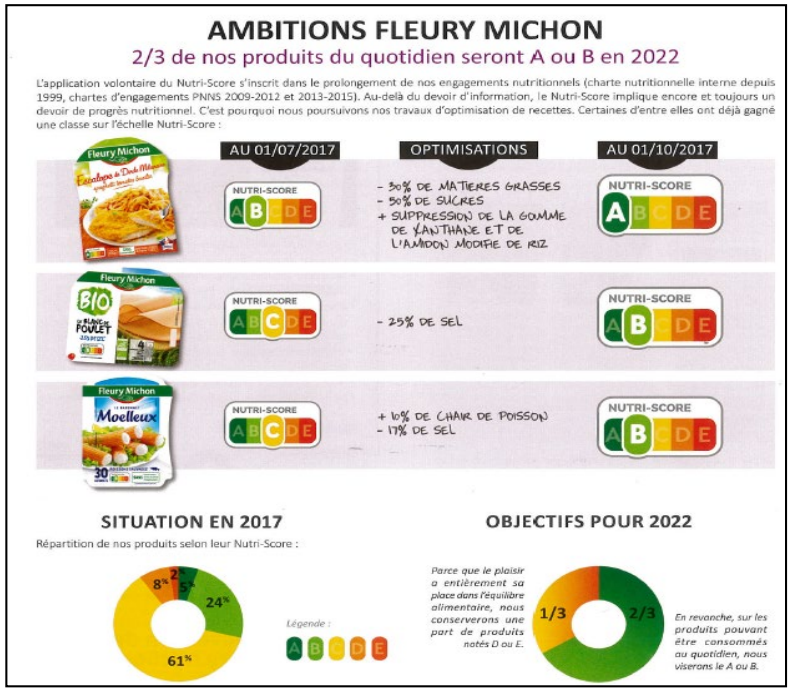




A petition on the French National Assembly website calling for mandatory Nutri-Score labeling on all products has already gathered more than 45,000 signatures.

My Research in 180 Bricks" workshop, Cité des Sciences et de l'Industrie, M. Touvier, January 2023 (children aged 7-10) In partnership with Sorbonne Paris Nord University

Reformulations



Source: Fleury-Michon

Intermarché

TOUS UNIS CONTRE LA VIE CHÈRE

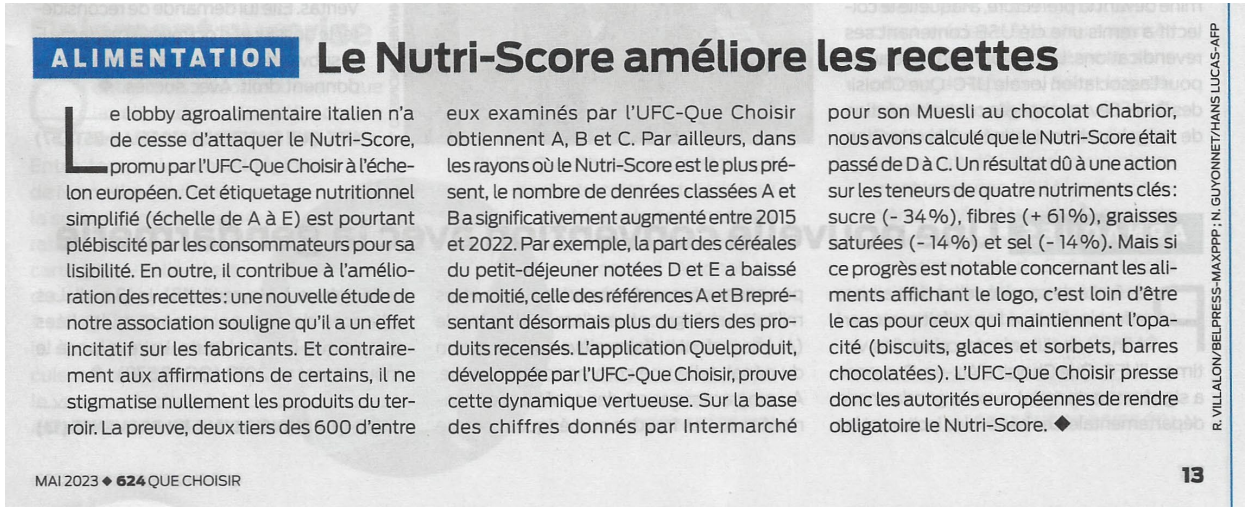
"Intermarché (distributor) announced in September 2019 that 900 foods from its own brands would be reformulated to display a Nutriscore A, B or C + a removal of the additives they contained ..."

Bonduelle

"Reduction of the salt content of 200 canned foods. Reduction of saturated fatty acids in salads (up to 33%) and salt (up to 50%)."

DAUNAT

''By 2022, 75% of products will be classified Nutriscore A or B, compared to 56% today"



ALIMENTATION

Le Nutri-Score améliore les recettes

Le lobby agroalimentaire italien n'a de cesse d'attaquer le Nutri-Score, promu par l'UFC-Que Choisir à l'échelon européen. Cet étiquetage nutritionnel simplifié (échelle de A à E) est pourtant plébiscité par les consommateurs pour sa lisibilité. En outre, il contribue à l'amélioration des recettes : une nouvelle étude de notre association souligne qu'il a un effet incitatif sur les fabricants. Et contrairement aux affirmations de certains, il ne stigmatise nullement les produits du terroir. La preuve, deux tiers des 600 d'entre eux examinés par l'UFC-Que Choisir obtiennent A, B et C. Par ailleurs, dans les rayons où le Nutri-Score est le plus présent, le nombre de denrées classées A et B a significativement augmenté entre 2015 et 2022. Par exemple, la part des céréales du petit-déjeuner notées D et E a baissé de moitié, celle des références A et B représentant désormais plus du tiers des produits recensés. L'application Quelproduit, développée par l'UFC-Que Choisir, prouve cette dynamique vertueuse. Sur la base des chiffres donnés par Intermarché pour son Muesli au chocolat Chabrior, nous avons calculé que le Nutri-Score était passé de D à C. Un résultat dû à une action sur les teneurs de quatre nutriments clés : sucre (- 34 %), fibres (+ 61 %), graisses saturées (- 14 %) et sel (- 14 %). Mais si ce progrès est notable concernant les aliments affichant le logo, c'est loin d'être le cas pour ceux qui maintiennent l'opacité (biscuits, glaces et sorbets, barres chocolatées). L'UFC-Que Choisir presse donc les autorités européennes de rendre obligatoire le Nutri-Score. ◆

R. VILLALON/BELPRESS-MAXPPP ; N. GUYONNET/HANS LUCAS-AFP

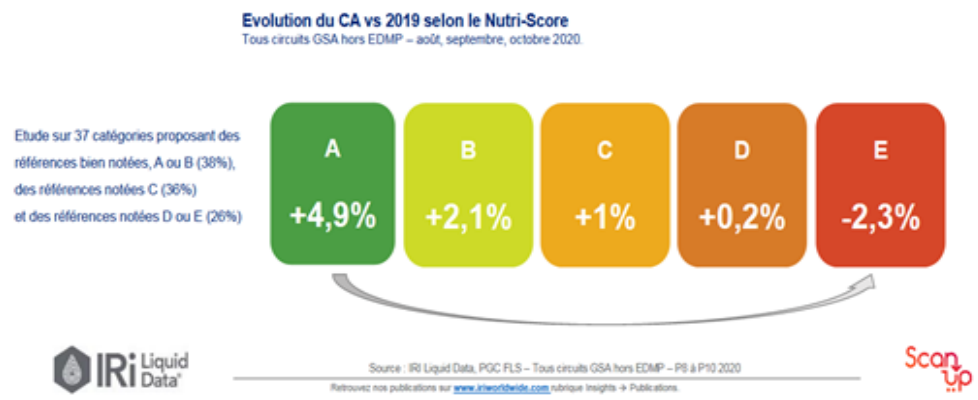
Promotions in supermarkets based on Nutri-Score

Eroski (Spain)

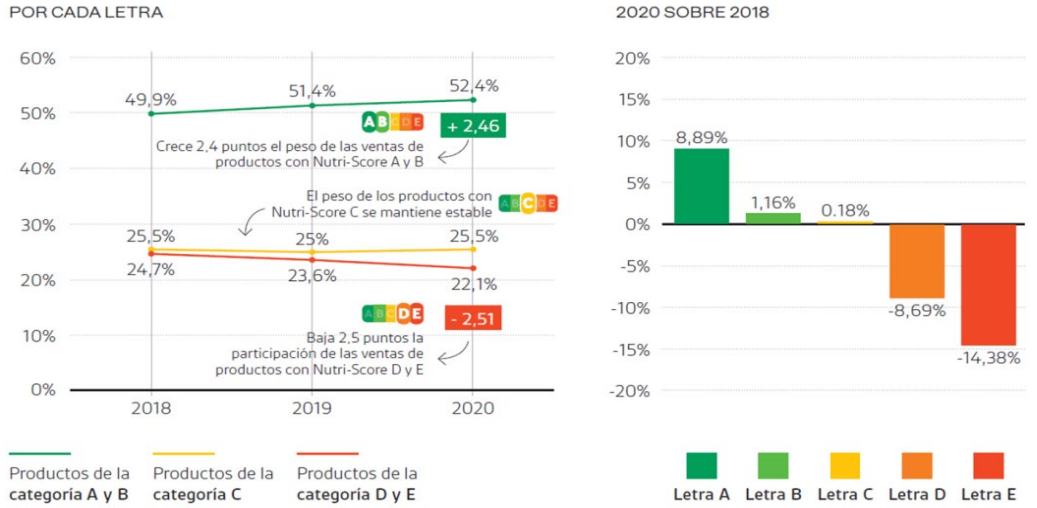
Delhaize (Belgium)

Positives changes in food sales fostered by Nutri-Score

Evolution of sales of food products according to NutriScore between 2019 and 2020 in supermarkets



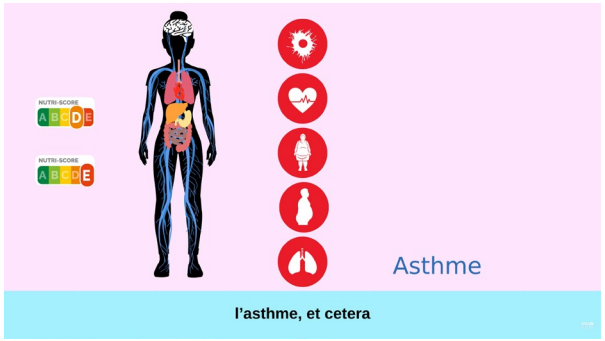
Evolución de ventas según Nutri-Score



To learn more about Nutri-Score: blog, videos, webinars, social media

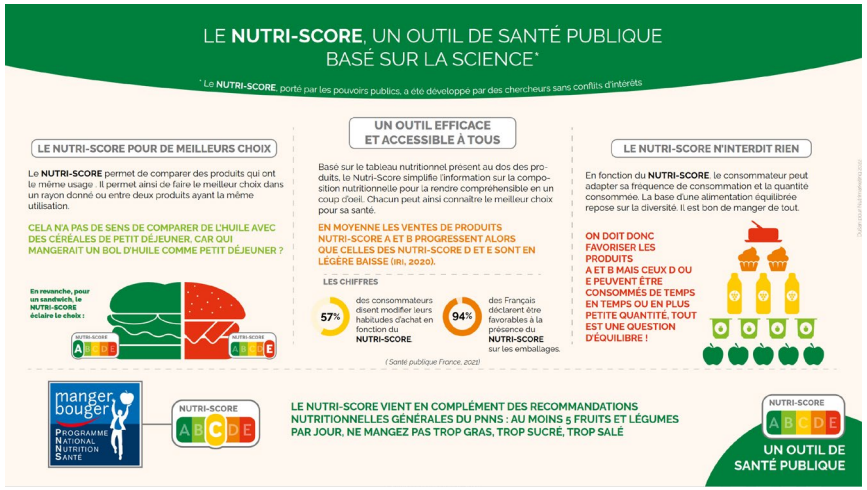
Nutriscore.blog : articles in French, English, Spanish

Short videos



https://www.youtube.com/watch?v=_zVlryawyVU
https://www.youtube.com/watch?v=JhGNmJVjCJU

Didactic forms



Emission 30' santé

Inserm

Ultra-processed foods: examples

Monteiro CA. et al.The star shines bright. [Food classification. Public health] World Nutrition January – March 2016

nature food

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Comment | Published: 01 June 2023

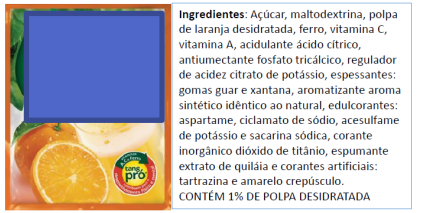
Best practices for applying the Nova food classification system

Euridice Martinez-Steele, Neha Khandpur, Carolina Batis, Maira Bes-Rastrollo, Marialaura Bonaccio, Gustavo Cediel, Inge Huybrechts, Filippa Juul, Renata B. Levy, Maria Laura da Costa Louzada, Priscila P. Machado, Jean-Claude Moubarac, Tonja Nansel, Fernanda Rauber, Bernard Srour, Mathilde Touvier & Carlos A. Monteiro

Nature Food **4**, 445–448 (2023) | Cite this article

Fruit
(Real food)

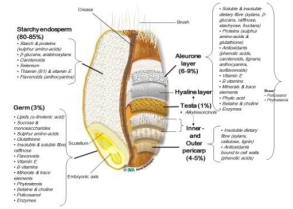
"Fruit"
(The imitation)



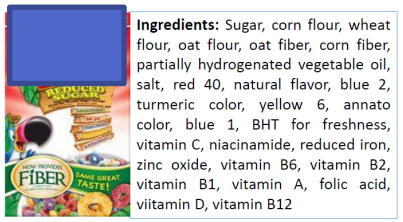
Fruit
(Real food)

"Fruit"
(The imitation)

Cereal
(Real food)



"Cereal"
(The imitation)



The real meal

Recipe: pasta, chicken, olives, tomato, onions, garlic, salt.

The imitation

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.

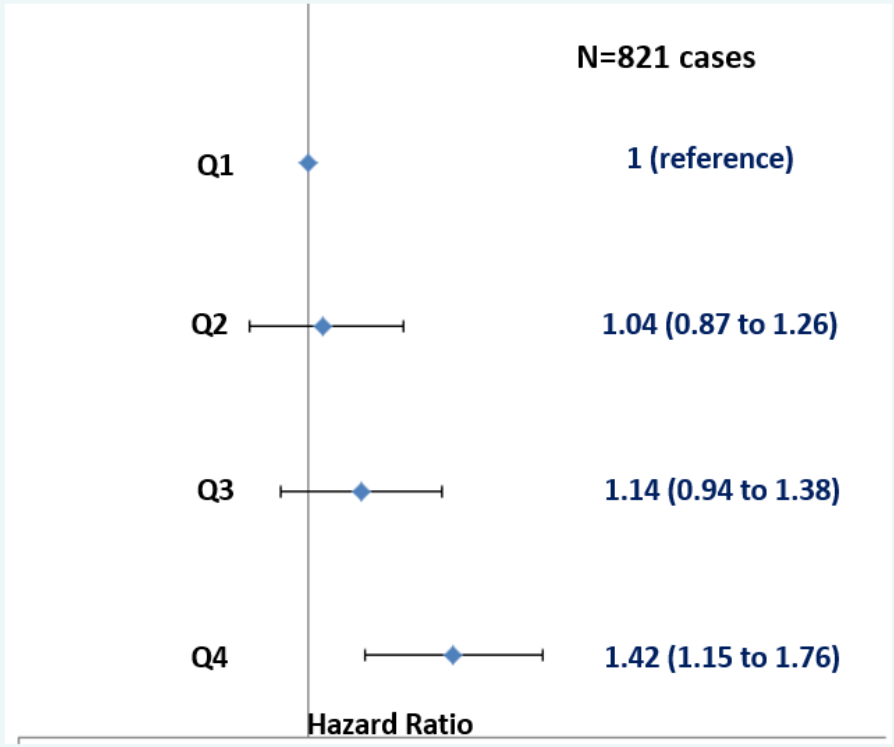
- Convenient, ready-to-eat
- Generally affordable
- Generally highly palatable, with added salt, sugar, flavours, taste and texture-enhancers
- Intensive appealing marketing and advertisement

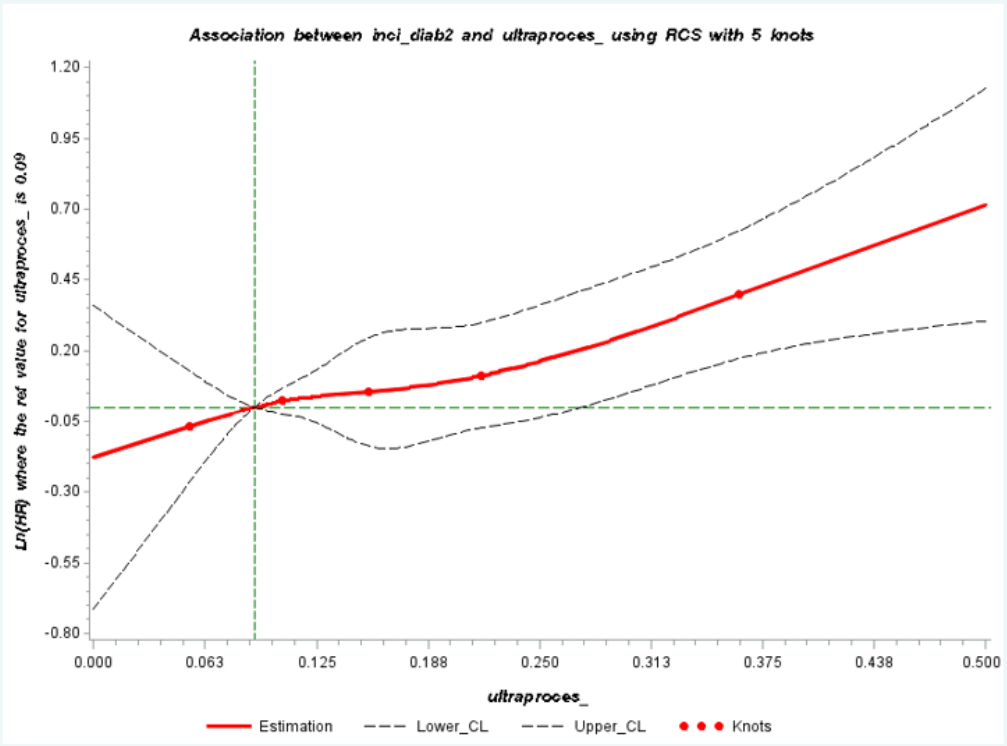
Monteiro et al, Public Health Nutr 2009
Martinez-Steele et al, Nat Food 2023
Monteiro et al, The Lancet 2025

Example of aetiological study linking UPF exposure to type 2 diabetes risk (NutriNet-Santé cohort)

N=104 707

JAMA Internal Medicine





An absolute increment of 10 in the percentage of UPF in the diet was associated with a 20% increase in the risk of T2D (HR=1.20 (1.10 to 1.30), p<0.0001)

Srour et al, JAMA Int Med 2019

Utra-processed food intake associated with increased chronic disease risk in NutriNet-Santé

Prospective studies in NutriNet-Santé

- Cancer *(Fiolet&Srour, BMJ 2018)*
- Cardiovascular diseases *(Srour, BMJ 2019)*
- Mortality *(Schnabel, JAMA Int Med 2019)*
- Gastrointestinal disorders *(Schnabel, AJG 2018)*
- Depressive symptoms *(Adjibade, BMC Med 2019)*
- Type 2 Diabetes *(Srour, JAMA Int Med 2020)*
- Overweight/Obesity *(Srour&Beslay Plos Med, 2020)*

e.g.: "A 10% increase in the proportion of ultra-processed foods in the diet was associated with an increase of ≈10% in risks of overall and breast cancers"

n=104,980 ; 2228 incident cancers

→ **High-impact scientific journals**

+ Since then, >100 other prospective studies worldwide
Monteiro et al, Lancet 2025

→ **Extensively covered by international press**

Altmetric: Top 5% of outputs of the same age

7292

→ **Concrete impact on public health policies**

- ✓ Parliamentary inquiry commission
- ✓ Auditions at the National Assembly and Senate: 2018, 2019, 2020, 2021, 2022, 2023 (nitrites), 2026, House of Lords UK 2024, EU Parliament 2025
- ✓ Contribution to the modification of national and international dietary guidelines *(WHO-FAO 2019, France, Brazil, Mexico, Israel,...)*

THE LANCET

Bloomberg Philanthropies

Royal College of Physicians

Ultra-Processed Foods and Human Health 1

Ultra-processed foods and human health: the main thesis and the evidence

Carlos A Monteiro, Maria LC Louzada, Euridice Steele-Martinez, Geoffrey Cannon, Giovanna C Andrade, Phillip Baker, Maira Bes-Rastrollo, Marialaura Bonaccio, Ashley N Gearhardt, Neha Khandpur, Marit Kolby, Renata B Levy, Priscila P Machado, Jean-Claude Moubarac, Leandro F M Rezende, Juan A Rivera, Gyorgy Scrinis, Bernard Srour, Boyd Swinburn, Mathilde Touvier

Ultra-Processed Foods and Human Health 2

Policies to halt and reverse the rise in ultra-processed food production, marketing, and consumption

Gyorgy Scrinis*, Barry M Popkin*, Camila Corvalan*, Ana Clara Duran, Marion Nestle, Mark Lawrence, Phillip Baker, Carlos A Monteiro, Christopher Millett, Jean-Claude Moubarac, Patricia Jaime, Neha Khandpur

Ultra-Processed Foods and Human Health 3

Towards unified global action on ultra-processed foods: understanding commercial determinants, countering corporate power, and mobilising a public health response

Phillip Baker*, Scott Slater*, Mariel White*, Benjamin Wood, Alejandra Contreras, Camila Corvalán, Arun Gupta, Karen Hofman, Petronell Kruger, Amos Laar, Mark Lawrence, Mikateko Mafuyeka, Melissa Mialon, Carlos A Monteiro, Silver Nanema, Sirinya Phulkerd, Barry M Popkin, Paulo Serodio, Katherine Shats, Christoffer Van Tulleken, Marion Nestle, Simón Barquera

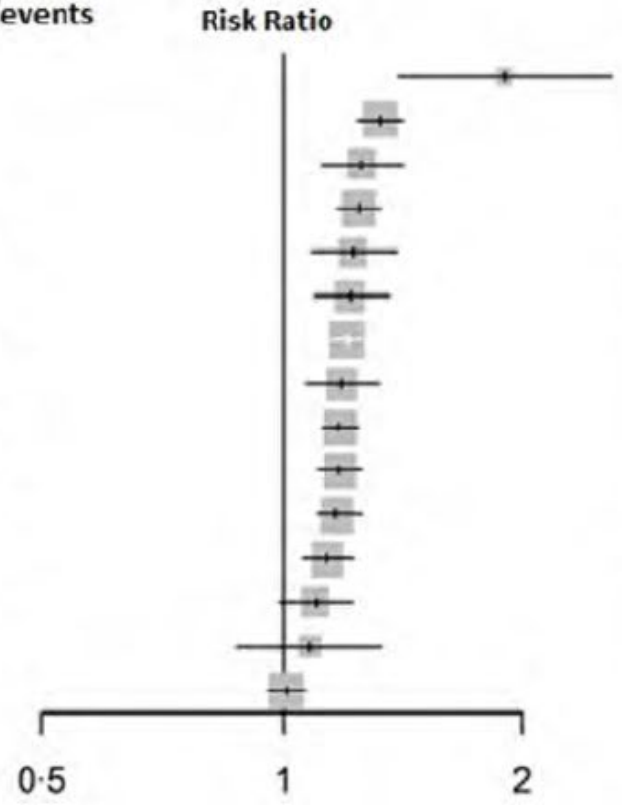
The Lancet, UPF Series, 2025

104 prospective cohort studies

-> 92 found positive associations between UPF and higher incidence of studied health outcomes

Figure 4. Results from meta-analyses of the prospective association between highest versus lowest exposure to the ultra-processed dietary pattern and risk of chronic disease outcomes

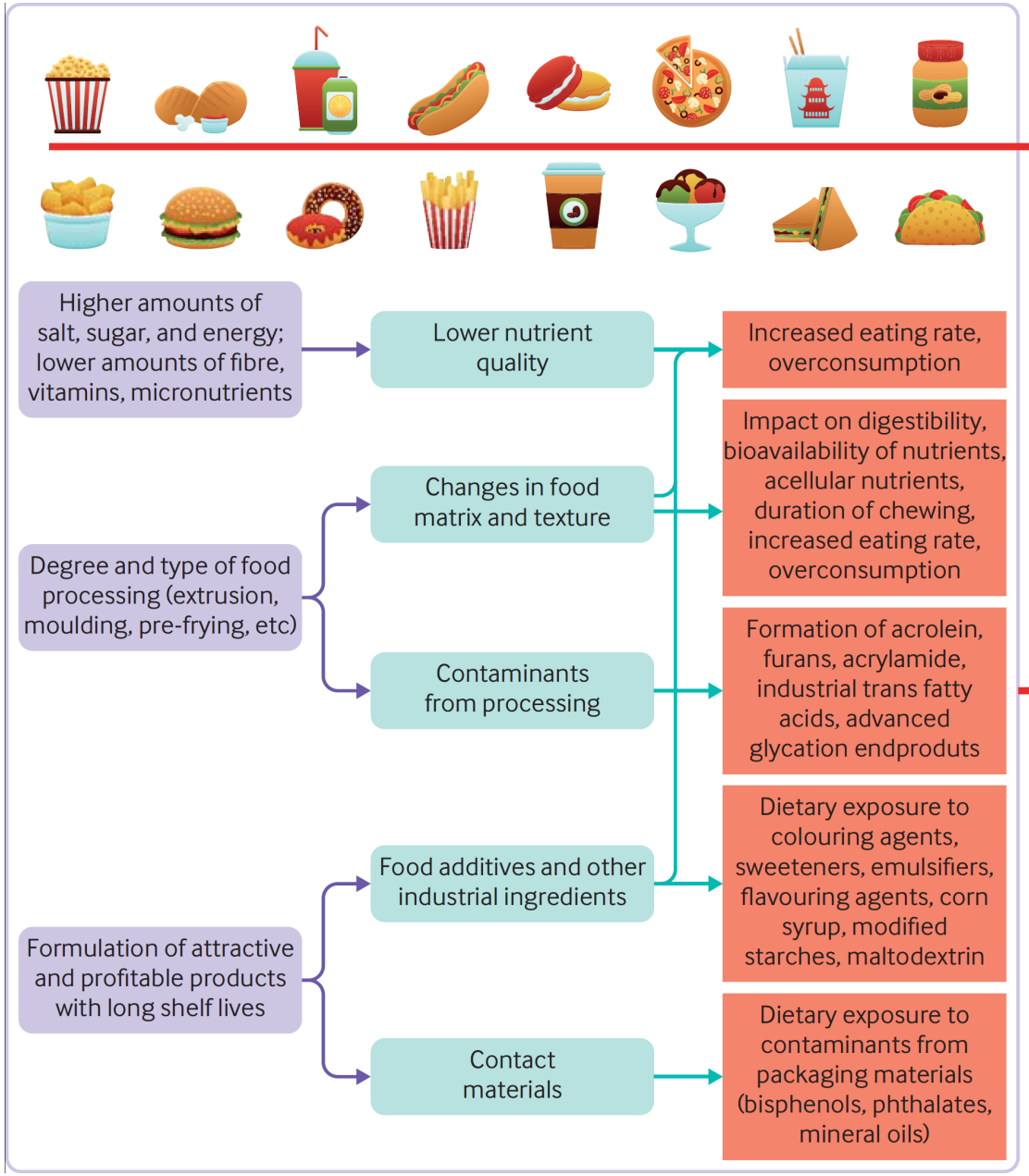
Outcome	Number of studies	Total number of participants	Number of cases/events
Crohn's disease	4	960,638	886
Abdominal obesity	4	47,589	3,492
Dyslipidemia	4	28,814	6,619
Type 2 diabetes	12	445,133	30,939
Depression	6	275,355	13,189
Chronic kidney disease	5	272,097	11,831
Overweight or obesity	8	541,297	47,143
Coronary heart disease or mortality	8	478,968	23,137
All-cause mortality	20	859,769	123,877
Cardiovascular disease or mortality	18	788,606	45,023
Hypertension	6	114,344	15,669
Cerebrovascular disease or mortality	7	467,849	9,932
Colorectal cancer	4	954,765	11,194
Ulcerative colitis	4	960,638	1,850
All-cancer mortality	9	695,822	34,406



RR	95% CI	I^2
1·90	1·40 - 2·59	33%
1·33	1·24 - 1·42	0%
1·26	1·12 - 1·43	56%
1·25	1·18 - 1·34	49%
1·23	1·08 - 1·39	84%
1·22	1·09 - 1·36	62%
1·21	1·15 - 1·26	26%
1·19	1·07 - 1·33	89%
1·18	1·12 - 1·25	79%
1·18	1·09 - 1·27	81%
1·17	1·08 - 1·26	34%
1·14	1·06 - 1·23	16%
1·10	0·99 - 1·23	74%
1·08	0·88 - 1·34	37%
1·01	0·96 - 1·07	48%

The Lancet – UPF Series 2025 – Paper 1

Ultra-processed foods and chronic disease risk: potential mechanisms



thebmj

Touvier et al, BMJ 2023

Consumption Data

Brand names of consumed foods & drinks (including barcode-scanning by the participant)

Composition Data (Food Additives)

Detection presence/absence of the additive

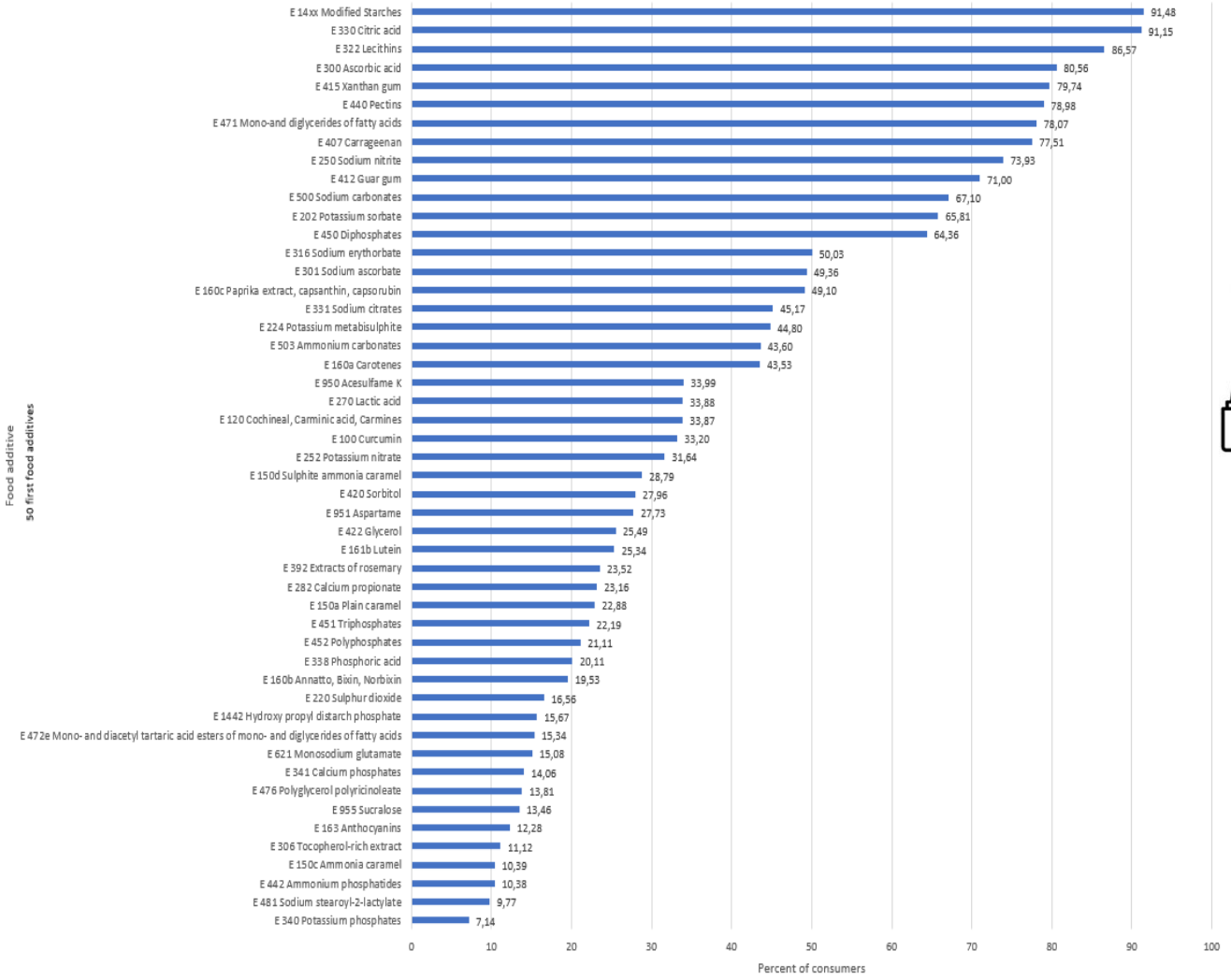
E.g., sriracha hot chilli sauce ingredient list

*Chilli 61%, sugar syrup, salt, garlic, water, acids: **E260, E330**, flavour enhancer: E621, stabiliser: E415, preservative: **E202**.*

If present, determination of the usual dose

Exposure to additive mixtures in the NutriNet-Santé cohort

Figure 1: Most frequently consumed food additives, by percent of consumers, NutriNet-Santé cohort, France, 2009-2020 (N=106,489)



Cluster 1: Consumers of additives found in cookies and sweet cakes
e322 lecithins, e471 mono-and diglycerides of fatty acids, e500 sodium carbonates, e450 diphosphates, e503 ammonium carbonates, e422 glycerol and e420 sorbitol

Cluster 2: Consumers of additives found in broths, meal substitutes, butter, and bread
e14xx modified starches, e621 monosodium glutamate, e304 fatty acid esters of ascorbic acid and e320 butylated hydroxyanisole (BHA)

Cluster 3: Consumers of additives found in dairy desserts, breakfast cereals and pastries
e407 carrageenan, e270 lactic acid, e282 calcium propionate, e452 polyphosphates, e160b annatto and e1442 hydroxy propyl distarch phosphate

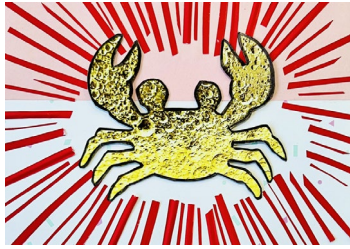
Cluster 4: Consumers of additives found in industrial sauces and processed meat
e250 sodium nitrite, e316 sodium erythorbate, e451 triphosphates, e120 cochineal, e330 citric acid, e415 xanthan gum, e202 potassium sorbate, e412 guar gum and e224 potassium metabisulphite

Cluster 5: Consumers of additives found in sugary and artificially sweetened sodas
e950 acesulfame K, e951 aspartame, e955 sucralose, e960 steviol glycosides, e440 pectins, e160a carotenes, e331 sodium citrates, e301 sodium ascorbate, e160c paprika extract, e150d sulphite ammonia caramel, e100 curcumin, e252 potassium nitrate, e338 phosphoric acid, e161b lutein, e211 sodium benzoate, e472 esters of mono- and diglycerides and e212 potassium benzoate.

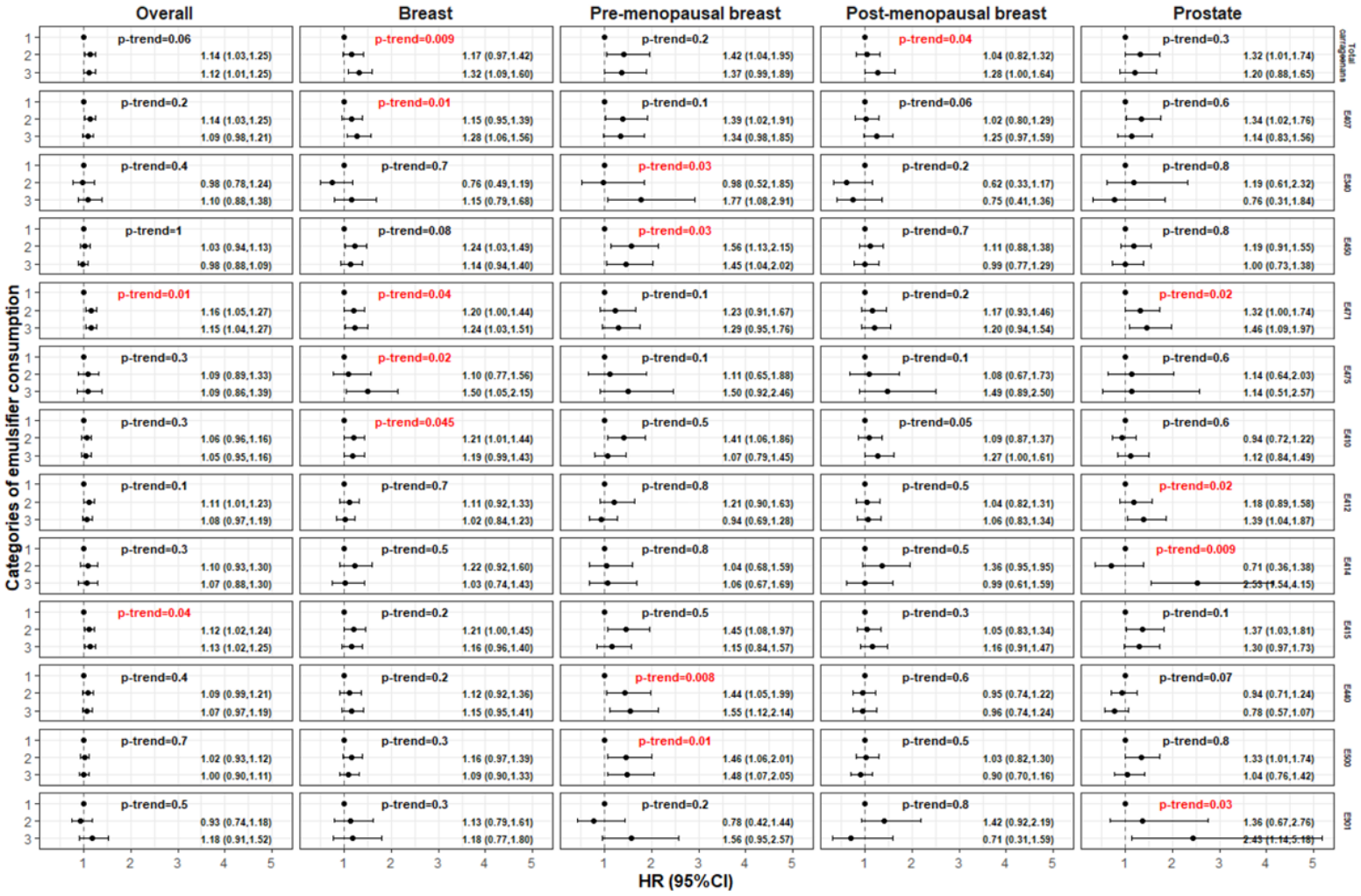
Cluster 6: Consumers of various staple foods with low additive content
Lowest exposure.

Chazelas et al, Scientific Reports, 2021

Food additive emulsifiers and risk of cancer



N=92,000, NutriNet-Santé cohort, 2604 incident cancer cases

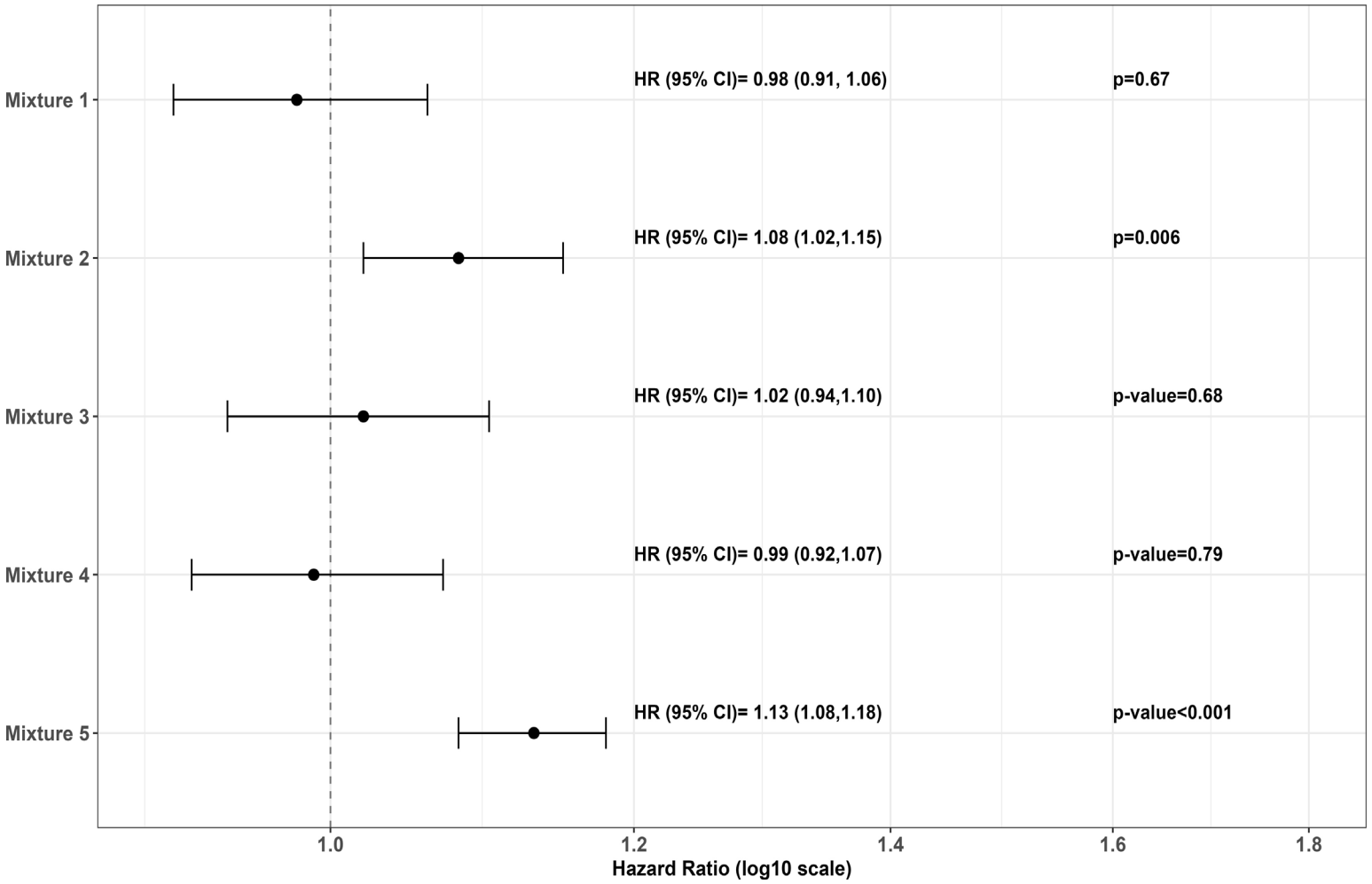


Total carrageenans ; E407 Carrageenan ; E340 Tripotassium phosphate ; E450 Diphosphates ; E471 MAG and DAG ; E475 Polyglycerol esters of FAs ; E410 Carob bean gum ; E412 Guar gum ; E414 Gum arabic ; E415 Xanthan gum ; E440 Pectins ; E500 Sodium bicarbonate ; E901 Beeswax

HR significance (3 vs. 1) ● = HR estimate, — = confidence interval

Sellem & Srour et al, Plos Medicine 2024

Food additive mixtures and type 2 diabetes incidence



- 2 food additive mixtures were associated with higher T2D incidence:
  - modified starches, pectin, guar gum, carrageenan, polyphosphates, potassium sorbates, curcumin, and xanthan gum
  - citric acid, sodium citrates, phosphoric acid, sulphite ammonia caramel, acesulfame-K, aspartame, sucralose, arabic gum, malic acid, carnauba wax, paprika extract, anthocyanins, guar gum, and pectin.
- Several synergistic and antagonist interactions between food additives were detected in exploratory analyses.
- These findings suggest that a combination of food additives may be of interest to consider in safety assessments, and they support public health recommendations to limit nonessential additives.

Payen de la Garanderie et al, PlosMed, 2025

Impact of industrial food on health: the food additives trail

Unique dietary data from the NutriNet-Santé cohort, including brands of industrial products + scan of bar codes

Food additive nitrites / nitrates

- Cancer: *Chazelas, Int J Epidemiol 2022*
- Type 2 diabetes: *Srour, Plos Medicine 2022*
- Hypertension: *Srour, JAHA 2023*

Artificial sweeteners

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

Food additive emulsifiers

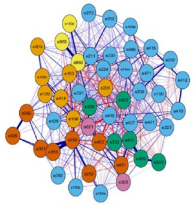
- Cardiovascular disease: *Sellem, BMJ 2023*
- Cancer: *Sellem&Srour, Plos Med 2024*
- Type 2 diabetes: *Salame, Lancet Diabetes 2024*

Food additive preservatives

- Cancer: *Hasenböhler, BMJ, 2026*
- Type 2 diabetes: *Hasenböhler, Nature Communications 2026*
- CVD and hypertension: *Hasenböhler, Eur Heart Journal 2026, In Press*

Food colouring additives

- Cancer: *Shah, Eur J Epidemiol, 2026*
- Type 2 diabetes: *Shah, Diabetes Care 2026, In Press*



Mixtures -> cocktail effects

- Mixture assessemnt: *Chazelas, Scientific Reports, 2021*
- *In Vitro* toxicity: *Recoules, Food and Chemical Toxicology 2024*
- Type 2 diabetes: *Payen de la Garanderie, Plos Med 2025*

erc ADDITIVES Project (PI MTouvier)

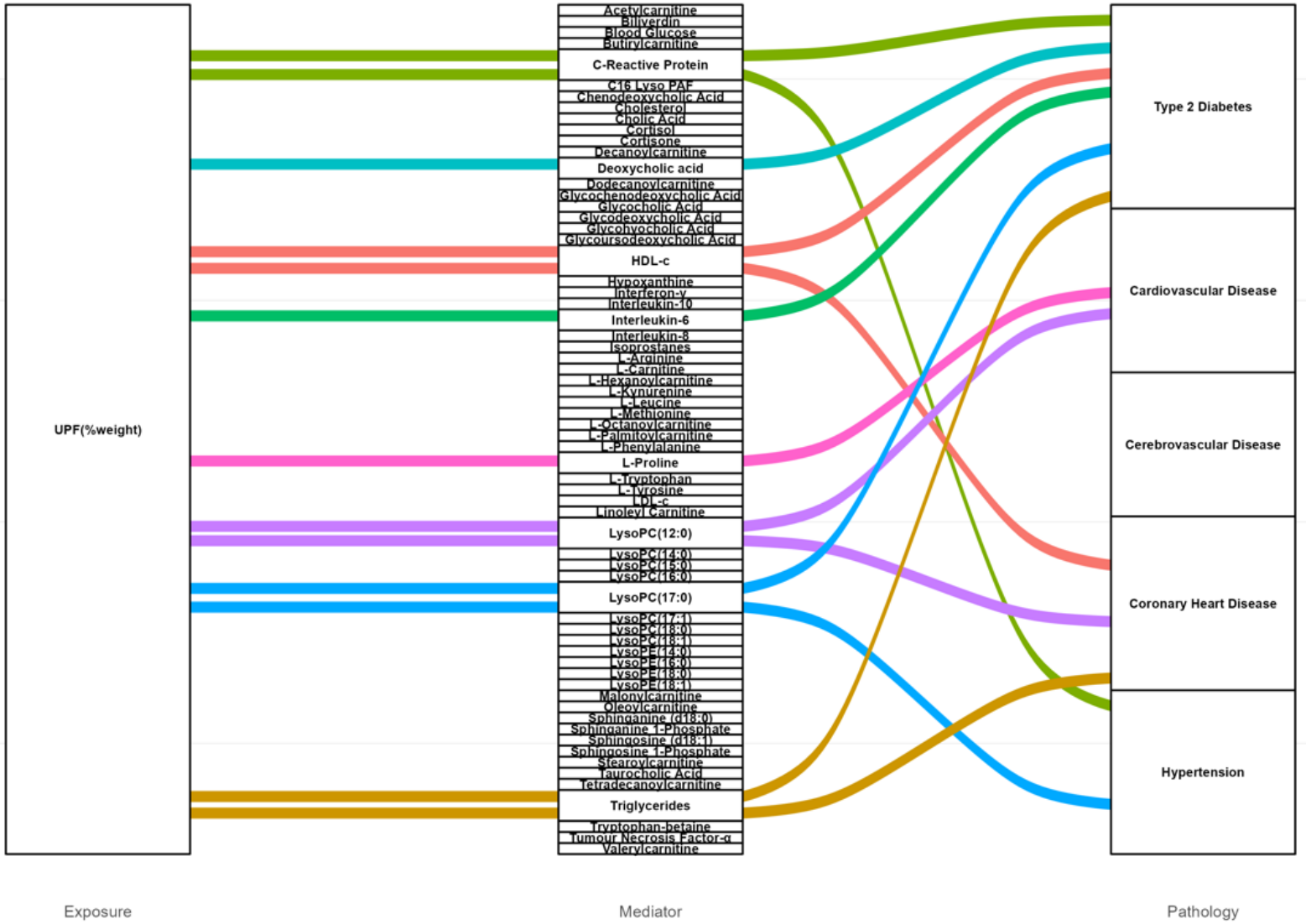
Key contribution to the re-evaluation of food additives

- Aspartame IARC-WHO, 2023
  Riboli, The Lancet Oncology, 2023
- Nitrites, French Food Safety Agency (ANSES), 2022
- ...

Ongoing: dyes, glutamate... + molecular epidemiology & microbiota + in vivo/vitro experiments

Mechanistic epidemiology linking UPF to chronic disease risk through inflammation and metabolic perturbations

- Nested case-cohort within NutriNet-Santé
- n=6150 with markers of inflammation, oxidative stress, metabolomics
- Mediation analyses (R Package CMAVERSE)



Hasenböhler & Payen de la Garanderie et al, in preparation

Open access Original research

BMJ Nutrition, Prevention & Health

Effect of a new graphically modified Nutri-Score on the objective understanding of foods' nutrient profile and ultraprocessing: a randomised controlled trial

N=21 159 participants

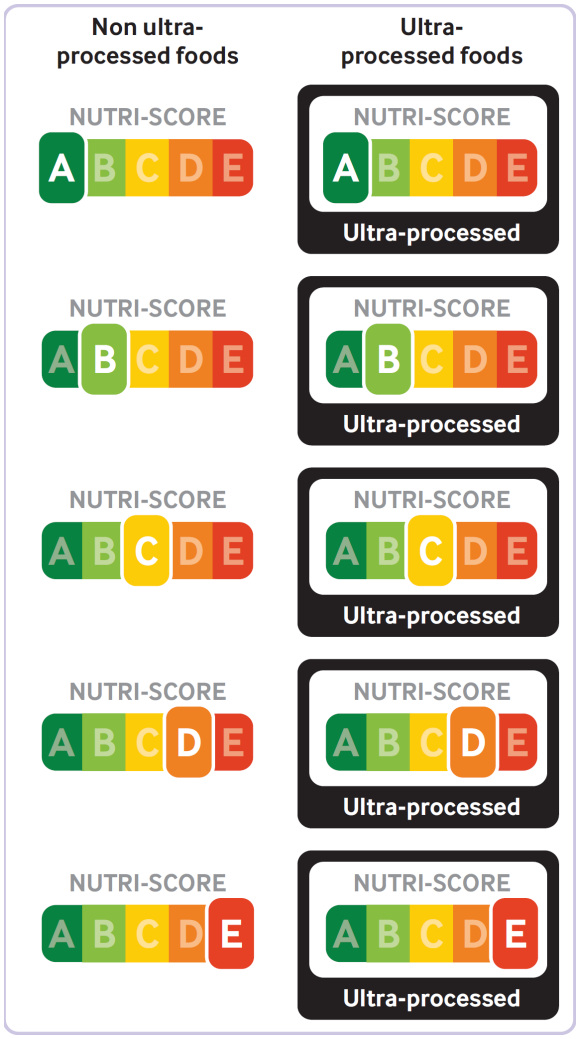
Bernard Srour ,[1] Serge Hercberg,[1,2] Pilar Galan,[1] Carlos Augusto Monteiro,[3] Fabien Szabo de Edelenyi,[1] Laurent Bourhis,[1] Morgane Fialon,[1] Barthélémy Sarda,[1] Nathalie Druesne-Pecollo,[1] Younes Esseddik,[1] Mélanie Deschasaux-Tanguy,[1] Chantal Julia,[1,2] Mathilde Touvier[1]

What this study adds

- We studied, in a randomised controlled trial design, the impact of the Nutri-Score V.2.0, combing information on nutrient profile and ultraprocessing, on the objective understanding of foods' nutrient profile and on the identification of ultraprocessed foods. The Nutri-Score V.2.0 improved objective understanding of both the nutrient profile dimension of food products ($OR_{\text{highest vs lowest score category}}$=29.0 (23.4–35.9)) and the ultraprocessing dimension (OR=174.3 (151.4–200.5)). The Nutri-Score V.2.0 also had a positive effect on purchasing intentions and on the products perceived as the healthiest.

How this study might affect research, practice or policy

- Adding information regarding the food processing dimension to interpretive front-of-pack nutritional labels might be of public health interest for consumers, as our results show that a combined label enabled them to independently understand these two correlated, yet distinct and complementary dimensions.



Srour BMJ Nutr Prev Health 2023

+ Ongoing analyses to integrate UPF penalty directly within the Nutri-Score algorithm and validation studies showing improvement of predictivity for obesity, CVD, T2D and hypertension

Food contact chemicals transfer from food contact materials into foods: do they contribute to the adverse health impacts of ultra-processed and packaged foods?

Yates et al. Globalization and Health (2024) 20:74
https://doi.org/10.1186/s12992-024-01078-0

GLOBALIZATION and HEALTH

COMMENT Open Access

A toxic relationship: ultra-processed foods & plastics

Joe Yates[1*], Suneetha Kadiyala[1], Megan Deeney[1], Angela Carriedo[2], Stuart Gillespie[3], Jerrold J. Heindel[4], Maricel V. Maffini[5], Olwenn Martin[6], Carlos A. Monteiro[7], Martin Scheringer[8], Mathilde Touvier[9] and Jane Muncke[10]

nature medicine

Review article

https://doi.org/10.1038/s41591-025-03697-5

Health impacts of exposure to synthetic chemicals in food

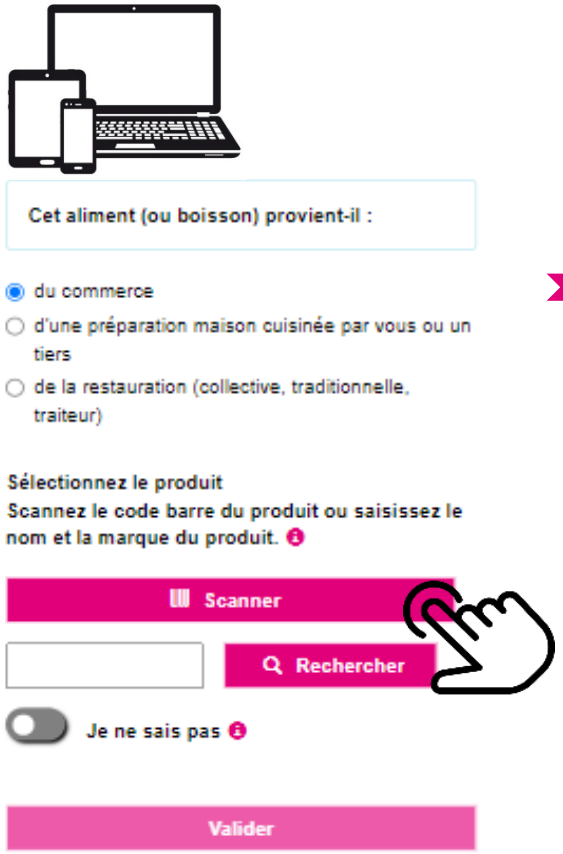
Received: 7 February 2025
Accepted: 4 April 2025

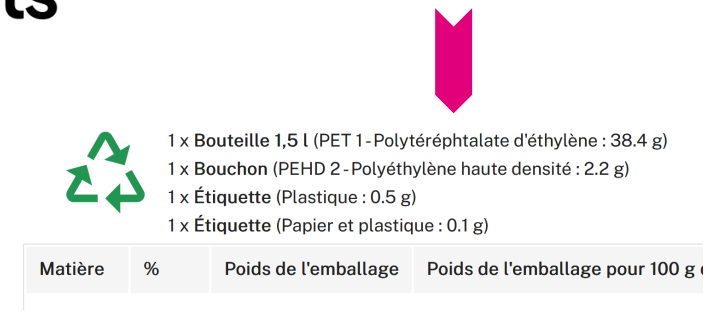
Jane Muncke[1], Mathilde Touvier[2], Leonardo Trasande[3,4] & Martin Scheringer[5]

→ **Food contact chemicals** (FCCs) are among the **key potential explanations for deleterious health impacts of "ultra-processed" foods**, which are generally **pre-packaged** and kept for weeks/months/years in their packaging (+warmed-up in it), fostering **migration of FCCs into food**

NutriNet-Santé : unique information on food packaging in an etiological cohort

24h dietary records including barcode scanning for industrial products





+ Food contact materials questionnaire

https://etude-nutrinet-sante.fr/upload/siteinfo/protectednew/Quest_Materiaux_Contact.pdf

Such detailed data are lacking worldwide in current epidemiological studies

Other studies: *'Diet soda'* << NutriNet: *'Diet Coca-cola, PET bottle'*

Launch of a new project: health impact of contaminants from food packaging

https://presse.inserm.fr/impact-sante-linserm-lance-quatre-projets-de-rupture-pour-la-recherche-en-sante/69477/

Impact Santé France 2030 / Inserm / ANR

Le projet FoodContact

Ambition générale
Mieux comprendre les effets sur la santé des matériaux en contact avec les aliments et des plus de 12 000 composés chimiques qui les constituent

Budget
3 M€

Consortium
Mathilde Touvier, chercheuse principale (Équipe de recherche en épidémiologie nutritionnelle, Centre de recherche en épidémiologie et statistiques – UMR U1153 Inserm, U1125 INRAE, CNAM, Université Paris Cité, Université Sorbonne Paris Nord)
Olivier Vitrac (INRAE, Laboratoire national de métrologie et d'essais, AgroParisTech) ; Jean-Baptiste Fini (Unité Physiologue moléculaire et adaptation (UMR 7221) – CNRS, Muséum d'histoire naturelle) ; Fabrice Pierre (Unité Toxicologie alimentaire (UMR 1331) – INRAE, École nationale vétérinaire de Toulouse, École d'ingénieurs de Purpan, Université Toulouse III-Paul Sabatier) ; Xavier Coumoul (Unité Toxicité environnementale, cibles thérapeutiques, signalisation cellulaire et biomarqueurs (UMR-S 1124 T3S) – Inserm, Université Paris Cité) ; Pierre Slamich (association Open Food Facts – organisation à but non lucratif)

Idée
Explorer l'impact et les modes d'action des matériaux en contact avec les aliments sur la santé humaine et modifier l'évaluation de la sécurité pour une meilleure protection des consommateurs

Rupture
Produire un ensemble complet de connaissances scientifiques, encore inédites, sur l'impact des matériaux en contact avec les aliments sur la santé

Impact
Œuvrer à une transformation radicale de l'évaluation des substances chimiques et des matériaux en contact avec les aliments pour limiter leurs effets sur la santé humaine et ouvrir la porte à la création, sur le modèle du Nuti-Score, d'un nouveau logo, le «Toxi-Pack score », visant à renseigner sur l'impact santé des emballages alimentaires

From Food Data Silos to the Food Exposome – Interoperability of databases ->INTERFOOD project

Major advances will come from linking **epidemiological food consumption databases** *(e.g. NutriNet, EPIC, INCA, Esteban)* with **food characterization databases** *(e.g. Ciqual, Oqali, Open Food Facts, EFSA, Agribalyse, GNPD)*:

- Nutrients & bioactive compounds
- Food additives & industrial ingredients
- Pesticides & contaminants
- Packaging/process-related chemicals
- Prices & environmental impact
- Market/product databases

Arugula
Green salad
Salad

Key challenge: databases use highly heterogeneous food nomenclatures
→ manual matching is slow, costly, non-reproducible

Strategic need: validated, shared tools to automate interoperability between databases

Objectives of our INTERFOOD project (PEPR SAMS): develop and validate interoperable tools to:

- Automate matching via FoodEx2 nomenclature (of the European Food Sagety Authority)
- Automate direct label-based matching between different nomenclatures
- Apply these tools to food exposome research in NutriNet-Santé
- Disseminate open tools & methodological guidelines to the scientific community

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Application of the Matching Core tool to study contaminants from food processing and contact materials

Total diet study 2

anses

2006 – 2009

212 food items selected for contaminant quantification, supposed to be representative of 90% of French food consumption

Quantification of different food contaminants of diverse origins (environmental contamination, packaging, food processing…)

Outil de matching textuel de l'INRAe a facilité le match

Bon fonctionnement sur des bases alimentaires avec des dénominations simples

→ EAT2 : items très génériques, très adaptés à l'outil

30% d'items EAT2 matchés directement avec des aliments NutriNet

59% avec des aliments proches, facilement validés

ÉTUDE NUTRINET SANTÉ

Match with NutriNet-Santé generic food items :

> 3,500

Selection of relevant contaminants (i.e. those possibly coming from food processing and/or food contact materials)

Estimation of dietary exposures to the selected contaminants amongst the cohort's participants based on the 24-h dietary records

ANR-23-PESA-0004
ANR-24-RRII-0005

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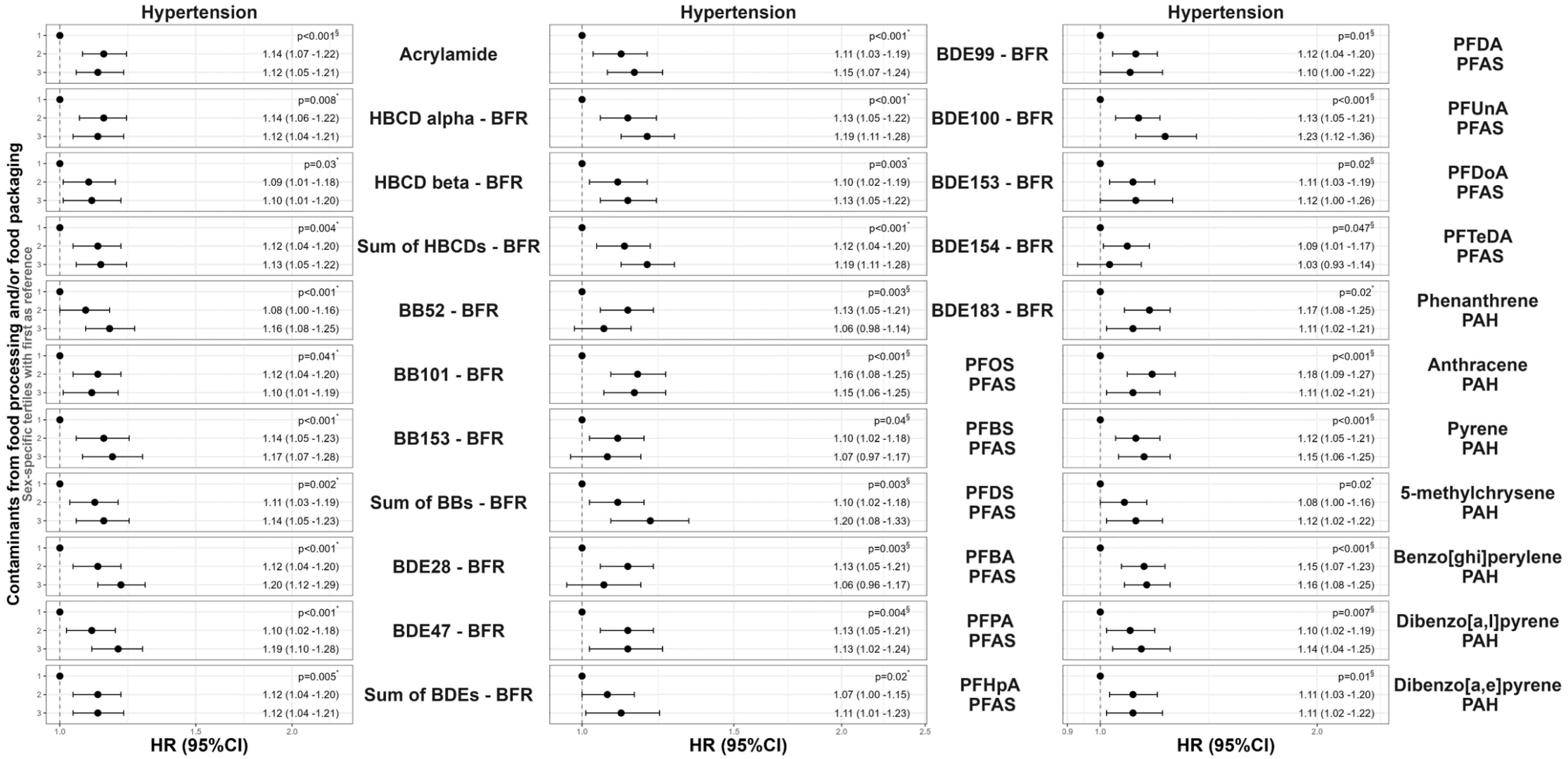
Contaminants from food processing or contact materials and risk of hypertension



ÉTUDE NUTRINET SANTÉ

anses
Total Diet Study 2

Le Folcalvez et al, under review

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Conclusion: new developments and perspectives

New AI-based digital tool in development to boost 24h dietary records

Connected sensors for physical activity assessment

World network of NutriNet studies (Coord. M Touvier)

Thank you for your attention

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https://etude-nutrinet-sante.fr/

https://cress-umr1153.fr/fr/teams/eren/