Ultra-processed foods:
A global threat to public health

GLOBAL FOOD RESEARCH PROGRAM
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A revolution in food science and modern grocery retailing over the last 60 years has led to explosive growth in manufacturing and consumption of ultra-processed foods (UPFs).[1,2] This shift began in high-income countries but has now reached countries at all income levels.[2-5] UPFs are a substantial factor affecting worldwide increases in the prevalence and incidence of obesity and other diet-related, non-communicable diseases.[6-9] UPFs' poor nutritional profiles, hyper-palatability (and, arguably, addictive nature[10-12]), and content of biologically harmful compounds all wreak havoc on health. Policy interventions are needed to curb rising UPF consumption and in turn, combat associated negative health outcomes and premature mortality.

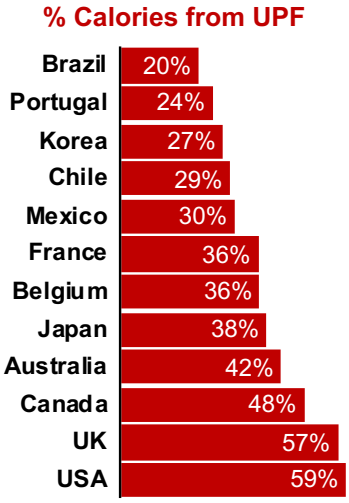
What are ultra-processed foods?

Food processing generally refers to any action that alters food from its natural state, such as drying, freezing, milling, canning, or adding salt, sugar, fat, or other additives for flavor or preservation.[13,14] Most foods and beverages are processed in some way before purchase or consumption; the term "*processed foods*" encompasses everything from frozen vegetables to canned beans to candies, chips, and sodas. Researchers developed the NOVA classification system[15,16] to categorize foods and beverages into one of four groups according to extent and purpose of processing:

GROUP 1	GROUP 2	GROUP 3	GROUP 4
Unprocessed/ minimally processed	**Processed culinary ingredients**	**Processed foods**	**Ultra-processed foods**
Foods unaltered or altered by processes such as removing inedible parts, drying, grinding, cooking, pasteurization, freezing, or non-alcoholic fermentation. No substances are added. Processing aims to increase food stability and enable easier or more diverse preparation. *Examples: Fresh or frozen fruits/vegetables, pulses, packaged grains, flours, nuts, plain pasta, pasteurized milk, chilled/frozen meat*	Substances obtained directly from Group 1 foods or from nature, created by industrial processes such as pressing, centrifuging, refining, extracting or mining. Processing aims to create products to be used in preparation, seasoning and cooking of Group 1 foods. *Examples: Butter, vegetable oils, other fats, sugar, molasses, honey, salt*	Products made by adding edible substances from Group 2 to Group 1 foods using preservation methods such as non-alcoholic fermentation, canning, or bottling. Processing aims to increase stability and durability of Group 1 foods and to make them more enjoyable. *Examples: Canned vegetables in brine, freshly made breads or cheeses, cured meats*	Formulations of low-cost substances derived from Group 1 foods with little to no whole foods; always contain edible substances not used in home kitchens (e.g., protein isolates) and/or cosmetic additives (e.g., flavors, colors, emulsifiers). Processing involves multiple steps and industries and aims to create products liable to replace all other NOVA groups. *Examples: Packaged snacks, cookies/biscuits, instant soups/ noodles, ready-to-eat/heat meals, candy, soft drinks*

UPFs are not simply foods that have been modified by processing, but rather edible products formulated from food-derived substances, along with additives that heighten their appeal and durability. UPFs are designed and manufactured for maximum profit: they contain low-cost ingredients, have long shelf-lives, are hyper-palatable, and are highly branded and marketed to consumers. They are typically calorie-dense and high in free sugars, refined starches, unhealthy fats, and sodium.[17] Scholars are increasingly recognizing and calling attention to the addictive qualities of UPFs.[10-12,18-20]

Changes in UPF consumption



UPFs have rapidly displaced unprocessed or minimally processed foods, freshly prepared meals, and traditional cooking in the diet in most countries, causing significant nutritional, social, economic, and environmental disruption and damage worldwide.[4,21-23] UPFs — which did not exist before the mid-20th century beyond a few products such as margarine or carbonated soft drinks— now account for roughly half or more of total calories consumed in the United States,[24] United Kingdom,[25] and Canada,[21] and about 20-40% of calories in other high- and middle-income countries,[26-34] with sales growing rapidly every year.[4] This worldwide shift towards greater consumption of UPFs coincided with global increases in obesity prevalence and other nutrition-related chronic diseases, and indeed, researchers have found connections between these trends.[70,3,17] Proposed reasons for UPFs' detrimental health effects include:

- **UPF consumption worsens nutritional intake:** UPFs are energy-dense and disproportionately contribute added sugars, sodium, unhealthy saturated and *trans*-fats, and highly refined carbohydrates to the diet while displacing consumption of less-processed and freshly prepared foods and their many beneficial nutrients.[29,31,35-38]
- **UPFs inherently encourage overconsumption** due to their:
  - Convenience (i.e., products are typically ready-to-eat or ready-to-heat);[39-42]
  - Hyper-palatability (formulations engineered to maximally please all the senses);[16,43-46]
  - Disrupted satiety signaling (e.g., UPFs are often not filling and are consumed absentmindedly during distracting activities like watching television);[45,47-54] and
  - Marketing that is highly pervasive and persuasive (often targeting children), as well as effective branding — both of which are largely absent for unprocessed or minimally processed foods.[55-62]
- **UPFs often contain harmful chemical substances**, including:
  - Contaminants formed during high-temperature cooking,[63-67]
  - Industrial additives linked to inflammation and gut dysbiosis (imbalances in the diversity and composition of gut microbiota),[68-70] and
  - Hormone-disrupting chemical compounds leached from plastic food manufacturing and packaging materials.[71-76]

Health outcomes related to UPF consumption

A large and growing body of research has found strong associations between high UPF intake and many elevated health risks, including increased overweight and obesity,[77-84] type 2 diabetes,[85,86] depression,[87,88] cardiovascular and cerebrovascular disease and mortality,[89-92] and all-cause mortality.[85,91-95] Many systematic and narrative reviews have now assessed the body of evidence for UPFs' role in these and other health outcomes, and they are consistent in their interpretation of the literature: High consumption of UPF is significantly associated with one or more adverse health outcomes in nearly every study to date.[6-8,96-99] (Note that in research, "high intake" of UPFs is often defined based on the top fraction of intake among study participants and thus varies from study to study. The heightened health risks detailed below were found in studies with "high intakes" as low as 20–30% of calories from UPFs and as high as >70% of calories from UPFs.)

Overconsumption and weight gain:

- A randomized controlled crossover trial wherein participants ate as much as they wanted on an ultra-processed or a minimally processed diet for two weeks each found that during the

ultra-processed weeks, participants consumed roughly 500 more calories per day and gained 0.9 kg of mostly fat mass.[9] This study is the first to provide evidence that a UPF-based diet directly causes **greater calorie intake** and subsequent **weight gain**.

- High UPF intake was significantly associated with 23–51% greater odds of **obesity** and 39–49% greater odds of riskier **abdominal obesity** across three meta-analyses of observational studies comparing groups with highest vs. lowest UPF consumption.[6-8]
- Added intake of UPF foods increases weight gain and the risk of **overweight/obesity**.[80-82] For example:
  - In a study that followed over 110,000 French adults for 10 years, a 10% increase in UPF intake was associated with 11% greater risk of developing **overweight** and 9% greater risk of developing **obesity**.[81]
  - A 10% increase in UPF consumption was associated with significant increases in **waist circumference** (+0.87 cm), **BMI** (+0.38 kg/m^2), and odds of having **obesity** (+18%) in a study that followed over 6,000 UK adults from 2008–2016.[82]

Vascular diseases:

- In studies comparing participants with highest vs. lowest UPF consumption, highest intake was significantly associated with a pooled:
  - 29% greater relative risk of **cardiovascular disease** and/or mortality, and
  - 34% greater relative risk of **cerebrovascular disease** and/or mortality.[6]
- High UPF intake was associated with a 21-23% greater risk of developing **hypertension** compared to low intake in two prospective studies of nearly 15,000 adults in Spain[100] and over 8,000 adults in Brazil.[101]
- Among children and adolescents, studies have found significant associations between high UPF intake and increases in **total and LDL cholesterol**[102] from preschool to school age as well as increased **cardiovascular disease** risk into early adulthood.[90]

Other diseases and risks:

- Studies examining UPF and **depression** found that participants in the highest quartile of UPF consumption had a 33% greater risk of developing depression relative to consumers in the lowest quartile,[88] and that for every 10% increase in UPF consumption, participants faced 21% greater relative risk of depressive symptoms.[87]
- A 10% increase in the proportion of UPF in the diet was associated with 11% increase in risk of **breast cancer** and 12% increase in risk of **overall cancer** in a large prospective study.[103]
- In a study that followed roughly 1,300 Spanish older adults over 6 years, those in the highest third of UPF consumption had 74% greater odds of experiencing **declining kidney function** than those in the bottom third, independent of other chronic diseases or demographic, dietary, and lifestyle factors.[104]
- High UPF intake was associated with a tripled risk of **frailty** in older adults in a study comparing the highest and lowest quartiles intake among nearly 2,000 older adults in Spain over 3.5 years.[105] Participants who developed frailty experienced at least three of the following: exhaustion, muscle weakness, low physical activity, slow walking speed, or unintentional weight loss.

Premature death:

- Pooled risk of **all-cause mortality** was 25–28% greater for highest consumers of UPF relative to lowest consumers across five prospective studies[85,93-95] in two meta-analyses.[6,7]
- Risk of death was 50% higher from **cardiovascular disease** and 68% higher from **heart disease** for people in the highest vs. lowest quartiles of UPF intake in a large prospective cohort of over 90,000 participants.[91] These mortality risks were higher for women than men.

Policy options to reduce purchase and consumption of UPFs

Many countries and smaller jurisdictions around the world have already begun enacting policies to improve populations' dietary quality and health by reducing demand for and disincentivizing purchase of unhealthy foods and beverages. While most of these policies have not, to date, specifically targeted foods based on degree of processing, the nutrient profiling models and criteria used in many regulations inherently capture and target UPFs given their generally poor nutritional profiles. Regulatory approaches include:

- **Fiscal policies:** Over 50 countries and smaller jurisdictions have instituted taxes on sugary drinks, energy drinks, or junk foods.[106,107] A large body of evidence indicates that these taxes work to reduce purchases and intake of unhealthy products and to increase purchases and intake of healthier alternatives.[108-114] Evidence strongly supports taxation of sugary drinks at 20% or higher to have a truly meaningful impact.[115-119]

  Learn more about sugary drink taxes →

- **Front-of-package (FOP) warning labels:** Simple, mandatory warning labels such as those adopted in Chile (*right, introduced 2016*), Peru (*2019*), Israel (*2020*), Mexico (*2020*), Uruguay (*2021*), and Brazil (*2022*), help consumers to quickly and easily identify unhealthy foods and drinks and to make healthier choices from the vast array of products available to them. Studies show that FOP warning labels can reduce purchases of unhealthy products and concerning nutrients and ingredients/additives, and that consumers better understand warning labels compared to other common FOP systems such as "traffic lights" or "Facts up Front"/Guideline Daily Amounts labels.[120-133] Real-world evalutions from Chile confirm that these policies can be very impactful.[134-137]

  Learn more about FOP labelling →

- **Marketing restrictions:** Pervasive marketing for junk foods and sugary drinks targeted at children and adolescents — is widely recognized as a key contributor to the obesity and non-communicable disease crises[138-140] and a driving factor behind the rapid growth of UPF consumption in markets worldwide. Reducing exposure to unhealthy food marketing during years of developmental vulnerability is a key prevention measure recommended by health leaders worldwide.[140-150] Jurisdictions have begun in earnest to implement and strengthen regulations that address both the ubiquity and persuasive power of UPF marketing.[143]

  In 2016, Chile prohibited use of creative techniques to appeal to children in any marketing for junk foods or sugary drinks, banned their sale or promotions in schools, and restricted TV advertising for these products to programming not aimed at children.[151,152] When it was apparent that children were still viewing junk food advertising during unrestricted TV programming (e.g., family primetime TV or on sports channels),[153] Chile took the unprecedented step to further ban any junk food advertising on TV from 6am to 10pm.[154] Results from early evaluations suggest that this law will significantly impact the marketing landscape and ultimately UPF intake in Chile.[137,155-157]

  Learn more about marketing restrictions →

- **School food environment protections:** Schools should provide a healthy, safe place for students to learn and grow, and they are an important food source for children via school meal programs. Implementing strong school food environment policies that restrict sales of UPFs, ban junk food marketing, and strengthen nutritional standards for school meal programs can lead to healthier food choices for kids at school and beyond school grounds.[143,158-164]

  Learn more about the school food environment →

- **A comprehensive approach:** Evidence supports approaches that include multiple, mutually-reinforcing policies.[165] Chile offers a prime example of this, having enacted the most comprehensive set of policies to date aimed at improving population diet and reducing chronic diseases.[166-168] Together, these policy interventions have the ability to shift social and cultural norms around UPFs, reducing demand for and consumption of these products and ultimately improving the dietary intake of individuals and entire populations.
  - **Policy gap:** In addition to reducing UPF consumption, increased consumption of healthy foods is needed. Israel offers an example of a dual approach in its FOP label policy (*right*), which uses both mandatory red warning labels on products that do not meet nutritional criteria and a green label on foods in their natural form or those that underwent minimal processing with no food additives.[169] Other options focused on increasing consumption of healthy foods (e.g., whole grains, fruits, vegetables, legumes) include: targeted subsidies, incentives for stores to locate in underserved areas and make healthier foods more available within stores, and setting nutrition standards for public procurement.[170]

  - **Nutrient profiling:** Well-designed nutrient profiling models (NPMs) are key to determining which foods and beverages should be subject to regulation. The chosen model can be applied across many policies, including taxes, FOP labels, marketing restrictions, and limits within school environments.[171-176] To date, most NPMs use criteria based primarily on products' nutrient or ingredient content (e.g., how much sugar a beverage contains).[3,177] The Pan American Health Organization (PAHO) NPM is the first to explicitly focus on capturing UPFs: In addition to setting thresholds for critical nutrients (free sugars, sodium, saturated fat, etc.), the PAHO NPM identifies products that contains any amount of other sweeteners (e.g., artificial or natural non-caloric sweeteners) as UPFs subject to regulation.[178] This is relevant for limiting potential unintended consequences of policies. For example, a policy that requires warning labels on high-sugar drinks but does not consider that non-calorically sweetened drinks (e.g., diet soda) are also ultra-processed could have limited impact on reducing UPF intake, even while reducing sugar consumption.

These and other policy options aimed at reducing UPF consumption and promoting healthier eating around the world are examined in depth in a 2021 paper in *Lancet Diabetes and Endocrinology* and in several other works from scholars and international organizations.[179-181]

Countering industry claims

1. **Industry claim:** Policies that aim to reduce UPF consumption will hurt employment.
   Reality: These policies do not affect employment and positively impact health and the economy.
   - Improvements in health from policies that reduce UPF consumption actually benefit the economy rather than harming it. Examples from jurisdictions that have examined employment or economic changes related to nutrition-related policies include:
     - Eighteen months after Chile implemented a comprehensive policy that included front-of-package warning labels, marketing restrictions, and banned sales and promotions in schools for junk foods and sugary drinks, researchers found no reductions to employment or average wages in the food and beverage sector compared to other sectors not impacted by the law.[182]
     - In Mexico, total employment did not decrease following introduction of sugary drink and junk food taxes in 2014.[183] The country experienced significant reductions in purchases of taxed foods[184,185] and drinks — particularly among lower-income and high-volume consumers, two groups facing the greatest health risk[186-188] — and increases in bottled water purchases.[186]
     - A 10% reduction in sugary drink consumption among Mexican adults from 2013 to 2022 was predicted to result in an estimated 189,300 fewer cases of type 2 diabetes, 20,400 fewer strokes and heart attacks, and 18,900 fewer deaths, which could lead to $983 million international dollars saved.[189]

- A sugary drink tax in Philadelphia, Pennsylvania, USA, lowered taxed beverage purchases by 38% with no negative impact on employment.[190,191]

2. **Industry claim:** UPFs can simply be reformulated to be healthier.
   Reality: Swapping out ingredients (e.g., non-nutritive sweeteners for sugar) or adding "healthy" ingredients to improve or mask a poor nutrient profile (e.g., adding fiber to ultra-processed snacks or protein isolates to ice creams) does not address all the ways in which UPFs are harmful.

   - The NOVA definition of UPF states clearly that UPFs are products resulting from a series of sequential industrial processes applied to foods — i.e., formulation, or the assemblage of ingredients. The ingredients, themselves, are just one facet of what makes a product ultra-processed. The assemblage of ingredients in UPFs very often uses intense food processing methods, such as extrusion or deep-frying — methods that remain problematic regardless of the product's ingredient formulation.
   - Most ingredients used in the formulation of UPFs result from intense food processing such the hydrogenation of oils, the making of protein isolates from whole foods, the conversion of corn starch into high-fructose corn syrup, etc.
   - UPFs are detrimental to health for many reasons, poor nutritional profile only being one. Tweaking product formulations to achieve a more appealing nutrition facts panel does nothing to address the problems of UPFs' hyper-palatability and addictive nature, content of harmful contaminants, or displacement of healthier, minimally processed foods in the diet.[192]
   - Industry has been reformulating UPFs since their inception. Current scientific evidence connecting UPFs to disease and mortality is based on consumption of UPFs that were already undergoing continuous reformulation. While reformulation could mitigate the harmfulness of some UPFs (e.g., replacing sodium chloride salt with potassium chloride), it is not a new solution that will make UPFs less detrimental, on the whole.

3. **Industry claim:** We are just giving consumers what they want.
   Reality: Industry aggressively cultivates consumer demand for UPFs.

   - The UPF industry has, for decades, generated consumer demand and brand loyalty through highly integrated advertising campaigns, promotions, product placement, and formulations engineered to get customers hooked on their products from an early age.[18]
     - As an example, industry capitalized on the COVID-19 pandemic as an opportunity to further engage in well-orchestrated marketing efforts, including positioning UPFs as "essential products" and donating UPFs to vulnerable populations already disproportionately suffering from the added risks associated with obesity and other chronic diseases — all while actively lobbying against healthy food policies.[193-197]
   - Transnational food and beverage corporations leverage their massive market power to alter entire food systems to their benefit: They control the price, availability, nutritional quality, and desirability of their products, and the outcome seen throughout the world is rapid growth in UPF consumption.[3,198]

Time to act

UPFs are the fastest-growing segment of the global food supply and a major driver of increasing diet-related, noncommunicable diseases worldwide. Transnational corporations continue to shape food systems on all levels, expanding the UPF industry at the expense of traditional foodways. Marketing for UPFs has pervaded low- and middle-income countries and led to global increases in UPF consumption and subsequent weight gain and diet-related diseases. As evidence mounts behind health policies including taxes, front-of-package labeling, marketing restrictions, and protections for a nutritious school environment, governments must take action in order to shift consumption away from UPFs and back towards healthier, unprocessed/minimally processed diets.

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