

## Commentary

# The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing

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### Abstract

Given evident multiple threats to food systems and supplies, food security, human health and welfare, the living and physical world and the biosphere, the years 2016–2025 are now designated by the UN as the Decade of Nutrition, in support of the UN Sustainable Development Goals. For these initiatives to succeed, it is necessary to know which foods contribute to health and well-being, and which are unhealthy. The present commentary outlines the NOVA system of food classification based on the nature, extent and purpose of food processing. Evidence that NOVA effectively addresses the quality of diets and their impact on all forms of malnutrition, and also the sustainability of food systems, has now accumulated in a number of countries, as shown here. A singular feature of NOVA is its identification of ultra-processed food and drink products. These are not modified foods, but formulations mostly of cheap industrial sources of dietary energy and nutrients plus additives, using a series of processes (hence ‘ultra-processed’). All together, they are energy-dense, high in unhealthy types of fat, refined starches, free sugars and salt, and poor sources of protein, dietary fibre and micronutrients. Ultra-processed products are made to be hyper-palatable and attractive, with long shelf-life, and able to be consumed anywhere, any time. Their formulation, presentation and marketing often promote overconsumption. Studies based on NOVA show that ultra-processed products now dominate the food supplies of various high-income countries and are increasingly pervasive in lower-middle- and upper-middle-income countries. The evidence so far shows that displacement of minimally processed foods and freshly prepared dishes and meals by ultra-processed products is associated with unhealthy dietary nutrient profiles and several diet-related non-communicable diseases. Ultra-processed products are also troublesome from social, cultural, economic, political and environmental points of view. We conclude that the ever-increasing production and consumption of these products is a world crisis, to be confronted, checked and reversed as part of the work of the UN Sustainable Development Goals and its Decade of Nutrition.

### Keywords

Sustainable Development Goals  
Decade of Nutrition  
Food processing  
Ultra-processed food  
NOVA  
The Anthropocene

On 1 April 2016 the UN General Assembly proclaimed the Decade of Nutrition, to run from 2016 to 2025 as part of the UN Sustainable Development Goals initiative<sup>(1)</sup>. It will be guided by the FAO, the WHO and other UN agencies, with support requested from civil society and the private

sector. All concerned repeatedly emphasize that this work is crucial, because of the evident multiple worsening threats to food systems and supplies, and thus to food security, human health and welfare, the living and physical world and the biosphere. At the General Assembly

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meeting, FAO Director-General José Graziano da Silva stated: 'This Resolution puts nutrition at the heart of sustainable development'.

### **Identification of ultra-processed food and drink products**

In support of the UN initiatives, in September 2016 the Global Panel on Agriculture and Food Systems for Nutrition, an independent expert group one of whose members is the FAO director-general, published its 'Foresight' report on *Food Systems and Diets: Facing the Challenges of the 21st Century*<sup>(2)</sup>. This 'includes important recommendations and advice for leaders at the most senior levels in countries and international organizations'. Its findings 'constitute a stark warning for all countries ... the situation is set to worsen dramatically over the next 20 years as powerful drivers of change such as population growth, climate change and urbanization converge on food systems'. As an example:

*'If the direction of current policies remains the same, then estimates suggest that by 2030, the number of overweight and obese people will have increased from 1.33 billion in 2005 to 3.28 billion, around one third of the projected global population. This is a major concern as no country to date has successfully reversed growth in obesity once it has been allowed to develop.'*

In this context, specific reference is made to production and consumption of ultra-processed food and drink products as a reason for the rise in obesity:

*'In 2000, sales of ultra-processed foods and beverages in the upper-middle-income countries were one third of those in the high-income countries. Fifteen years later, they were more than half.'*

The term 'ultra-processed' was explained and given a context:

*'The term "ultra-processed" was coined to refer to industrial formulations manufactured from substances derived from foods or synthesized from other organic sources. They typically contain little or no whole foods, are ready-to-consume or heat up, and are fatty, salty or sugary and depleted in dietary fibre, protein, various micronutrients and other bioactive compounds. Examples include: sweet, fatty or salty packaged snack products, ice cream, sugar-sweetened beverages, chocolates, confectionery, French fries, burgers and hot dogs, and poultry and fish nuggets.'*

As also stated in a 2015 report published by the Pan American Health Organization (PAHO) of the WHO<sup>(3)</sup>:

*'The most striking change in food systems of high-income countries, and now of low- and middle-income countries, is displacement of dietary patterns*

*based on meals and dishes prepared from unprocessed or minimally processed foods by those that are increasingly based on ultra-processed food and drink products. The result is diets with excessive energy density, high in free sugars and unhealthy fats and salt, and low in dietary fiber that increase the risk of obesity and other diet-related non-communicable diseases. The proportion of ultra-processed products in food supplies can be seen as a measure of overall population diet quality.'*

The September 2016 'Foresight' report, which ends with an annex listing all types of ultra-processed food products, goes on to state<sup>(2)</sup>:

*'Sales of ultra-processed food and sugar-sweetened beverages are growing. This growth is almost exclusively found in lower-middle income and upper-middle-income countries ... Sales of ultra-processed foods in East and South East Asia are expected to approach those of high-income countries by 2035.'*

The concept of ultra-processing, developed by a team at the University of São Paulo of which we are members, was first proposed in a *Public Health Nutrition* commentary in 2009<sup>(4)</sup>. It was created as part of the thesis that the nature, extent and purpose of food processing explain what is now the relationship between food, nutrition, health and disease. This thesis is now acknowledged in reports, statements and commentaries from the FAO<sup>(5,6)</sup> and PAHO<sup>(3,7)</sup>, and in leading scientific journals<sup>(8,9)</sup>. It has been used in an official national set of food-based dietary guidelines<sup>(10,11)</sup> and by many investigators in several countries (see later). It was initially summarized as follows<sup>(4)</sup>:

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

The present commentary has five main sections. First, we give reasons why proper understanding of the relationship between diet and public health now needs to emphasize food processing. Second, we specify the need to make precise definitions of food processing and to distinguish between different types of processing. Third, we present NOVA, the food classification based on the nature, extent and purpose of food processing that places foodstuffs in four groups, one of which is specified as ultra-processed food and drink products. Fourth, we summarize the use of NOVA in a number of countries to describe and monitor

population dietary patterns and to assess the impact of ultra-processed products on the quality of diets and health outcomes. Fifth, we summarize some health, social, economic, political and environmental consequences of replacing minimally processed foods and freshly prepared meals by ultra-processed products. Then finally, we propose that the rapidly increasing production and consumption of ultra-processed food and drink products, which is contributing to climate disruption and also to pollution, degradation and depletion of air, land, water and sources of energy, is in itself now a world crisis to be confronted, checked and reversed as part of the UN Sustainable Development Goals and its Decade of Nutrition.

### Reasons to emphasize food processing

Special attention to food processing is now crucial in order to understand the connection between diet and public health. Here are five reasons that justify this statement. They explain why the NOVA classification has been developed and why it is necessary to identify the sources of ultra-processed products.

One. Conventional food classifications no longer work well. They usually group foods and foodstuffs in terms of their botanical origin or animal species and according to nutrients they contain. In this way they often group together foods that have different effects on health and disease. So 'cereals and cereal products' often group whole grains together with sugared 'breakfast cereals' and cookies (biscuits), and 'meat and meat products' often group fresh chicken together with 'nuggets'. This sidelining of food processing has serious consequences, as shown below.

Two. Evidence on the relationship between food processing and health outcomes has been increasing steadily. An obvious example is industrial *trans*-fats, produced by the partial hydrogenation process in the manufacture of a vast number of fatty branded packaged products, including margarines, biscuits and other 'long-life' baked goods. *Trans*-fats are now known to be a cause of CVD<sup>(12)</sup>. Reports issued by UN agencies and other authoritative organizations<sup>(13,14)</sup> list some processed foods and drinks as certainly or probably implicated in obesity and chronic diseases. These include energy-dense food products, fast foods, soft drinks, sugary drinks, refined starchy foods, processed meat and salt-preserved foods. But such reports apparently do not see any pattern, and stop short of examining processing as such. Both the US 2010 and the 2015–2020 Dietary Guidelines for Americans reports<sup>(15,16)</sup> advise less consumption of common ingredients of processed foods such as sodium, added sugars, *trans*-fats, refined grains and processed meats. Yet these reports also do not examine processing as such, and the term 'processing' is not even included in their glossaries of terms. Also, concern about food additives is usually limited and confined to issues of contamination; much less

attention is given to the use of cosmetic food additives (notably, flavours and colours) that are used in order to make combinations of cheap processed oils, refined sugars and starches palatable and attractive.

Three. Food systems and supplies are changing globally and are determining changes in food purchase and consumption. Specialist food retailers are being rapidly displaced by supermarkets whose central aisles are dominated by branded packaged products. Home cooking has decreased in favour of snacking on processed products, consumption of pre-prepared dishes, and the very rapid rise of franchised fast-food caterers selling processed meat products, French fries and sugared soft drinks. Branded products such as fatty, sugary or salty snack foods and sugared soft drinks are available in all sorts of retail outlets, often round the clock<sup>(2,6,17)</sup>.

Four. All these phenomena are being driven by transnational corporations. These corporations are identified in a 2012 *PLoS Medicine* series, and in 2014 by Margaret Chan, Director-General of the WHO, as 'Big Food'<sup>(18,19)</sup>. Since the 1980s they have taken advantage of the freedom to make foreign direct investments, an engine of economic growth, which, as reported by the Organisation for Economic Co-operation and Development, have risen from \$US 61 million in 1985 to \$US 1 068 000 million in 2000 – and to \$US 1 730 000 million in 2015<sup>(20,21)</sup>. This has dramatically changed food supplies in middle- and low-income countries, as shown elsewhere<sup>(22,23)</sup>. The annual turnovers of a number of corporations exceed the gross national product of mid-range countries and, unlike many national governments, they can divert or invest billions of dollars in new technologies and markets<sup>(24)</sup>. As stated in a 2000 report by the Global Policy Forum<sup>(25)</sup>:

*'Although TNCs [transnational corporations] are collectively the world's most powerful economic force, no intergovernmental organisation is charged with governing their behaviour. The unwillingness or inability of governments to control TNCs in a period of deregulated global trade and investment does not bode well [is not good] for people's health or the environment.'*

Five, and related. It is now becoming increasingly well known that transnational food corporations have colossal resources to manufacture, market, promote and lobby for their packaged branded products. Their impact is most evident in the middle- and low-income countries they have penetrated since the 1980s, where they often plan 'double-digit' growth, meaning 10 % or more increase in annual sales<sup>(24)</sup>. As pointed out in the September 2016 'Foresight' report<sup>(2)</sup>:

*'Food and beverage companies spend large amounts on advertising, accounting (including alcohol retail) for 17 % of global media spending in 2012. Coca Cola and Nestle, which were among the top ten*

*largest global advertisers in 2014, together spent US \$6.21 billion – equivalent in size to almost two-thirds of the entire UK overseas aid budget.*

*A recent review of food marketing practices concludes that food promotion in high-income countries has been geared towards increased access to cheaper, bigger and tastier calorie-dense food. Much consumer influencing is conducted “below the radar” using less obvious methods than advertising, such as brand association, sensory complexity, the size and shape of portions, packages and serving containers. These practices are also following similar patterns in low- and middle-income countries. There is convincing evidence that advertising influences food choice among children.’*

Taken all together, these and other factors, including the impact of ultra-processed food and drink products on social life, culture, employment and the environment, of which more below, show that in this 21st century it is necessary to pay special attention to food processing and to ultra-processed products (see Box 1).

### **Food processing as such is not the issue**

So, what does ‘processing’ mean? Organizations that represent the interests of food and drink corporations<sup>(26,27)</sup>

or professional organizations<sup>(28–30)</sup> that are supported by food product manufacturers<sup>(31)</sup> have published reports, brochures or papers between 2010 and 2014 on food processing. These use very broad characterizations, such as ‘food processing is any deliberate change made in a food from the time of origin to the time of consumption’<sup>(26)</sup>, or ‘a variety of operations by which raw foodstuffs are made suitable for consumption, cooking, or storage’<sup>(27)</sup>, or else ‘food processing is the alteration of foods from the state in which they are harvested or raised to better preserve them and feed consumers’<sup>(30)</sup>.

Additives are explained with statements such as<sup>(27)</sup>:

*‘Food additives are added for a particular purpose whether it is to ensure food safety, to add nutritional value or to improve food quality. They play an important role in preserving the freshness, safety, taste, appearance and texture of foods. For example, antioxidants prevent fats and oils from becoming rancid whereas emulsifiers stop peanut butter from separating into solid and liquid fractions. Food additives keep bread free of mould for longer and allow fruit jams to “gel” so they can be spread onto bread.’*

It is also true in a broad sense that<sup>(27)</sup>:

*‘We all process foods everyday when preparing a meal for ourselves or our family and virtually all*

#### **Box 1** The food industry is essential

It is sometimes thought that concerns about food processing amount to some sort of attack on the food industry in general. Indeed, public statements made about food, nutrition and health often refer critically to ‘the food industry’ without giving any clear idea of what is being referred to.

This practice is unhelpful. The food industry as a whole is obviously essential for the welfare and survival of the human race, for the sustenance of civilizations, and now for the reliable supply of food to rapidly growing urban populations. Food production, preservation, manufacture, distribution and sale create safe, secure and convenient food supplies for all populations and communities with adequate and stable disposable incomes, all over the world.

The food industry includes farmers and other food and drink producers, manufacturers, distributors, retailers and caterers, and associated industries, of all sizes, and their unions and trade organizations<sup>(9)</sup>. These and other workers, cooperatives, tradesmen, shopkeepers, entrepreneurs, industrialists, and their representatives, are all together the true food system ‘private sector’. It is practically meaningless to characterize ‘the food industry’, a very broad term, as if any critical judgement could be made of industry as a whole.

Any meaningful critical judgement on the present role played by the food industry within food systems needs to isolate the transnational and other very large corporations and companies whose profits depend on food and drink products which, consumed at levels now usual in many countries, and projected to be so in most countries, are a major cause of concern for global public health. Specifically, the critical focus needs to be on the lightly regulated transnational manufacturing and catering corporations and their trade, representative and allied organizations that dominate the market for ultra-processed food products. These corporations and organizations are often identified and treated as if they are ‘the food industry’ or even ‘the private sector’. But they do not and cannot represent the interests of the food industry as a whole.

Singling out transnational corporations does not mean that they are solely responsible. They have been enabled to grow very fast and to become very powerful because of political and economic trade policies agreed at global level that have given them extraordinary freedom to do what they want within existing laws.

*foods undergo some form of processing before they are ready to eat ... Processing spans the whole food chain from harvesting on the farm to different forms of culinary preparation in the home.'*

Practically all food is processed in some sense and in some way, including by 'other procedures' not mentioned above such as hydrogenation, hydrolysis and extrusion. Thus the term 'processing' (like the term 'industry') is very general and therefore not helpful. It is a mistake to make any judgement of food supplies or foods simply because they are 'processed'. Further, attempts to distinguish between different types of processing by using undefined terms such as 'highly' or 'heavily' processed, or 'fast', 'convenience', 'snack' or 'junk' food, are also unhelpful.

Verdicts on food processing as such have little or no meaning. Food scientists and technologists and food manufacturers rightly emphasize the benefits of originally ancient and also relatively novel processes such as drying, non-alcoholic fermentation, chilling and freezing, pasteurization and vacuum-packing. But on the other hand – just to take two examples – evidence on the harm done by partial hydrogenation is now conclusive, and on sugaring (notably with soft drinks or 'soda') is very strong<sup>(12–14)</sup>.

It is possible to make sense of food processing and its effects on human health only when analysis and assessment are discriminating and precise, with terms defined and with types, uses and effects of processing identified and distinguished. Definitions need to be meaningful, detailed and objective, which is to say specific, coherent, clear, comprehensive and workable. This is part of the purpose of the NOVA food classification<sup>(4,5,11,32–35)</sup>.

## The NOVA classification

NOVA (which is not an acronym) groups foods according to the nature, extent and purpose of the industrial processing they undergo. Food processing as identified by NOVA involves physical, biological and chemical processes used after foods are separated from nature, and before being consumed or prepared as dishes and meals.

Foods may be consumed by themselves (such as fruits, nuts, milk); or as a main item or accompanying items of dishes and meals (such as grains, flours, vegetables, meat, eggs); or as food products used in making these dishes and meals (such as oils, butter, sugar, salt). Or, they may be food products ready to consume or heat (such as bread, cheese, ham; packaged snacks, soft drinks, pre-prepared frozen dishes). NOVA classifies all foods and food products into four groups. See the Appendix for detailed lists of foods and food products in each of the four groups.

### **Group 1. Unprocessed or minimally processed foods**

Unprocessed (or natural) foods are edible parts of plants (seeds, fruits, leaves, stems, roots) or of animals (muscle, offal, eggs, milk), and also fungi, algae and water, after

separation from nature. Minimally processed foods are natural foods altered by processes that include removal of inedible or unwanted parts, and drying, crushing, grinding, fractioning, filtering, roasting, boiling, non-alcoholic fermentation, pasteurization, refrigeration, chilling, freezing, placing in containers and vacuum-packaging. These processes are designed to preserve natural foods, to make them suitable for storage, or to make them safe or edible or more pleasant to consume. Many unprocessed or minimally processed foods are prepared and cooked at home or in restaurant kitchens in combination with processed culinary ingredients as dishes or meals.

### **Group 2. Processed culinary ingredients**

Processed culinary ingredients, such as oils, butter, sugar and salt, are substances derived from Group 1 foods or from nature by processes that include pressing, refining, grinding, milling and drying. The purpose of such processes is to make durable products that are suitable for use in home and restaurant kitchens to prepare, season and cook Group 1 foods and to make with them varied and enjoyable hand-made dishes and meals, such as stews, soups and broths, salads, breads, preserves, drinks and desserts. They are not meant to be consumed by themselves, and are normally used in combination with Group 1 foods to make freshly prepared drinks, dishes and meals.

### **Group 3. Processed foods**

Processed foods, such as bottled vegetables, canned fish, fruits in syrup, cheeses and freshly made breads, are made essentially by adding salt, oil, sugar or other substances from Group 2 to Group 1 foods. Processes include various preservation or cooking methods, and, in the case of breads and cheese, non-alcoholic fermentation. Most processed foods have two or three ingredients, and are recognizable as modified versions of Group 1 foods. They are edible by themselves or, more usually, in combination with other foods. The purpose of processing here is to increase the durability of Group 1 foods, or to modify or enhance their sensory qualities.

### **Group 4. Ultra-processed foods**

Ultra-processed foods, such as soft drinks, sweet or savoury packaged snacks, reconstituted meat products and pre-prepared frozen dishes, are not modified foods but formulations made mostly or entirely from substances derived from foods and additives, with little if any intact Group 1 food.

Ingredients of these formulations usually include those also used in processed foods, such as sugars, oils, fats or salt. But ultra-processed products also include other sources of energy and nutrients not normally used in culinary preparations. Some of these are directly extracted from foods, such as casein, lactose, whey and gluten. Many are derived from further processing of food constituents, such as hydrogenated or interesterified oils,

hydrolysed proteins, soya protein isolate, maltodextrin, invert sugar and high-fructose corn syrup.

Additives in ultra-processed foods include some also used in processed foods, such as preservatives, antioxidants and stabilizers. Classes of additives found only in ultra-processed products include those used to imitate or enhance the sensory qualities of foods or to disguise unpalatable aspects of the final product. These additives include dyes and other colours, colour stabilizers; flavours, flavour enhancers, non-sugar sweeteners; and processing aids such as carbonating, firming, bulking and anti-bulking, de-foaming, anti-caking and glazing agents, emulsifiers, sequestrants and humectants.

A multitude of sequences of processes is used to combine the usually many ingredients and to create the final product (hence 'ultra-processed'). The processes include several with no domestic equivalents, such as hydrogenation and hydrolysis, extrusion and moulding, and pre-processing for frying.

The overall purpose of ultra-processing is to create branded, convenient (durable, ready to consume), attractive (hyper-palatable) and highly profitable (low-cost ingredients) food products designed to displace all other food groups. Ultra-processed food products are usually packaged attractively and marketed intensively.

### NOVA in use

The NOVA classification has now been applied worldwide. Uses so far include description of population dietary patterns, assessments of changes over time in the dietary share of ultra-processed products, and analyses of the association of this share with the nutrient profile of diets and with health outcomes.

In Brazil, NOVA has been used to assess: the socio-economic and demographic distribution of dietary patterns<sup>(36,37)</sup>; time changes in dietary patterns<sup>(36,38)</sup>; the impact of the dietary share of ultra-processed products on the dietary content of macronutrients<sup>(39–41)</sup> and micronutrients<sup>(42)</sup>; and the association of consumption of ultra-processed products with obesity<sup>(43,44)</sup>, metabolic syndrome<sup>(45)</sup> and dyslipidaemias<sup>(46)</sup>. NOVA has also been used in Brazil to study the relationship between household food purchase patterns and relative prices of ultra-processed and all other food items<sup>(47)</sup>, as well as the influence of the food environment<sup>(48–50)</sup> and of food advertising<sup>(51)</sup> on the consumption of ultra-processed products; and to evaluate the impact of a nutrition education intervention<sup>(52)</sup>.

In the USA, NOVA has been used to describe population dietary patterns and to assess the impact of ultra-processed products on the overall consumption of added sugar<sup>(53)</sup>, on the dietary content of other critical macronutrients and micronutrients<sup>(54)</sup>, and on urinary levels of phyto-oestrogens<sup>(55)</sup>. With some adaptation, it has been

used also to evaluate the nutritional quality of packaged foods purchased by US households and to study differences in purchase according to race/ethnicity<sup>(56,57)</sup>. In Canada, it has been used to assess secular trends in national dietary patterns<sup>(58)</sup> and the impact of ultra-processed products on indicators of nutrient profile of diets<sup>(59,60)</sup>. In the UK, NOVA has been used to describe population dietary patterns and to study the relationship between household food purchase patterns and relative prices of ultra-processed and all other food items<sup>(47)</sup>, and to estimate the potential for reduction of CVD by reducing consumption of ultra-processed products<sup>(61)</sup>. In Australia, it has been used to assess dietary sodium intake and food sources of sodium<sup>(62)</sup>, to study national time trends in aspects of food practices implicated in diet-related health risks<sup>(63)</sup>, and to build a tool to measure healthy and sustainable dietary behaviours<sup>(64)</sup>.

In Chile, NOVA has been used to describe population dietary patterns and to assess the impact of the consumption of ultra-processed products on the nutritional quality of diets<sup>(65,66)</sup>. It has been used in Mexico to describe population dietary patterns and determinants of consumption of ultra-processed food products<sup>(67)</sup>. In Norway, it has been used to assess the participation of ultra-processed foods in national food sales<sup>(68)</sup>; in New Zealand, to describe the nutrient profile of supermarket foods<sup>(69)</sup>; and in Sweden to study time trends in consumption of ultra-processed products and in adult obesity<sup>(70)</sup>. In Spain, the association between the consumption of ultra-processed foods and the 9-year incidence of obesity and hypertension was tested in a cohort of middle-aged adults<sup>(71,72)</sup>.

Studies on time trends in sales of ultra-processed products have covered seventy-nine middle- and high-income countries<sup>(73)</sup> and fourteen countries in Asia<sup>(74)</sup>. A paper published in *The Lancet* in 2013<sup>(9)</sup> compared strategies used by the manufacturers of tobacco, alcohol and ultra-processed products, with implications for prevention and control of non-communicable diseases. A PAHO report described socio-economic determinants of sales of selected ultra-processed products in fifteen Latin American countries and analysed the association between annual changes in sales of these products and annual changes in population mean BMI<sup>(3)</sup>. A WHO report has used NOVA to assess and compare the impact of the dietary share of ultra-processed products on the excessive overall intake of free sugars in the USA, Canada, Brazil and Colombia<sup>(75)</sup>.

Altogether, studies based on NOVA show exponential growth in consumption of ultra-processed products and confirm that they displace unprocessed or minimally processed foods and freshly prepared dishes and meals made from these foods together with processed culinary ingredients. For example, between 1998 and 2012, per head sales of sweet or savoury snacks and soft drinks increased by 50 % in upper-middle-income countries and by 100 and 300 %, respectively, in lower-middle-income countries<sup>(73)</sup>. In Brazilian urban households, ultra-processed products

represented 18.7 % of total energy of food baskets in 1988, increasing by 50 % to 29.6 % in 2009, while minimally processed foods declined from 44.0 to 38.9 % and processed culinary ingredients from 35.7 to 28.9 %<sup>(38)</sup>.

Studies based on NOVA also show that the consumption of ultra-processed products increases the overall energy density of diets and their content of saturated and *trans*-fats and free sugars, and decreases dietary fibre, phyto-oestrogens, magnesium, potassium, vitamin A, iron and zinc, among other key micronutrients. For instance, the average content of added sugars in the US diet is 19.5 % among the highest consumers of ultra-processed products (upper quintile) and 7.5 % among the lowest consumers (lower quintile)<sup>(53)</sup>. In the Brazilian diet, the content of vitamin A, iron and zinc among the lowest consumers of ultra-processed products exceeds by 5, 15 and 25 %, respectively, the same content among the highest consumers<sup>(42)</sup>.

Ecological studies and cross-sectional and cohort studies have documented a direct association between ultra-processed products and obesity<sup>(3,43,44,70,71)</sup>, hypertension<sup>(72)</sup>, metabolic syndrome<sup>(45)</sup> and dyslipidaemias<sup>(46)</sup>.

NOVA has also been used to orient the nutrient profile model developed by the PAHO for the region of the Americas<sup>(7)</sup>. The dietary share of ultra-processed products has been recommended by a leading international organization as a way to monitor the overall quality of national diets<sup>(76)</sup>.

The NOVA four food groups are also the basis for the four main recommendations of the current official national Brazilian dietary guidelines<sup>(10)</sup>, recognized by the FAO<sup>(6)</sup> as the first food-based dietary guidelines that take social, cultural, economic and other aspects of sustainability into account. The main recommendations of the national dietary guidelines of Uruguay, published in December 2016, are also based on the NOVA four food groups<sup>(77)</sup>.

The main recommendations of the Brazilian guidelines are:

1. Make natural or minimally processed foods, in great variety, mainly of plant origin, and preferably produced with agro-ecological methods, the basis of your diet.
2. Use oils, fats, salt and sugar in small amounts for seasoning and cooking foods and to create culinary preparations.
3. Limit the use of processed foods, consuming them in small amounts as ingredients in culinary preparations or as part of meals based on natural or minimally processed foods.
4. Avoid ultra-processed products.

### The trouble with ultra-processing

As stated, ultra-processed products are not modified foods, recognizable as such, but formulations of industrial sources of dietary energy and nutrients, particularly unhealthy types of fat, starches, free sugars and salt, plus

additives including those designed to intensify sensory impact. They typically contain little or even no intact food.

The ingredients of ultra-processed products make them fatty, sugary or salty, often high in saturated fats or *trans*-fats, and depleted in dietary fibre and various micronutrients and other bioactive compounds. This is why, in several countries, as shown above, higher consumption of these products is associated with unhealthy dietary nutrient profiles and several diet-related non-communicable diseases.

When solid, because of their main ingredients and the lack of dietary fibre and water, the energy density of ultra-processed products ranges from fairly high (about 940–1150 kJ (225–275 kcal) per 100 g for baked products) to high (about 1460–1675 kJ (350–400 kcal) per 100 g for ‘energy’ bars) or very high (1675–2090 kJ (400–500 kcal) per 100 g for most biscuits and for chips (crisps))<sup>(10)</sup>. When formulated as drinks, ultra-processed products are often sugared, and are usually depleted in or devoid of nutrients. These attributes make most ultra-processed products prone to cause inadvertent overconsumption of dietary energy, and thus overweight and obesity<sup>(14,78)</sup>.

They also typically have high glycaemic loads<sup>(79)</sup>. This makes them liable to disturb and even derange endogenous processes in the nervous system that signal satiety and control appetite, and thus increase the risk of obesity and diabetes<sup>(13)</sup>.

Ultra-processed products are often formulated to be habit-forming, and are sometimes even quasi-addictive, which makes it hard to make healthy choices and to avoid overconsumption<sup>(80,81)</sup>.

Many ultra-processed products create a false impression of being healthy by, for example, the addition of dietary fibre and some micronutrients and the replacement of sugar by artificial sweeteners, or the reduction of sodium, enabling manufacturers to make health claims despite the product remaining unhealthy<sup>(82,83)</sup>. Vast sums of money are spent by the biggest corporations on advertising and promotion of regular or reformulated products, including cross-advertising between brands, to make them attractive, exciting and even glamorous, especially to children and young people<sup>(84–86)</sup>. All these practices impede ability to make healthy choices.

Ultra-processed products now dominate the food supplies of various high-income countries. For instance, they made up 57.9 % of the US food supply in 2009–2010<sup>(53)</sup> and 47.7 % of the total dietary energy intake in Canada in 2004<sup>(60)</sup>. In middle-income countries, figures are lower, for instance 29.8 % in Mexico<sup>(67)</sup>, 28.6 % in Chile<sup>(66)</sup> and 21.5 % in Brazil<sup>(39)</sup>; but, as shown by sales data in Latin American countries<sup>(3)</sup>, they are rising rapidly. Estimates of the contribution of ultra-processed products to the total dietary energy intake in low-income countries are not yet available, but the highest proportional increase in sales of sweet and savoury snacks and sugary soft drinks is seen in lower-middle-income countries<sup>(73)</sup>.

Thus, ultra-processed products have troublesome effects on global nutrition and health. The evidence so far indicates that the displacement of unprocessed or minimally processed foods and freshly prepared dishes and meals by ultra-processed food and drink products is driving the high and increasing global burden of obesity and other diet-related chronic non-communicable diseases<sup>(87)</sup>. The evidence also indicates that this change in dietary patterns can worsen the still relevant burden of micronutrient deficiencies in low- and middle-income countries<sup>(87)</sup>, notwithstanding the fortification of some ultra-processed products with some micronutrients.

Ultra-processed products and their makers are also causing social, cultural, economic, political, environmental and other problems. Much of what follows is obvious or common sense, and is much discussed in the literature. Some invites further research, which should not delay action to slow, stop and reverse the increases in production and consumption of ultra-processed products.

Social life in and out of the home is weakened by ultra-processed products. Because they are convenient, being formulated as ready-to-consume snacks and drinks and ready-to-heat items, they displace dishes and meals made at home. The shared experiences of acquiring, preparing, cooking and enjoying food together, part of our evolution as humans<sup>(88,89)</sup>, with all the knowledge this brings of the nature, meaning and value of food, become increasingly lost. Meal tables and all that goes with them are used less often, or even not at all. The kitchen becomes less used and the dining room, a special place for people who live in the same place to come together and share in one another's lives, may disappear. Instead, people at home get into the habit of eating alone, at different times, inattentively, often when doing something else. Children and young people eat while using their computer or playing video games. Out of the house, ultra-processed products are consumed anywhere, any time, while working, walking or driving, or when using cell phones. These are generally isolated situations, concealed by advertisements and other marketing suggesting that ultra-processed products enhance social interaction<sup>(11,90,91)</sup>.

Culture, national and local, is also harmed by ultra-processed products. Transnational ultra-processed food and drink manufacturers, distributors and caterers are increasingly oligopolistic<sup>(17,18,22)</sup>, and work in concert, as is evident from joint trade organizations set up to defend their shared interests<sup>(24)</sup>. Supported by international free trade agreements<sup>(92)</sup>, they displace authentic established varied food systems and cultures, and generate uniform consumer habits. Their strategy in effect is to teach the world to snack<sup>(93)</sup>. Everywhere, food customs that are part of the identity of countries and regions, and food cultures based on shared meals, are being undermined by ultra-processed products, with their branding, promotion, packaging and labelling. The contents of any type of product – the soft drinks and burgers and many other

ultra-processed products made by giant corporations – are much the same everywhere. The impression of variety is given by marketing campaigns with vast sums spent on them worldwide using multimedia, social media, the Internet and television, as well as all sorts of printed advertisements, which further invalidate what have been established dietary patterns, culinary knowledge and skills, and social cultures. This has an alienating effect on children and young people, who get the impression that the culture and nature of their own country and location, ethnicity and tradition are boring<sup>(11,94,95)</sup>.

Production and consumption of ultra-processed products also have troublesome economic consequences. Transnational and other big corporations using cheap ingredients for their products operate economies of scale and have huge reserves of money for investment and development. They may take over national and local businesses, including the makers, distributors and sellers of minimally processed foods<sup>(24,25)</sup>. In order to join in the market and to compete, national and regional manufacturers increasingly produce their own variations of ultra-processed products. Demand for cheap oils, sugar, starches and other common ingredients of ultra-processed products creates crop monocultures in many countries in order to produce raw materials usually for export and not foods for direct human consumption. Judgements vary on the economic effects. Some national and local businesses and family farmers adapt and flourish, but livelihoods especially of the most impoverished vulnerable and impoverished communities can be made even more insecure<sup>(96–98)</sup>. In high- and middle-income countries, the price of most ultra-processed food products has decreased relative to that of most minimally processed foods<sup>(99)</sup>. But varied freshly prepared meals made from minimally processed foods with processed culinary ingredients can readily be made to be cheaper than ultra-processed products<sup>(47,100–102)</sup>. Ultra-processed products also carry another cost: obesity and related chronic diseases such as diabetes are debilitating and impede ability to work, and their treatment, for those without health insurance or access to publicly funded health services, can mean financial catastrophe<sup>(96,103)</sup>.

There are also political consequences. Ultra-processed products have made the fortunes of the transnational food and drink corporations, of which, as mentioned, the largest have annual turnovers the size of middle-ranked national economies<sup>(24,25)</sup>. The deregulation that has enabled transnational corporations to grow exponentially, their ability to move into the countries that give them most scope and their freedom to act as they choose within the law, all give them more power and elected national governments less ability to act in the public interest<sup>(9,19,24,25)</sup>. Thus, it becomes difficult for governments, should they wish to do so, to enact fiscal and other statutory policies designed to make unprocessed and minimally processed foods more available and cheaper, and ultra-processed



products less available and relatively or absolutely more expensive. WHO Director-General Margaret Chan has explained<sup>(19)</sup>:

*'Efforts to prevent noncommunicable diseases go against the business interests of powerful economic operators.... It is not just Big Tobacco anymore. Public health must also contend with Big Food, Big Soda, and Big Alcohol. All of these industries fear regulation, and protect themselves by using the same tactics. Research has documented these tactics well. They include front groups, lobbies, promises of self-regulation, lawsuits, and industry funded research that confuses the evidence and keeps the public in doubt. Tactics also include gifts, grants, and contributions to worthy causes that cast these industries as respectable corporate citizens in the eyes of politicians and the public. They include arguments that place the responsibility for harm to health on individuals, and portray government actions as interference in personal liberties and free choice.'*

*This is formidable opposition. Market power readily translates into political power. Few governments prioritize health over big business. As we learned from experience with the tobacco industry, a powerful corporation can sell the public just about anything. Let me remind you. Not one single country has managed to turn around its obesity epidemic in all age groups. This is not a failure of individual will-power. This is a failure of political will to take on big business.'*

Production and consumption of ultra-processed products are also damaging the environment. For example in the USA, food packaging is about half of total packaging by weight and accounts for almost two-thirds of total packaging waste by volume<sup>(104)</sup>. Bottles, containers, wrappings and other packaging of ultra-processed products create colossal amounts of garbage, some not biodegradable, thrown away in the street and countryside, washed out of sewers, and disposed of in landfill sites. The manufacture and distribution of ultra-processed products and their ingredients often involve long international transport routes and therefore excessive use of non-renewable energy, which contributes to climate disruption<sup>(105)</sup>. Intensive breeding of animals for human food is especially prodigal in its use of energy. Cattle bred for the burger trade require animal feed produced by monocultures such as of soybeans and corn, and many other inputs including antibiotics, and in countries such as Brazil involve the destruction of great tracts of rainforest and savannah<sup>(106,107)</sup>. All this, in common with other forms of industrial agriculture, contributes to climate disruption, causes pollution, loss of biodiversity, and depletion, degradation and losses of water, soil, energy and other non-renewable natural resources.

## Living in the Decade of Nutrition

The Anthropocene, generally agreed as beginning in the 1950s, is the epoch in which human activities are disturbing natural planetary balance to an extent that may well become irreversible. Concerted public policies and actions are needed very urgently, to make life on Earth sustainable<sup>(108,109)</sup>.

Human activities that are thwarting sustainability include those leading to climate disruption; precipitate urbanization; the pollution, degradation and depletion of air, land, water and sources of energy; gross abuses and waste caused by mass production of animals; and food and nutrition insecurity<sup>(110)</sup>.

We propose that the ever-increasing production and consumption of ultra-processed food and drink products should be identified as one of the human activities leading to the crises listed above. We also propose that the impact of ultra-processed products on human health is itself a world crisis, to be confronted, checked and reversed as part of the UN Sustainable Development Goals and its Decade of Nutrition.

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## Appendix

### The NOVA classification

The NOVA classification, outlined above, groups foods according to the nature, extent and purpose of the industrial processing they undergo. Food processing as identified by NOVA involves physical, biological and chemical processes used after foods are separated from nature, and before being consumed or prepared as dishes and meals. Methods used in the culinary preparation of

food at home or in restaurant kitchens are not industrial, by definition, and so are not taken into account by NOVA, which classifies all foods, including culinary ingredients and other food products, into the following four groups. This Appendix lists the main items in the four groups.

*Group 1. Unprocessed or minimally processed foods*

This first NOVA group of unprocessed and minimally processed foods includes fresh, squeezed, chilled, frozen or dried fruits and leafy and root vegetables; grains such as brown, parboiled or white rice, corn cob or kernel, wheat berry or grain; legumes such as beans of all types, lentils, chickpeas; starchy roots and tubers such as potatoes and cassava, in bulk or packaged; fungi such as fresh or dried mushrooms; meat, poultry, fish and seafood, whole or in the form of steaks, fillets and other cuts, or chilled or frozen without added salt or oil; eggs; milk, pasteurized or powdered; fresh or pasteurized fruit or vegetable juices without added sugar, sweeteners or flavours; grits, flakes or flour made from corn, wheat, oats or cassava; pasta, couscous and polenta made with flours, flakes or grits and water without added salt or oil; tree and ground nuts and other oilseeds without added salt or sugar; spices such as pepper, cloves and cinnamon and herbs such as thyme and mint, fresh or dried; plain yoghurt with no added sugar or artificial sweeteners; tea and coffee with no added sugar; drinking-water.

*Group 2. Processed culinary ingredients*

This second NOVA group of processed culinary ingredients includes vegetable oils crushed from various seeds

or nuts, or fruits such as olives; butter and lard obtained from milk and pork; starches extracted from corn and other plants; sugar and molasses obtained from cane or beet; honey extracted from combs and syrup from maple trees; and salt mined or from seawater.

*Group 3. Processed foods*

This third NOVA group of processed foods includes canned or bottled vegetables, fruits and legumes; salted or sugared nuts and seeds; salted, pickled, cured or smoked meats and other animal foods; canned fish; fruits in syrup; cheeses; and unpackaged freshly made breads.

*Group 4. Ultra-processed foods*

This fourth NOVA group of ultra-processed food products includes carbonated drinks; sweet or savoury packaged snacks; ice cream, chocolate, candies (confectionery); mass-produced packaged breads, buns, cookies (biscuits), pastries, cakes and cake mixes; breakfast 'cereals', 'cereal' and 'energy' bars; margarines and spreads; processed cheese; 'energy' drinks; sugared milk drinks, sugared 'fruit' yoghurts and 'fruit' drinks; sugared cocoa drinks; meat and chicken extracts and 'instant' sauces; infant formulas, follow-on milks and other baby products (which may include expensive ingredients); 'health' and 'slimming' products such as powdered or 'fortified' meal and dish substitutes; and many ready-to-heat products including pre-prepared pies and pasta and pizza dishes; poultry and fish 'nuggets' and 'sticks'; sausages, burgers, hot dogs and other reconstituted meat products; and powdered and packaged 'instant' soups, noodles and desserts.