DIALOGUE ON

ULTRA-PROCESSED FOOD PRODUCTS: SOLUTIONS FOR HEALTHY AND SUSTAINABLE FOOD SYSTEMS

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SUMMARY

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INTRODUCTION

This publication presents the chief scientific evidence on the impact of the production and consumption of ultra-processed foods on human and planetary health. Moreover, this summary exposes the lines of reasoning that justify why the construction of healthy and sustainable food systems needs to consider the nature, extent, and purpose of food processing, listing action and public policies based on this recognition, such as the development of food guides, the establishment of nutrition labeling rules, and regulation of food environments.

This document was elaborated from a base document written by researchers from the Center for Epidemiological Research in Nutrition and Health (Nupens) and the *Cátedra Josué de Castro* on Healthy and Sustainable Food Systems, both located at the Faculty of Public Health, at the University of São Paulo (USP). Its content was enriched and revised during an event held on May 18, 2021, based on the contributions of 80 experts in the areas of epidemiology, nutrition, health, and environment.

The analysis focuses on the need to reduce the production and consumption of ultra-processed foods, standing out as a relevant approach that integrates the set of essential changes in food systems. The proposed solutions represent one of the internationally discussed agendas. Throughout 2021, global events will target themes related to food systems, including the UN Food Systems Summit, the UN Climate Change Conference (COP26), and the UN Biodiversity Conference (COP 15).

Evidence supporting fresh or minimally processed foods as the basis for healthy and sustainable diets has been known for a long time. In the last decade, research carried out in several countries has demonstrated that the consumption of ultra-processed foods is currently the main deterioration factor of food quality. At the same time, a robust body of evidence, including cohort surveys,

experimental studies, and even a randomized controlled trial, shed light on the increased consumption of ultra-processed foods as a chief cause of the current obesity and diabetes pandemic as well as of several chronic diseases related to these two conditions. Although to a lesser extent, the evidence also brings to light the detrimental effects of ultra-processed consumption on agrobiodiversity and both dietary carbon and water footprints.

Nupens/USP and the *Cátedra Josué de Castro* hope that the evidence and solutions listed in this document can contribute to policymaking that effectively promotes populational and planetary health.

Enjoy the reading!

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Data: 24th of June 2021

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We acknowledge the 80 participants of the online event held on May 18, 2021, who contributed to the improvement and revision of the first draft of the document.

Cátedra Josué de Castro from the University of São Paulo and Nupens/USP acknowledge support from the Global Health Advocacy Incubator and funding from Bloomberg Philanthropies for translation and design of the translated documents.

Support:

IBIRAPITANGA

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THE NOVA FOOD CLASSIFICATION

Established in 2009 by NUPENS/USP, the NOVA food classification stood out as the pioneer system to organize food by the degree and purpose of processing. Its development took place in line with the epidemiological reality of Brazil and many other countries, which have shown increasing records of non-communicable chronic diseases (e.g., diabetes and hypertension) in the last two decades. These rising rates coincide with a natural transitional process, in which the traditional homemade meals were replaced by ready-to-eat options, such as packaged items, frozen food, and fast food.

These data have led the science of nutritional epidemiology to evaluate the impact of food processing on human and planetary health. Hence, this gaze sensitive to food considers all the steps that the ingredients undergo before reaching the final consumer.

The NOVA food classification has four categories: fresh or minimally processed foods (purchased as fresh products or close to their natural states, such as fresh fruits or packaged rice), culinary ingredients (extracted from raw ingredients and used for cooking, such as oils, salt, and sugar), processed foods (a mixture of the two previous groups, such as a strawberry jam made from the fruit with added sugar), and ultra-processed food products (accurate definition in the text below).

Widely accepted among the scientific community, the NOVA has influenced research worldwide and demonstrated the harmful influence of ultra-processed products. This classification is also the basis of the Food Guide for the Brazilian Population and other official documents providing guidelines for suitable healthy eating in countries such as France, Belgium, Canada, and Uruguay.

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ULTRA-PROCESSED FOOD PRODUCTS

Ultra-processed products – which can be food and drink – are not exactly food but rather formulations of substances obtained through the fractionation of fresh food. These substances include sugar, oils, and fats for domestic use, protein isolates or concentrates, interesterified oils, hydrogenated fat, modified starches, and numerous substances of exclusively industrial use.

Furthermore, dyes, flavors, emulsifiers, thickeners, and other additives are often added to these products to enhance their formulations and deliver sensory properties similar to fresh or minimally processed foods. These ingredients serve to mask undesirable characteristics of the final product. Despite the claims commonly seen on ultra-processed packaging, fresh foods are either a small percentage of their composition or simply absent, e.g., “strawberry flavor” or “grape flavor” products.

The list of ultra-processed food and drink products is extensive, including soft drinks, dairy drinks, fruit nectar, powdered mixture for preparing fruit-flavored drinks, packaged snacks, sweets, and chocolates, “cereal”, ice creams, bread, and pre-prepared pizzas, chicken and fish nuggets, sausages, and many other products.

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EXECUTIVE SUMMARY

Dietary patterns based on ultra-processed food products are significantly associated with one or more negative health outcomes. This stands out as the conclusion of a large and growing body of scientific research, including numerous systematic reviews and meta-analyses. Studies carried out with varied populations and different experimental designs confirm that the consumption of ultra-processed products triggers weight gain, increased adiposity, diabetes, hypertension, and other cardiovascular diseases, depression, cancers in general, breast cancer, childhood asthma, kidney dysfunctions, and premature deaths.

Several mechanisms explain these relationships linked to intrinsic characteristics of the composition, processing, consumption and commercialization of ultra-processed food products. In general, these food and drink products have a higher energy density, more free sugar, saturated and trans fats, and lower content of dietary fibers, proteins, micronutrients, and bioactive compounds. Moreover, ultra-processed products have specific production characteristics with techniques that destroy the food matrix and remove water from food, impacting the satiety controlling systems.

The impact of food standards based on ultra-processed products also extends to critical and negative consequences for the environment. Although to a lesser extent, increasing evidence has demonstrated the relationship of these food products with relevant environmental indicators, such as biodiversity loss, increasing packaging use, and greenhouse gas emissions.

Ultra-processed food production requires a reduced number of high-yielding plant species (e.g., soybeans, corn, wheat, and sugarcane) as raw materials. This logic demands intensive agricultural systems based on monocultures, requiring excessive land use, heavy mechanization, high consumption of water and fossil fuels, chemical fertilizers, genetically modified organism (GMO) seeds, pesticides, antibiotics, and long-distance transport.

In light of the robust scientific evidence regarding the negative impacts of these dietary patterns, different approaches are proposed for the adoption of effective public policies to promote and protect healthy and sustainable eating.

Elaborating dietary guidelines with recommendations based on the level and purpose of food processing is the first presented solution. Brazil is a pioneer in adopting this approach due to its inclusion in the 2nd edition of the Dietary Guidelines for the Brazilian Population and the Dietary Guideline for Brazilian Children Under 2 Years of Age, both published by the Brazilian Ministry of Health. These guidelines are international references and, by adopting the NOVA classification as a reference, they contribute to the promotion of environmental and socio-economic sustainability, healthy eating patterns, and the protection of food cultures. In addition, they are easy to implement, since

the recommendation to reduce the consumption of ultra-processed food products is straightforward, triggering cohesive policymaking in different governmental sectors, involving the entire supply chain.

Considering the need for consistency between healthy eating recommendations, based on the level and purpose of industrial food processing, and the information available on food labels, the adoption of warning front-of-package nutrition labels (FOPNL) with the Nutrition Profile Model of the Pan American Health Organization (PAHO) represents the most effective approach to discouraging the purchase of ultra-processed products. It stands out as an informative symbol inserted on the main panel of food labels to inform the consumer simply and clearly about the high content of nutrients associated with health issues, such as salt, sugar, and fat.

Although a variety of approaches and designs of nutrition labeling are currently in use, the warning format supported by PAHO and adopted by several Latin American countries, such as Chile, Mexico, and Uruguay, prompts the best performance and understanding of consumers. Other possible evidence-based solutions can be adopted, such as regulating nutrition and health claims; enforcing the existing laws of prohibition of misleading advertising practices on labels of ultra-processed food products; highlighting and discerning the list of ingredients to facilitate the identification of ultra-processed food products and including highlighted information on the presence of cosmetic additives on food labels.

Regulatory measures for food environments recommended by the World Health Organization (WHO) and PAHO should also be aligned with healthy eating recommendations based on the degree and purpose of industrial food processing. In this regard, the following solutions stand out: restriction of marketing of ultra-processed food products, especially for children; restriction of ultra-processed food products in the school environment, including regulations for canteens and food purchase from the Brazilian School Feeding Program (PNAE, in Portuguese); restriction of ultra-processed food products in other institutional environments, such as public and private companies; increased taxation for ultra-processed food and drink products, such as sweetened beverages; price reduction and creation of marketing strategies that promote fresh or minimally processed foods and culinary preparations; adoption of guides, protocols, codes of conduct, and regulatory actions to monitor digital influencers, and the promotion of fresh or minimally processed foods and culinary preparations in delivery applications and digital food environments.

The solutions presented in this document are based on scientific evidence, but also consider real experiences from countries, states, and municipalities that have established different measures attaining already documented positive impacts. In addition to the pioneerism of the Dietary Guidelines for the Brazilian population, Latin American stands out as the region with more implemented public policies with positive results on the reduction in the

consumption of ultra-processed food products than other regions worldwide. Mexico, Chile, Peru, and Uruguay, for example, developed and implemented policies that increased taxation, fomented warning FOPNL on unhealthy products, and limited marketing strategies targeting children and, consequently, have observed a decrease in the consumption of ultra-processed food products. Other experiences considered as international benchmarks are policies to promote healthy diets in schools, such as the Brazilian School Feeding Program (PNAE).

The challenge of building healthier and more sustainable food systems requires structural interventions, including the aforementioned elaboration of food guidelines that instruct food and nutrition education actions and the adoption of regulatory measures that facilitate consumer understanding and discourage the consumption of ultra-processed products.

Moving forward with these solutions depends on international, national, and regional governance that ensures equitable representation of key actors from different sectors, such as the public sector (e.g., governments and intergovernmental organizations), civil society (e.g., non-governmental organization and social movements), and the private sector (e.g., companies that have products, practices and policies that promote healthy and adequate diets).

These structures must consider diversity, balance of powers and responsibilities. Hence, strengthening the role of local leadership and expanding spaces for dialogue and the formation of networking is pivotal to face the asymmetries of power that permeate food systems regulations. Actions in this regard also collaborate to manage and avoid the corporate influence or the commercial interest in initiatives aiming to reduce the consumption of ultra-processed food products. Moreover, the formulation and implementation of solutions and public policies should be guided by the defense of public interest. Therefore, the relationship between the public and private sectors must be transparent, free from any conflict of interest, and easily followed up and monitored by civil society.

Coherent measures to guarantee access to fresh or minimally processed foods and disseminate explicit recommendations to avoid the consumption of ultra-processed food products are crucial actions to structure healthy and sustainable food systems.

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1. SCIENTIFIC EVIDENCE: WHAT ARE THE IMPACTS OF ULTRA-PROCESSED FOOD PRODUCTS ON HUMAN HEALTH

In the last ten years, the term "ultra-processed" has gained space in the scientific agenda, and a series of research started to indicate several mechanisms linking ultra-processed food products to the increased risk of developing Chronic Non-Communicable Diseases (NCDs).

In general, these food and drink products have higher energy density (i.e., more calories per gram of food), more free sugar, and more saturated and trans fats when compared to non-ultra-processed foods. Moreover, ultra-processed foods have lower dietary fiber content, proteins, micronutrients, and bioactive compounds [1-5].

Chronic Non-Communicable Diseases (NCDs) are a chief health challenge faced in the 21st century. In 2016, the WHO estimated that these pathologies were related to 71% of deaths worldwide [6]. Through the Global Burden of Disease Study (2015), the organization also brought to light that the NCDs with the more significant impact on the total burden of disease have food-related aspects as the main determinants, whether directly or indirectly[7].

The evidence linking ultra-processed food products and health risks is robust. Reinforced by several systematic reviews and meta-analyses, the scientific evidence confirmed the association between the consumption of ultra-processed food products and health deterioration. Unanimously, the results indicate that the dietary patterns based on ultra-processed foods are significantly associated with one or more negative health outcomes [8–12].

In this sense, a specific factor has caught the attention of the scientific community: the effect of ultra-processed food products is not limited to diseases already related to food, such as hypertension and diabetes. Recent research also registers impacts in less obvious contexts, such as depression and even some types of cancer.

The effects of these food and drink products reach all age groups of populations, from childhood obesity to frailty in the elderly [13], impacting health in the short, medium, and long term. The consequences are aggravated in the current COVID-19 pandemic scenario, with the weakening of the population's nutritional status already impacted by the increase in food and nutrition insecurity levels.

A summary of the chief scientific evidence on the ultra-processed food products impact on health follows:

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Weight gain and adiposity

- A randomized controlled clinical trial offered participants two diets (one based on ultra-processed food products and the other on minimally processed foods). The experiment showed that the ultra-processed diet resulted in an exceeding consumption of about 500 calories per day, and a 0.9 kg gain after two weeks, mainly due to increased fat mass[14].
- Prospective studies in children and adults have shown that the greater the ultra-processed food products consumption, the greater the risk of weight gain, development of overweight/obesity[15–17], and abdominal obesity[18], in addition to significant increases in waist circumferences [16,18,19], Body Mass Index (BMI) [16,18,19], and fat mass [18,19].
- Ultra-processed food products intake was significantly associated with 23-51% higher odds of obesity and 39-49% higher odds of developing abdominal obesity in three meta-analyses of observational studies. The comparison was carried out between groups with the highest and lowest ultra-processed food products consumption [8–10].

Diabetes:

- Data analysis from a British cohort shows an association between the higher ultra-processed food products intake and a higher risk of developing type 2 diabetes. The result is in line with other previously published research [20].

Cardiometabolic outcomes:

- A study from a combined analysis of results from cross-sectional studies assessed the relationship between ultra-processed food products consumption and health and found that participants, who consumed more ultra-processed ones, had 29% higher risks of developing cardiovascular disease and/or mortality and a 34% higher risk of suffering from cerebrovascular disease and/or mortality in comparison to participants consuming less ultra-processed food products[8].
- A higher ultra-processed food products intake was associated with a 21-23% higher risk of developing hypertension compared with a lower ultra-processed food products intake in two prospective studies of nearly 15.000 adults in Spain [15] and over 8.000 adults in Brazil [21].
- A higher share of ultra-processed food products in the diet (> 71% of total calories) was associated with a 28% higher prevalence of metabolic syndrome compared with a lower share (<40% of total calories) among US adults. A 10% upsurge in ultra-processed food products intake was

associated with a 4% increase in the prevalence of metabolic syndrome in the same population. Ultra-processed food products consumption was also linked to a more elevated risk of metabolic syndrome among Brazilian adolescents [23].

- Among children and adolescents from preschool to school age, studies have found an association between ultra-processed food products intake and increases in total and LDL cholesterol [24] and an increased risk of developing cardiovascular disease in early adulthood [25].
- A lower ultra-processed food products intake (compared to a higher consumption) was linked to a significant reduction in diastolic blood pressure of Spanish children from four to seven years old [26].

Other diseases and risks:

- Studies assessing the relationship between ultra-processed food products intake and depression brought to light that participants who consumed more ultra-processed food products had a 33% higher risk of developing depression than those consuming less ultra-processed foods. For every 10% increase in ultra-processed food products consumption, participants presented a 21% increase in the risk of experiencing depressive symptoms [27].
- A 10% increase in the ultra-processed food products proportion in the diet was associated with an 11% increase in the risk of developing breast cancer and a 12% risk upsurge regarding cancer development in general [28].
- Among children and adolescents, studies have pointed out significant associations between ultra-processed food products intake and asthma in Spain and Brazil, as well as a significant connection between the higher ultra-processed food products intake and wheezing in Brazil [29].
- In a study assessing nearly 1,300 elderly Spanish people over six years, the highest ultra-processed food products consumers were 74% more likely to experience a decline in kidney function compared to participants who ate the least ultra-processed food products, regardless of other chronic diseases, demographic factors, diet, and lifestyle [31].
- Ultra-processed food products intake was associated with a tripling risk of frailty in the elderly in a study comparing the intake between the highest and lowest consumption quartiles among nearly 2,000 adults in Spain over three and a half years[32].

Early death

- The combined risk of all-cause mortality was 25-28% higher for individuals consuming more ultra-processed food products than

individuals with minor intake in five prospective studies [33–36], also cited in two meta-analyses [8, 9].

- Death risk was 50% superior from cardiovascular diseases and 68% from heart disease for people in the highest quartiles of ultra-processed food products intake to individuals within the lowest quartiles. Data was acquired from a cohort with >90,000 participants [37]. These mortality risks were higher for women than men.

There is no safe intake of ultra-processed food products

Studies investigating the impact of ultra-processed food products on health usually divide participants into three to five groups, always based on the ultra-processed food products intake. Values vary according to the assessed population and the studied outcome.

The body of scientific evidence available so far undermines the designation of a safe amount for the intake of ultra-processed food products. Researchers point out that the greater the consumption of these products, the greater the negative impact on health. However, individuals intaking inferior amounts of ultra-processed food products are also exposed to the health risks highlighted in this document.

This fact, which has been reinforced in recent years, corroborates the so-called "Golden rule" of the Dietary Guidelines for the Brazilian Population (2014 edition), which recommends avoiding any consumption of ultra-processed food products. Moreover, these food items should not be offered to children as recommended by the Dietary Guidelines for Brazilian Children Under 2 Years of Age (2019).

2. SCIENTIFIC EVIDENCE: HOW ULTRA-PROCESSED FOOD PRODUCTS IMPACT HUMAN HEALTH

As the ultra-processed term already suggests, not only the content of these products impact human health but also their processing. Ultra-processed food products undergo specific production processes with techniques that destroy the food matrix; therefore, modifying the raw material. Moreover, water removal from ultra-processed food products is a standard process, which impairs the brain's perception of the ingested nutritional content. In this way, the satiety controlling systems are affected in the body. The low water content also reflects a significant drop in total water intake (including the water content coming from both drinks and solid foods) since ultra-processed food products often replace meals based on non-ultra-processed foods [1].

Another relevant mechanism is the production of practical and portable options, enabling consumption anywhere. Ultra-processed food products are usually sold as snacks, drinks, or (semi) ready meals, supported by aggressive marketing strategies creating different narratives. Bridging ideas, such as the need for convenient food requiring no cooking, or health claims already refuted by science, e.g., the possible benefit of adding fiber or vitamins to breakfast cereal has become normal practice. Furthermore, these claims are often prominently displayed on the packaging and elicit consumer behavior due to the creation of the halo effect, which is related to the overestimation of the nutritional quality of an item by the consumers based on one or more specific claims. Thus, increasing the perception of healthiness of an ultra-processed food product.

In light of the above, marketing strategies in print, television, and digital media seduce customers, who desire the products and are also persuaded by artifices, such as limited-edition items, association with characters, collectible gifts, attractive prices, discounts, and innovations [2]. Therefore, they are widely associated with ways of eating that induce excessive and unnoticed consumption of calories, in addition to replacing freshly cooked meals prepared with fresh or minimally processed food known as healthy.

Forde et al. (2020) [3], based on clinical studies from different countries, have shown that people exposed to higher consumption of ultra-processed food products ate their meals 50% faster than those exposed to non-ultra-processed foods, suggesting that this represents a relevant mechanism to explain differences in energy consumption. Additionally, a clinical trial brought to light that the *ad libitum* consumption of a diet based on ultra-processed food products generates a higher energy intake than a diet based on fresh or minimally processed foods. That occurs due to the characteristics of ultra-processed food products, such as higher energy density and satiety issues [4].

Large portion sizes, a common feature of various ultra-processed food products, have also been associated with weight gain [5, 6].

In addition to this issue, hyperpalatability is also noteworthy. Described in detail in the book "Salt, Sugar, Fat" by Michael Moss, the search for the so-called "ecstasy point" is crucial in the ultra-processed manufacturing process. The idea is to reach a specific balance of flavors that is extremely pleasing to the consumer's taste, triggering a deliberately exaggerated intake. Furthermore, there is scientific evidence indicating the addictive potential of these products, playing a role in neuronal mechanisms [7].

Epidemiological studies have also shown that the consumption of ultra-processed food products is systematically associated with the deterioration of food nutritional quality [8-12, 13]. Experimental research demonstrated that they induce high glycemic responses and have low satiety potential [14]. In addition, there is evidence that increased consumption of ultra-processed foods is linked to increased inflammation, mainly through augmented body fat[15].

Additives presented in ultra-processed food products, particularly thickeners, dyes, and artificial sweeteners, have also been associated with metabolic changes in experimental studies with animal models [16-19]. A growing body of evidence indicates that a significant part of this mechanism may be linked to disturbances in the homeostasis of the intestinal microbiota caused by the consumption of ultra-processed food products [20,21]. In other words, ultra-processed food products modify the characteristics of the microbial community dwelling in the human intestine and are responsible for a series of processes that impact health. When there is an imbalance in the microbiota, the consequences can be different, ranging from digestive problems to the production of so-called super antibiotic-resistant bacteria. Regarding this relationship between ultra-processed food products and intestinal microbiota, there is still no detail on the causal pathway of association in humans.

Additionally, chemical compounds formed during manufacturing processes or released from the packaging of ultra-processed food products can also explain the association between their consumption and the occurrence of diseases. Acrylamide, acrolein, and nitrosamine, contaminants present in heat-treated processed products, have been associated with a higher risk of developing cardiovascular diseases [22, 23], neoplasia [24], and insulin resistance [25,26] in population studies. Bisphenol A, an industrial chemical used in some plastic packaging for ultra-processed products, plays a negative role in cellular pathways related to weight and glucose homeostasis. Its intake has been associated with an increased risk of developing obesity [27] and several other chronic diseases [28]. Recent studies carried out data from the US population evaluated at NHANES demonstrated that the consumption of ultra-processed food products was linked to a higher urinary concentration of bisphenols, phthalates, and organophosphates, which are endocrine disruptors used in industrial plastic packaging [29,30].

3. SCIENTIFIC EVIDENCE: IMPACT OF ULTRA-PROCESSED FOOD PRODUCTS ON THE ENVIRONMENT

Saving natural resources is essential to ensure future food security. The most recent national food guides bring an environmental perspective to light, explaining that avoiding the consumption of ultra-processed foods reduces unnecessary carbon emissions and improves the nutritional quality of diet [1,2]. Recognizing the importance of food choices for personal health, well-being, as well as the environment indicates that civilization progress should be strengthened.

The food production chain is responsible for 80% of the land-use conversion and biodiversity loss, 80% of the consumption of water resources and groundwater contamination, and 20-30% of greenhouse gas emissions [3]. Such impacts have been associated with current patterns of food consumption, which underwent a transition in which the traditional patterns, based mostly on fresh and minimally processed plant food, have lost ground to another standard with eminent consumption of ultra-processed and animal-based products.

This section of the document proposes to discuss the environmental impacts linked to the production, sale, and consumption of ultra-processed food products based on three main aspects: land use and biodiversity loss, packaging and solid waste, and greenhouse gases emissions.

Land use and biodiversity loss

The food production chain has been identified as the main agent triggering biodiversity loss. The economy of scale led to monotonous rural landscapes mainly due to the conversion of natural ecosystems into monocultures and pastures in the last 50 years, which resulted in habitat loss and, consequently, biodiversity loss [4].

The Amazon savannization process is a result from this shift, leading to a worrying loss of moisture and biodiversity. The effect is devastating, considering that the region scaffolds the climate system in South America and irrigates the continent's agriculture [5,6].

Other tropical biomes worldwide continue to be affected by this pattern, such as the Brazilian northeastern *Cerrado* explored for soy production and Indonesian forests losing space for palm oil production, an ingredient used on a large scale to produce ultra-processed food products. Territories destined to produce diversified foods, including those maintaining agrobiodiversity, are being destroyed. Currently, large areas are used to produce commodities.

This change in territorial dynamics caused by the consumption of ultra-processed food products [6,7] undermines the number of edible species. While traditional food patterns demand a great diversity of foods, which tend to vary with the territory and throughout the seasons, the ultra-processed food patterns demand a reduced number of high-yielding plant species (e.g., soy, corn, wheat, and sugar cane). These species are processed to provide raw material to produce ultra-processed food products [1,8].

The logic implies intensive agricultural systems based on monocultures [4], requiring large tracts of land and prompting biodiversity loss. Moreover, the intensive mechanization use, excessive consumption of water, fossil fuels, chemical fertilizers, GMO seeds, pesticides, and antibiotics together with the need for long-distance transport comes along with this agricultural shift [1]. Agricultural intensification as a strategy to increase eco-efficiency fails since it increases resource use and negatively impacts the land's regenerative capacity.

Packaging and waste

The environmental consequences regarding the use of packaging to conserve and store ultra-processed food and drink products, especially plastic packaging for sugary drinks, must be examined in detail[9]. Since negative impacts on human health are caused by chemical compounds released from the packaging of ultra-processed food and drink products, such as bisphenol A due to its carcinogenic and endocrine-disrupting properties [10], the waste produced by the industry must be regulated and controlled.

The largest plastic waste generators worldwide are large transnationals within the food and drink sector, such as Coca-Cola, Danone, Mars Incorporated, Mondelez International, Nestlé, PepsiCo, Perfetti Van Melle, and Unilever. Coca-Cola is responsible for producing around three million metric tons of plastics per year, standing out as the major plastic waste generator compared to any other company in the world [11].

Considering that merely 9% of plastic waste produced up to 2015 was recycled or reused worldwide, packaging waste in natural environments is remarkably distressing and linked to cumulative chemical pollution in nature, negatively affecting marine life and contaminating the food chain [12].

Greenhouse Gas Emissions

Although less frequent, studies on the environmental footprint of ultra-processed food products consumption have found noteworthy results in different contexts. In the Australian diet, for instance, the participation of discretionary food – a category with characteristics comparable to ultra-processed products – is responsible for 29.4% of the total carbon footprint,

while raw red meat represents 17% of the total due to its admitted unsustainable process from an environmental point of view [6].

A second Australian study pointed out that discretionary food generates more than a third of a diet's environmental impacts, whether in water, energy and land use, or carbon emissions [13]. In France, the share of products that could be classified as ultra-processed (food with high fat/sugar/salt content, mixed dishes, cold cuts, and alcoholic beverages) resulted in 29.4% and 34.4% of the carbon footprint in the diet of women and men, respectively, while meat from ruminants contributed to 13.6% and 15.0%, respectively [14].

In the United Kingdom, consumption of soft drinks, sweets, sugar, oil, and fat corresponded to 18.8% of the carbon footprint [15]. A comparative study carried out within the British reality evaluated the environmental impacts (global warming, human toxicity, eutrophication, photochemical pollution, and ozone layer depletion) and the costs related to the life cycle of ready-to-eat meals and similar homemade meals. In this case, the industrial meals were more expensive for the consumer and augmented the environmental impacts, especially due to the increase in manufacturing stages, refrigerated storage, and the waste generated in its life cycle [16, 17].

In Brazil, 12.2% of the diet's carbon footprint results from ultra-processed food products and 55.5% from red meat [18]. Analyzes on the temporal consumption trend of ultra-processed animal products among a representative sample of the Brazilian population over 30 years (from 1987-2017) shed light on an increase of 340% in the participation of these products in the diet. During these three decades, with the increased consumption of ultra-processed animal products among Brazilians, there was an increase in their environmental impact, i.e., the carbon footprint (gCO2-eq/1000 kcal) increased 319%; the water footprint (liters/1000 kcal) increased 323%, and the ecological footprint (m2/1000 kcal) raised 305%[19].

4. NEEDED SOLUTIONS: FOOD-BASED DIETARY GUIDELINES

Food-based dietary guidelines are official documents that provide recommendations and guidelines on healthy eating to enhance food consumption patterns and promote the health of individuals and populations. They serve as a tool for educational actions of food and nutrition and should encourage the development of public policies on food and nutrition security in an intersectoral approach (1). Food guides must scaffold the scientific evidence on the relationship between diet and health and, therefore, should be revised periodically.

Currently, discussions at the international level highlight the need for updates on dietary guidelines to consider the food system's impacts on health and the environment, thus promoting healthy and sustainable diets. In this regard, these documents have triple potential to reorient systems by providing dietary recommendations aimed at controlling obesity, overcoming malnutrition, and ideally, promoting environmental sustainability (2). The Food and Agriculture Organization of the United Nations (FAO) (3,4) and other technical and scientific publications (5,6) recognize and reiterate the potential of guides.

Dietary guidelines based on the level and purpose of food processing respond to this current health demand as they are built according to the following dimensions:

- Promotion of healthy eating patterns as the dietary approach is more suitable for understanding the relationship between diet and health than tracking isolated foods or nutrients. Prioritizing the consumption of fresh or minimally processed foods as a basis for healthy eating demonstrates the applicability of classifying food according to their processing level in different contexts, thus valuing the breadth of different dietary patterns worldwide;
- Environmental, economic, and social sustainability by considering the scientific evidence of negative impacts of ultra-processed food consumption on health and the environment and stimulating short production and trading, thus favoring small producers and income generation (3);
- Protection of food culture by valuing the local food standards and nationally produced food, which has cultural, family, and social value and protects health (7);
- Facilitated implementation since the recommendation to reduce the consumption of ultra-processed food products is straightforward, simple, and plays a central role in promoting healthy eating. The centrality of this recommendation can ease the dissemination of dietary guidelines through campaigns helping the population to identify those products that should be avoided;

- Cohesive induction of public policies in different government sectors, involving the entire supply chain. The following public policies already implemented in Brazil are examples: a normative prohibiting the use of federal resources to purchase and offer ultra-processed foods (8), and a regulation restricting the acquisition of ultra-processed foods for the preparation of school meals and menus as part of PNAE (9).

Although knowing the role of nutrients is pivotal to understand the health-disease relationship, this aspect is insufficient to explain the relationship between humans and food and to guarantee the health and well-being of populations (4). Nutrient-based dietary guidelines have been widely disseminated and oriented by the "food pyramid" paradigm. This approach obliviates the level of processing and changes in the nutritional composition of a particular food, fitting non-comparable foods (e.g., home-baked potatoes and ready-to-fry frozen potatoes) in the same box. Furthermore, this type of division disregards cultural dimensions of food and the fundamental relationship between populational diet and the food systems development model(10).

Even though most dietary guidelines globally are still based on nutrients and food groups, a growing number of countries are adopting the processing level of foods when developing updated versions of the recommendations. The pioneering country in this regard was Brazil, considering the 2nd edition of its dietary guidelines published in 2014, followed by the second edition of the Dietary guidelines for Brazilian children under two years of age (11).

The Brazilian Guide's Golden rule is "always prefer fresh or minimally processed food and cooking preparations to ultra-processed foods" (12). Following Brazil, other countries also included recommendations based on processing degree in their most recent guides, such as Uruguay (13), Peru (14), France (15), Canada (16), Israel (17), and Ecuador (18). Given the challenges in redirecting the dietary recommendations to this paradigm shift, an international network of food guides, based on the degree of food processing, was created in 2018 to support countries to develop and implement food guides based on food processing (19).

The challenge of coming up with healthier and more sustainable food systems requires structural interventions, including the construction of food guides, steering actions of food and nutrition education, and supporting public policies to promote healthy eating. The inclusion of explicit recommendations to avoid the consumption of ultra-processed food products enhances these effects since these food items trigger direct health damage, environmental impacts, and sociocultural damage.

5. NEEDED SOLUTIONS: FOOD LABELING

Food labels are the consumer's first contact with the product and are the tool responsible for transmitting the food's attributes to a potential buyer, thus influencing the decision process (1-3). Even though it provides relevant information, the nutritional content found on food labels is seldom used by consumers (4-7). Studies have pointed out that consumers take less than 10 seconds on average to select each item at the time of purchase, which is an insufficient time to evaluate the information on the back of the package (4,5,7). Furthermore, nutrition information requires consumer knowledge to be correctly interpreted and, therefore, is underutilized or ignored at the time of purchase (4-7).

Considering the need for consistency between the information available on food labels and healthy eating recommendations, based on the degree and purpose of industrial food processing, several evidence-based approaches can be adopted, including:

- Regulations of marketing on ultra-processed food products labels: restriction on the use of characters, celebrities, public figures, sporting events, athletes, and awards (e.g., promotions, gifts, games, collectibles, and social charity). Children and adolescents are especially persuaded by sales strategies, having their choices influenced by "fun" elements on the label, such as characters and/or prizes (8-14);
- Regulation of nutrition and health claims on ultra-processed food products labels. Claims, such as "rich in fiber" and "fit", among others, highlight the product's positive attributes but ignore its negative traits, often inducing the consumer to believe that ultra-processed food products are healthy or nutritious, thus stimulating excessive consumption (2,15-19);
- Prohibition and enforcement of existing laws regarding misleading marketing practices. Choice-influencing label components of ultra-processed food products, such as "illustrative" images of food items absent on the product's ingredient list, should be regulated. These elements could lead the consumer to erroneous conclusions on the product's nature, characterizing misleading advertising;
- Stressed prominence and visibility for the ingredients list can assist the consumer in identifying whether a product is ultra-processed or not. The location, size, and color of information presented on labels are the chief factors that draw consumers attention and influence their decision making (20). Another strategy is to standardize the nomenclature of food additives and similar ingredients. For instance, the European Union keep track of all listed additives by a numerical reference (E-

numbers), which can be used to define how natural a food is and with a more effective identification than chemical names (21);

- Improvement of the rules for declaring the ingredients aggregated in the ingredients list of packaged products. The presence of aggregated items (e.g., margarine, cheese, and chocolate) is found in ingredient lists of ultra-processed food products, undermining the consumer's understanding of the actual composition of the product;
- Adoption of clear and straightforward front-of-package nutrition warning labeling, an informative symbol placed on the front of the packaging of food products to inform consumers about the high content of nutrients associated with health issues (22). Studies pointed out that this type of frontal nutrition labeling provides faster and simpler identification about which products are less healthy, directly interfering with consumer's purchase intention (7, 23-26). Front-of package warning labels can also encourage manufacturers to improve the nutritional quality of their products in order to meet the nutritional criteria needed to avoid the use of warning signs (27-29). Unlike front-of-package nutrition labeling in scale format (ranging from "healthy" to "unhealthy"), warning labels are only placed on products with higher nutritional risk to health, an approach more easily identified and interpreted by the consumer (30). Although a variety of front-of-package nutrition label designs are currently in use worldwide, the warning format is considered the most effective in discouraging the purchase of ultra-processed food products (31).
- Adoption of the Nutrition Profile Model established by the Pan American Health Organization for front-of-package warning labeling. The document defines the recommended nutritional profile to develop fiscal policies and regulations, such as nutrition labeling. The criteria used to propose the cutoff points for the warnings (for free sugar, saturated, trans and total fat, sodium and, sweeteners) were based on scientific evidence, respecting recommendations of the World Health Organization (WHO) and the NOVA classification to identify the food products that are eligible, or not, to have a warning (22);
- Inclusion of information on the presence of cosmetic additives as part of the front-of-package labeling to help to identify ultra-processed food products. In this sense, highlighting the number of ingredients and additives that make up the product should also be considered.

In Chile, a pioneering country in Latin America to implement the front-of-package nutrition warning labeling system (32), evidence points to changes in consumer purchase patterns and the products' nutritional profile (27,30). The Chilean front-of-package warning label and other regulations implemented in the country were associated with a decline in the purchase of sugary drinks by approximately 24% one year after the implementation of the law (30). Other countries, such as Mexico, Peru, and Uruguay (33, 34) have also included front-

of-package warning labeling as part of mandatory food and drink label information. In these countries, combining warning front-of-package nutrition labeling with other complementary public policies related to ultra-processed food products, such as restriction on marketing, regulation of sales in schools, and taxation policies, have the potential to increase the impact of this measure (22).

In Brazil, the National Health Surveillance Agency (Anvisa), published RDC No. 429 in October 2020, which includes mandatory front-of-package nutrition labeling (35). Even though scientific evidence suggests front-of-package warning labels in triangular format (36), the design approved in Brazil was the magnifying glass format, with a reduced area on the food packages. Moreover, neither cutoff points recommended by PAHO were considered nor the prohibitions on the use of nutrition and health claims in products containing high content of critical nutrients.

Considering the importance and influence of food labeling throughout the process of choosing healthier foods, the adoption of rules facilitating the consumer's understanding of food composition, thus helping them to identify and classify foods according to the NOVA standards, is necessary to ensure consistency with the recommendations of Brazilian food guides.

6. NEEDED SOLUTIONS: REGULATION OF FOOD ENVIRONMENTS

Food environments are the physical spaces where food is purchased. It is common to overlook several factors influencing food choices in these environments and, consequently, the diet content. Among these factors is physical and economic access to food, the presence of advertising and information on products, in addition to food quality and safety (1, 2).

Three main concepts emerge from the analysis of food environments. Currently, science addresses food deserts, which are spaces where the access to fresh or minimally processed foods is limited, and food swamps – where there is a large offer of fast food and establishments predominantly selling ultra-processed food products together with the lack of healthy foods (3).

Assessing these two concepts sheds light to a third idea: food apartheid. The term reflects the disparity in dietary patterns, taking into account race, geography, religion, economics, and gender issues (4,5). In this sense, socioeconomically vulnerable environments tend to promote unhealthy food more intensely and hinder access to healthy options (6).

When analyzing food deserts and swamps, the role of socioeconomic disparities in the organization and structuring of food environments are highlighted. Hence, socioeconomically vulnerable environments tend to promote more unhealthy foods or hinder access to healthier foods due to multiple factors (6).

Studies performed in the United States pointed out that socioeconomically favorable areas with mostly white inhabitants have easier access to establishments with greater availability, variety, quality, and lower food price, especially fruits and vegetables (7;8). On the other hand, areas with low socioeconomic levels and high prevalence of black and Latino residents are places where numerous establishments offer an inferior variety of products, inferior quality, and higher prices, such as convenience stores and neighborhood markets (7;8;9). The Brazilian scenario is similar (10-14).

The relationship of the food environment with health issues has also been investigated. The greater availability of health food establishments and supermarkets nearby individuals' homes was inversely associated with BMI and obesity (15-17). In contrast, the greater availability of fast-food restaurants and convenience stores close to residences was associated with increased BMI levels and body fat percentage (17,18).

In Latin America, a systematic review of environmental studies focusing on environments relevant to obesity and related chronic diseases stressed that studies conducted in Brazil and Mexico found positive associations between

healthy eating environments and improved diet quality. The research demonstrates that physical access to healthy foods can positively impact individuals' diet (19).

In addition to the physical component, the review also considered other factors such as marketing strategies and prices in food environments. In general, studies have shown that processed food prices are more affordable than fresh food (19). Regarding the promotional aspects, health claims and marketing strategies to promote unhealthy options were registered, especially targeting children (19).

Supermarket roles are noteworthy when concerning the offer of ultra-processed products in food environments since they stand out as the main places to purchase food in several countries and the participation of ultra-processed food products in supermarket purchases is 25% greater than purchases made in other stores. The combination of convenience and promotions (20,21) with the advertisement in printed leaflets (22,23) can be highlighted as feasible justifications. Interestingly, ultra-processed food products are also the majority in "health and well-being" sections, thus misleading consumers (24).

Furthermore, digital food environments have gained increasing relevance. In the virtual space, the marketing of ultra-processed food products gains other facets, such as partnerships with digital influencers. In partnerships with manufacturers of ultra-processed food products, digital influencers may end up promoting the consumption of unhealthy food (25). In addition, delivery services, which became increasingly popular due to covid-19, represent another strategy to encourage the purchase of these products. A study carried out in a large Brazilian city found that 80% of establishments registered in delivery applications sell ultra-processed drinks, 39% ultra-processed snacks, and 43% ice-cream, sweets, and packaged snacks (26).

Strategies to achieving healthy eating environments

Considering the need for consistency between the regulatory measures of food environments recommended by the World Health Organization (WHO) (27), the Pan American Health Organization (PAHO) (28), and healthy eating recommendations based on the level and purpose of industrial processing of food, the following solutions stand out:

- Restriction of marketing of ultra-processed food products, especially for children, based on the guidelines of Resolution 163/2014 of the National Child and Adolescent Rights Council (Conanda, in Portuguese) (29). Children and adolescents are going through their first years of life and, therefore, still developing. Advertising interferes negatively with this audience, encouraging excessive consumption of unhealthy options. Marketing aimed at children is considered abusive, thus illegal under the Consumers' Defense Code (30);

- Supply restriction of ultra-processed products in the school environment, including regulations for school canteens and the rules established in Ordinance No. 6 of 2020 (31) to food purchase and elaboration of menus according to the National School Feeding Program (PNAE). Several Brazilian states and cities have regulations on the food supply in school canteens;
- Restriction of ultra-processed food supply in other organizational environments, such as public and private companies;
- Increased taxation for ultra-processed food products, such as sweetened beverages. The measure is supported by scientific evidence discouraging the consumption of these products, encouraging the consumption of healthier and cheaper options, such as water. WHO recommends at least a 20% increase in the final price of sweetened beverages to promote the needed changes in public health (32). Adoption of public policies encouraging fresh or minimally processed foods and their culinary preparations, as well as promoting their sales in various places, such as supermarkets, open markets, restaurants, and institutional environments (33).
- Decrease in price and design of marketing strategies that promote fresh or minimally processed foods, and their placement in strategic locations at sales point to encourage sales and consumption.
- Regarding digital food environments, the adoption of guidelines, protocols, codes of conduct, and regulatory actions is essential to monitor and intervene in the activities performed by digital influencers (25). Moreover, the promotion of fresh or minimally processed foods and their culinary preparations in delivery applications are recommended together with increased prices for ultra-processed food products (26).

Aiming to improve the profile of food environments, scientists created an instrument to assess the healthiness of establishments. In line with NOVA classification, the tool enables the evaluation of sales spaces taking into account the food availability, prices, advertising strategies, and shelf placement. Thus, it enables the classification of businesses as healthy or unhealthy (34).

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7. MYTHS ABOUT ULTRA-PROCESSED FOOD PRODUCTS

"Policies aimed to reduce the consumption of ultra-processed food products will harm employment."

On the contrary, the impact of these policies is positive on health and the economy. That was confirmed by examples such as Chile, which created a set of actions – restrictions on UPF marketing and sale and changes in the front-of packaging labeling – and maintained the jobs and average salaries in the sector of food and drinks. [1] This pattern was also observed in Mexico in 2014[2]. The taxes on sugary beverages in Philadelphia (USA) did not impact industrial jobs either. [3]

"Ultra-processed food products can simply be reformulated to become healthier.

Merely replacing ingredients or adding "healthy" compounds to improve or mask a poor nutritional profile does not exempt ultra-processed food products' impact on health. Regardless of the ingredients, intensive processing remains (e.g., extrusion or immersion frying), which also play a detrimental role in human health. Furthermore, several other issues, such as high palatability leading to dependence on these products, harmful contaminants, and the reduction of minimally processed foods in the diet. [4]

"The food industry offers the consumers only what they want."

The industry aggressively cultivates consumer demand for ultra-processed food products. Such demands are generated through advertising campaigns, promotions, and building relationships with consumers from childhood. [5] Moreover, transnational food and beverage corporations have leveraged their enormous market power to change all food systems to their advantage: they control the price, availability, nutritional quality, and convenience of their products. The outcome seen worldwide is the rapid consumption growth of ultra-processed food products and diseases related to their consumption. [6, 7]

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FINAL CONSIDERATIONS

Faced with the scientific evidence-based negative impacts of ultra-processed food products on human and planetary health, nations and multilateral stakeholders must take the lead to impede the growth of both production and consumption of these food products. We hope that the evidence presented in this document will contribute to overcoming policy inertia, thus bridging regulatory and public policy gaps to transform the current food systems. It is unbearable to continue believing that ultra-processed food industries will regulate themselves and inflect with the intensity and urgency needed to cope with the obesity epidemic and environmental devastation.

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