Factsheet
Food processing

Cosun
Nutrition Center

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Nutritional guidelines form the foundation of dietary policy. Dietary patterns are increasingly gaining attention in these guidelines for a healthy nutrition. The consumption of ultra-processed foods (UPF) is one of the dietary patterns that has been gaining attention in recent years in relation to health risks, from both nutritional scientists and the media. The mechanisms of action are primarily thought to relate to the combination of eating speed and the energy density of UPF, which increases the risk of weight gain. Sugar-sweetened beverages, refined grains, and processed meats - well-known risk factors for chronic diseases - are components of UPF and contribute to the overall health effects of this group. Several countries have incorporated recommendations to limit UPF consumption in their official dietary guidelines. However, various nutrition experts have raised (scientific) questions about these recommendations.

The current state of scientific knowledge on UPF (in relation to the development of chronic diseases) is discussed in this factsheet.

According to Richard Wrangham[1], Professor of Biological Anthropology, the ancestors of Homo sapiens learned around a million years ago to control fire, letting them prepare better tasting and more easily digestible foods. The majority of food processing methods developed after the introduction of farming around 11,000 years ago. Beer (7,000 BC), cheese (5,000 BC), chocolate (1900 BC), mustard (400 AD), tofu (965 AD), high-fructose corn syrup (1957) and cultured meat (2013) are a few of the countless innovations that new foods have added to the human diet. Drying, fermenting, salting and smoking are among the methods used. Food processing is useful and often necessary because it benefits edibility, digestibility, perishability, microbiological and other safety characteristics, composition (nutritional value), palatability, sustainability and convenience[2,3]. Prior to World War I, food processing consisted of such simple actions as cleaning, sorting, cutting, chopping, pureeing, grinding and heating, followed by canning, preserving, freezing and packaging. In the 1930s, the food industry began to extract components from food. This approach developed rapidly during World War II and boomed from the 1950s onwards. Additives and micronutrients were added to various types of foods. Using a combination of heating and physical-chemical processing, components of food were isolated and combined in a new product, such as ready-to-eat meals, savoury snacks, beverages and all kinds of sweets. In recent years, the extensive processing of foods has been subject to criticism and introduced the concept of 'ultra-processed foods'. UPF are considered problematic in terms of nutrition due to their low levels of fresh ingredients, dietary fibre and micronutrients and may contain harmful ingredients such as additives. There is a great deal of debate among nutrition experts concerning the effect of UPF on our health, such as by Mike Gibney in 2019 and judging by the debate between Carlos Monteiro (advocate of a recommendation) and Arne Astrup (opposed to this) at an important American nutrition conference[4,5].

The summary of this factsheet can be downloaded on this page

Definition

There are a number of different definitions (and therefore classifications) of UPF, which has resulted in different associations with health risks[6], including in one and the same data file[7]. A consistent definition appears to be difficult to achieve. The World Health Organization is currently developing a more objective and operational definition of UPF. The UK's Scientific Advisory Committee on Nutrition (SACN) examined seven classification systems[3]. Only the so-called NOVA classification met all five pre-established criteria, including a workable definition and use in research into health effects. NOVA, developed by Brazilian Carlos Augusto Monteiro, is the most commonly used classification system based on the degree of food processing. It differentiates between four categories of foods (see **Table 1**).

Monteiro (in[4]) uses the following definition of ultra-processed foods: "Industrial formulations made mostly or entirely with substances extracted from foods, often chemically modified, and from additives, with little if any whole food added. Sequences of processes are and must be used to obtain, alter, and combine the ingredients and to formulate the final products (hence 'ultra-processed')." According to Gibney *et al.*[8], this definition makes several interpretations possible. Gibney[9] has shown that the NOVA classification has changed seven times in ten years. The emphasis was initially on the number of ingredients and processing method, but the goal of the processing, such as to improve taste, is now also a central element of the classification. The definitions have also been expanded with more elements. In a recent study, over 300 experts classified more than 200 foods and the results showed considerable inconsistency between the individuals involved in the classification of the foods in one of the four categories in the NOVA classification system[10]. Only with four of the more than 200 foods, there was complete agreement on the allocation in one of the four NOVA categories. Apparently, it is difficult for scientists to uniformly interpret the classification system for UPF and according to Gibney[7] and Forde[6], every grouping is somewhat subjective. Moreover, Hässig *et al.*[11] found a strong similarity between non-experts' estimates of processing levels and the NOVA classification system in Switzerland.

Table 1. NOVA-classification[4]

Group 1	Unprocessed or minimally processed foods, such as vegetables, fruits, meat and fish. Additives are absent in this group. Minimal processing methods include the boiling, freezing, peeling and crushing of fruit.
Group 2	Culinary ingredients from group 1 or from nature, such as salt, olive oil and sugar. Used to prepare and/or season group 1 foods.
Group 3	Processed foods designed for a longer shelf life and improved taste, such as canned vegetables, bread prepared by a local bakery, beer and wine.
Group 4	Ultra-processed foods: industrial formulations that usually contain more than five ingredients, such as ready-to-eat meals, supermarket bread, follow-on milk, chocolate, chips, cookies, regular and diet soft drinks, meat substitutes and pizza. An additive is an ingredient.

Health effects

The consumption of UPF is suggested to be associated with negative effects on public health, particularly obesity and chronic diseases[12,13]. The number of studies examining the relationship between UPF and health has increased significantly in recent years, and several meta-analyses have been conducted[14,15,16,17]. Observational (epidemiological) research shows a positive link between the degree of UPF consumption and an increased risk of chronic lifestyle diseases[18]. In the various overview articles of cohort studies published, associations were identified between the consumption of UPF and higher blood pressure[19], more dental caries in children and adolescents[20], a higher risk of irritable bowel syndrome[18,21], cardiovascular diseases[18,21], overweight and obesity[18,21,22], type 2 diabetes[23,24], gestational diabetes and preeclampsia[25], cancer[18,21,26], depression[21,27,28] and total mortality[12,18,29]. Various pathological processes underly the aforementioned diseases and conditions, making it challenging to find a (common) mechanism of action for all of these processes[30].

The extent to which these links can be attributed entirely to food processing or are caused in full or in part by the underlying suboptimal nutrient composition and the high energy density of many UPF is still unclear. Most observational studies on the association between UPF consumption and chronic diseases have not adjusted for the energy density of the consumed food[31]. Additionally, other factors, such as education, smoking habits, alcohol consumption, and physical activity, may differ between people who consume high and low amounts of UPF. From an epidemiological perspective, in spite of a variety of statistical techniques, these factors are difficult to isolate, resulting in residual confounding. For example, UPF contains more energy, saturated fat, sugars and salt than less processed food[32]. Salt, sugar and fat are ingredients in UPF and are usually included in larger quantities than in less processed food[4]. Research in 13 countries (with middle and high incomes) shows that the consumption of minimally processed foods, such as fruits, vegetables, and legumes, was lower with a high consumption of UPF, which was associated with a lower intake of dietary fibre, protein, and various micronutrients, including potassium. It also shows that a high consumption of UPF is associated with a higher intake of energy, free sugars, and saturated fat[33]. Despite this association, UPF is not equivalent to products with relatively high levels of salt, saturated fat, and sugar, as Popkin *et al.*[34] have shown for products in the US.

Research in seven European countries, including the Netherlands, by Cordova *et al.*[14] shows that it is unwise to treat UPF as a single group, as the effects of different food groups vary. A high consumption of the total group of UPF was associated with an increased risk (with a relative risk of 1.09) of multimorbidity involving cancer and cardiometabolic diseases (including type 2 diabetes). Seven groups of UPF, including plant-based alternatives to meat and dairy, showed no significant association with multimorbidity. However, a high consumption of UPF products of animal origin and artificially sweetened and sugar-sweetened beverages was associated with a higher risk (both with a relative risk of 1.09) of multimorbidity. In three US cohorts, a link between the consumption of UPF, sugar-sweetened and/or artificially sweetened beverages, and processed meat with cardiovascular diseases was found. This was not the case for the other groups of UPF[16]. Similar results were found in another American cohort[35]. Within the UPF group, it is primarily the well-known risk factors for chronic diseases, namely processed meat and sugar-sweetened beverages, that contribute to higher health risks.

A Dutch cohort study showed that the risk of developing type 2 diabetes is not the same for different groups of UPF[69]. A dietary pattern with a relatively large number of

hot savoury snacks and a pattern with a relatively large number of cold savoury snacks was associated with an increased risk of developing type 2 diabetes. A traditional Dutch diet was not associated and a pattern with a relatively large number of sweet snacks and baked goods was inversely associated with the development of type 2 diabetes[69].

Epidemiological nutritional research typically yields small (<1.20) relative risks. Studies examining the association between the consumption of UPF and (chronic) diseases are no exception. When interpreting these risks, it is important to consider the absolute risk of developing the disease in question. For instance, Dai *et al.*[15] found a relative risk of 1.15 for the development of colorectal cancer in relation to UPF consumption. In this case, high UPF consumption would increase the risk by 15%. The absolute risk of developing colorectal cancer was estimated in this study to be 1.5%. Based on this research, the estimated absolute risk from high UPF consumption would rise to 1.7% instead of 1.5%. Low absolute risks are particularly common for diseases that are generally less prevalent in the population.

All indications (from overview articles containing a number of meta analyses) for the above links between UPF consumption and health risks originate from epidemiological (cohort) research and have a reputation, as mentioned above, for not providing evidence of cause and effect[5,36]. With UPF, its heterogeneity also makes it difficult to isolate any effect of UPF. The consumption of UPF is related to numerous other factors, including the existing guidelines for a healthy diet, as well as socioeconomic status. These are disruptive factors that must be corrected statistically. That is not always sufficiently possible because the disruptive factor has not been (adequately) measured. This correction was carried out in different ways in the various studies. In addition, the questionnaires used (usually food frequency questionnaires) in cohort studies are not designed to classify products according to their processing degree, which means that unvalidated assumptions are needed[3,36,37]. The results from the various studies are therefore uncertain.

In the ideal situation, the dietary guidelines are based on epidemiological research, controlled clinical studies and mechanism data. Epidemiological studies provide hypotheses that be confirmed by clinical studies. A proven mechanism of action makes an identified effect in a clinical study biologically plausible.

Controlled clinical trial

Several clinical studies are currently in progress. So far, only one intervention study has been completed, conducted by the American researcher Kevin Hall[33]. In this study, randomly assigned participants followed either an ultra-processed diet or an unprocessed diet for two weeks, immediately followed by the other diet for another two weeks. The meals were comparable in terms of calories, energy density, macronutrients, sugar, sodium and dietary fibre. Participants were allowed to consume whatever they wanted. The energy intake was greater during the ultra-processed diet (508 ± 106 kcal/d) due to a higher intake of carbohydrates (280 ± 54 kcal/d) and fat (230 ± 53 kcal/d), but there was no difference in protein intake (−2 ± 12 kcal/d). Changes in body weight were strongly correlated with energy intake (r = 0.8) among participants who gained 0.9 ± 0.3 kg during the ultra-processed diet and lost 0.9 ± 0.3 kg during the unprocessed diet. As with any study, there are remarks to be made. The energy density of highly processed foods in solid form was nearly twice as high as in unprocessed foods. The energy intake rate of UPF was around 50% higher (48 versus 31 kcal/min). This suggests that the differences between the processing levels in the two diets were due to significant differences in food texture and energy density, and that the increase in energy intake observed with UPF was possibly associated with the softer texture/faster eating rate and higher energy density of UPF[30,39]. Both factors have been known for decades to be very important causes of obesity and associated diseases. Research into the relationship between UPF and weight gain did not provide supporting evidence for the mechanisms of palatability or a change in appetite. According to Astrup[4], the study is too short and distorted by differences in, for example, energy density to determine a causal relationship. Given that this sole clinical study had weight gain as the end point, the remainder of this factsheet focuses primarily on weight gain.

Mechanisms

Little is known with certainty about the numerous mechanisms of action that may be responsible for the link between UPF consumption and weight gain. Valicente *et al.*[40] mapped out the possible mechanisms of a potential link between the consumption of UPF and development of overweight and obesity based on 366 publications. The authors distinguish three types of mechanisms in the relationship between the consumption of UPF and body weight: food choices (low cost and palatability), food composition (added salt, sugar, fat, additives and texture) and digestive processes (eating rate, gastric emptying time and gut microbiota). These mechanisms could explain why the consumption of UPF leads to weight gain. However, the results of the overview article show that the intake of UPF is not sufficient or necessary for weight gain and that the identified effects are modest (i.e. relatively minor).

No differences were found for various mechanisms of weight gain (e.g. high versus low in dietary fibre or texture, gastric emptying, and transit time of food in the intestines). For other explanations, there is either a lack of data (microbiome changes, food additives) or insufficient data (packaging, food costs, shelf life, and appetite stimulation).

The authors of the review article conclude that it is unwise to make recommendations regarding the role of UPF in the diet due to the uncertainty about the causality and likelihood of the underlying mechanisms.

Eating rate, energy density and body weight

According to Gibney and Forde[30], the current data suggests that a high rate of energy intake could be the mechanism linking the consumption of UPF with increased energy intake. Meals with a slower eating rate result in lower food consumption and energy intake compared to meals with a faster eating

rate[41]. Particularly, a faster eating rate of UPF with high energy density could lead to excessive energy intake, potentially causing weight gain[31]. The findings of the study by Teo *et al.*[42] suggest differences in eating rate due to variations in texture. The energy density of meals was found to contribute to observed differences in energy intake between minimally processed and ultra-processed meals. The average energy intake rate is higher with UPF than with less processed foods[39]. UPF consumption is positively associated with the energy density of the diet. Compared to unprocessed foods, UPF have a higher energy density (mean: 1.1 versus 2.2 kcal/g). High energy density appears to be a key factor in excessive energy intake, and thus weight gain[43].

The team of American professor Rolls at Pennsylvania State University studied the effect of energy density on energy intake in adults and children ages 3-5 years. Their research shows consumption of a consistent total weight of food and drinks, even when the energy density of these products was reduced[44,45]. Pure oil and fat, at nine kilocalories per gramme, has the highest energy density. At the other extreme end is water, with zero kilocalories. In other words, a meal rich in fat (such as fried eggs, sausage and bacon) has a relatively high energy density, while a meal with a lot of water (soup) has a relatively low energy density. Body weight (higher) is associated with eating rate (faster), as demonstrated in a cross-sectional study of the Dutch population[46]. Softer foods (due to preparation) are quicker to eat than raw foods. Eating raw foods requires more chewing time. Food consumption, energy intake, and eating rate were lower with hard foods compared to soft foods[47]. The eating rate is higher, and the chewing frequency is lower when consuming UPF, which was associated with a higher energy intake and weight gain compared to the consumption of non-UPF[48]. Little or no chewing of soft or liquid foods increases eating rate. For the same amount of energy, liquid foods have a lower satiety effect than (semi-)solid foods[31]. The eating rate can be influenced by the texture of the food[48]. Research from Wageningen University[49] has shown that beverages provide more energy per unit of time than solid foods: for example, 420 kcal/min for whole chocolate milk and 41 kcal/min for a boiled egg. On average, the energy consumed per minute from cooked vegetables is nearly 65% higher than from raw vegetables. Foods with a low eating rate have a solid texture, high energy density, and low water content. These characteristics do not directly align with the extent of food processing. A higher eating rate is associated with higher energy intake, particularly for products with high energy density and textures that facilitate rapid consumption. In line with this, there is a link with overweight and obesity[31]. Therefore, the generally higher eating rate of UPF could contribute to potential health effects, especially when a relatively high proportion of energy comes from UPF.

Consumption of ultra-processed foods

The consumption of UPF increases with rising prosperity. Globally, both the supply and demand for the number and quantity of UPF consumed have risen, with significant variation between regions. Sales are highest in Australia, North America, Europe, and Latin America, while the fastest growth in sales is observed in Asia, the Middle East, and Africa[50].

There are various estimates of UPF consumption based on the NOVA classification. In Europe, approximately 27% of total daily energy intake comes from UPF, with significant differences between countries. The lowest intake is estimated for Italy (~13% of energy intake), while the highest consumption is calculated for Sweden (~43% of energy intake).

In Western Europe in particular, the average contribution of UPF to energy intake is high compared to countries in Central, Eastern and Southern Europe. From 2012-2016, Dutch adults derived around 37% of their daily energy intake from UPF[51]. Vellinga *et al.*[32] estimate that the percentage for the Dutch population is 61% among 1 to 79-year-olds. Children (ages 1 to 18) derive 75% of their energy from the consumption of UPF and the difference in age composition is an important explanation for the higher estimate by Vellinga *et al.*[32] compared to Mertens *et al.*[51]. SACN[3] estimates for the United Kingdom that 51-68% (for different age groups and with different socioeconomic backgrounds) of energy intake comes from UPF. Marino *et al.*[36] presented comparable results with the highest energy% for the United States (usually above 55% and the highest estimate of 65% among children aged 2-19 years) and the United Kingdom (mostly above 50 en%). Italy, on the other hand, had the lowest (around 10 en%) energy intake via UPF. The results of the various studies show that in general, there are significant differences in UPF consumption.

The limited data on trends in UPF consumption show a mixed picture. Mertens *et al.*[51] observed a decline among adults in six (out of eleven studied) European countries, including the Netherlands, between 2007 and 2014. In contrast, a (slight) increase in energy intake from UPF was found among 2-19-year-old Americans during the period 1999-2018. During this time, the consumption of composite dishes increased, while the consumption of sugar-sweetened beverages decreased[50]. All consumption figures should be interpreted with caution for various reasons. Comparisons between countries are limited by differences in methodology and data collection periods. The age composition of the samples differs, while it is known that the consumption of UPF (expressed in en%) is higher among (young) children than adults[32,36]. The studies are not designed to classify products according to their processing degree. This must take place afterwards using partly incomplete information and assumptions. An unambiguous identification of UPF is difficult, making estimates indecisive.

Table 2. Average contribution in terms of percentage of UPF to energy intake in various European countries

Energy%	< 20	20-30	>30
Number of countries with an UPF contribution to energy intake in terms of percentage			
Women	5	8	9
Men	6	7	9

General dietary recommendations

Guidelines for a healthy diet have shifted from recommendations on the intake of specific nutrients, such as saturated fat and vitamin C, to individual foods, such as tea, and groups of foods, such as vegetables. Foods are usually grouped according to their origin, such as dairy, meat (products) and fruit[9]. What is increasingly emphasised is that the effects of food on health should be examined based on dietary patterns because there are no good or bad foods, only good and bad dietary patterns[9]. The general guideline established by the Health Council of the Netherlands[52]: "Eat a more plant-based and less animal-based diet" is an example of this. UPF is one of the patterns in relation to health risks that has attracted interest in recent years among nutrition scientists.

Due to an increase in overweight and obesity, the Brazilian government has recommended avoiding the consumption of UPF since 2014. Their example was followed by other South American countries (Uruguay, Peru and Ecuador) a few years later. In Belgium, France, Israel, Malaysia and Canada, the population is also advised to limit the consumption of UPF[4]. The dietary guidelines established by the Health Council of the Netherlands do not contain any general recommendations related to UPF, although a number of specific guidelines point in a comparable direction: replace refined grain products with whole grain products, limit the consumption of processed meat and drink as few sugar-containing drinks as possible.

The Health Council of the Netherlands is currently reassessing the dietary guidelines and will also be devoting attention to UPF. The Health Council of the Netherlands writes: "The 2015 dietary guidelines do not contain a specific guideline on processed foods in general. A future update of the dietary guidelines may include determining whether further evaluation is warranted based on the latest scientific knowledge on this topic." The upcoming American dietary guidelines (2025-2030) also focus on UPF in relation to body weight. The results of the review are now available. A correlation has been found between the consumption of UPF and various measures of adiposity in children, adolescents, adults, and older adults, with the evidence being classified as limited[53]. The draft recommendations based on this do not include a general recommendation about UPF. However, the diet would benefit, according to the advice, from a lower consumption of processed meat, sugar-sweetened foods, and refined grains[54].

Between 1983 and 2022, 25 (dietary) recommendations were implemented in the United States by the governments of the states and the country. One of these, focused on school food in the state of Massachusetts, was related to UPF[55].

The SACN and Nordic Recommendation Committee claim that differentiating UPF does not have any added value for the existing food classifications and recommendations.

According to the British Nutrition Foundation[37], UPF does not need to be included in the nutrition policy (such as in dietary guidelines) due to a lack of a widely supported definition, the need for knowledge about mechanisms of action and concern about its suitability as a tool for identifying healthy foods. According to the British Nutrition Foundation[37], any change to the English dietary guidelines must be carefully considered, especially when there is a significant risk of confusion and unintended consequences, including a potential decoupling from other dietary recommendations. The British Nutrition Foundation[3] urges caution in relation to evidence concerning the health effects of UPF consumption because these effects are already covered by the existing guidelines.

The Finnish Food Authority has deliberately chosen not to formulate a recommendation on UPF in its most recent guidelines[56].

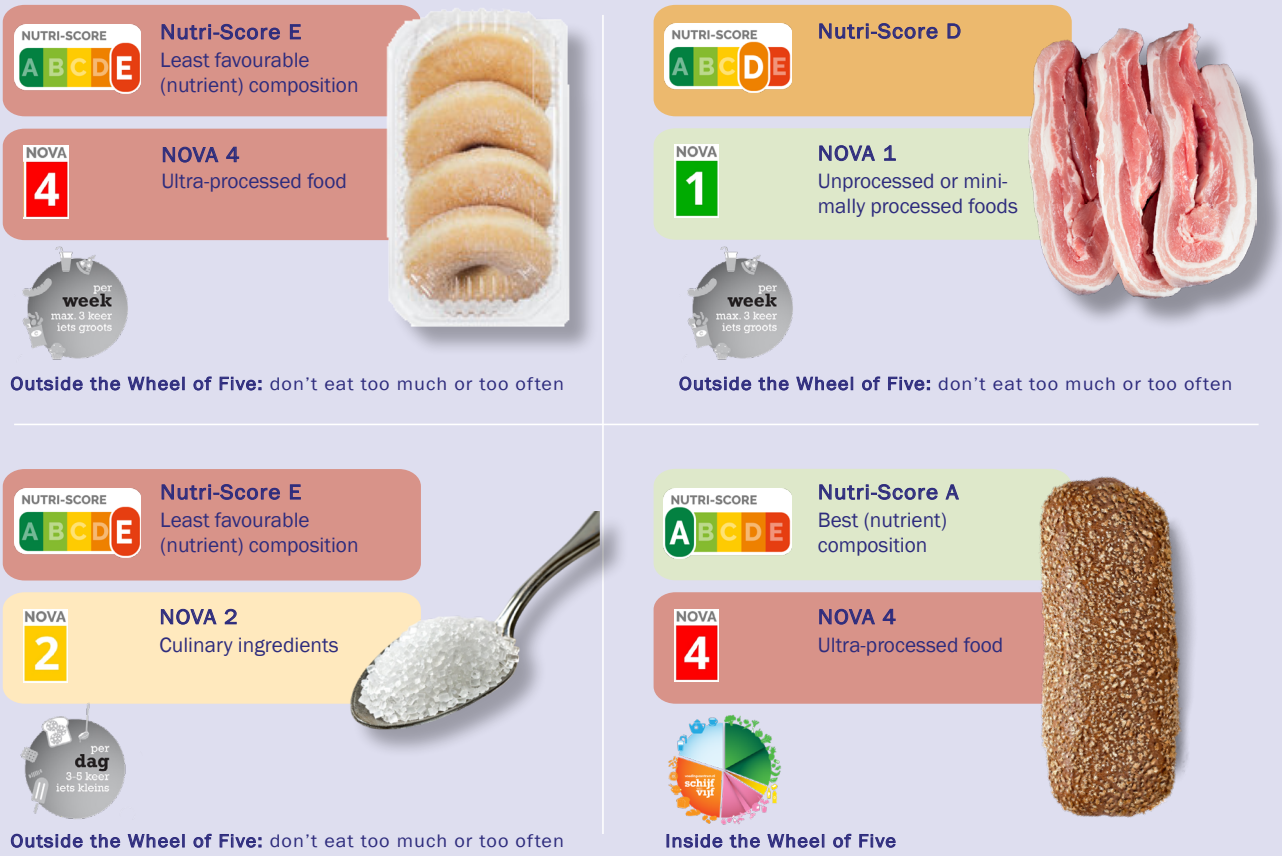

Figure 1. Comparison of the classification based on the degree of processing (NOVA classification), Dutch dietary guidelines (Wheel of Five), and (nutrient) composition per product group (Nutri-Score) for four different food products. This figure shows that assessing the healthiness of products based on their degree of processing often does not align with existing dietary guidelines.

Added value of recommendations on ultra-processed food

To what extent do UPF recommendations have added value for nutrition policy and education? Various nutrition scientists question the usefulness of focusing on the degree of food processing beyond the conventional classification system, which focuses on food quality[5,9]. In terms of the plausibility of the various mechanisms studied, Valicente *et al.*[40] have concluded that none of them have a strong scientific basis. This poses a challenge for policymakers, who need to use the best scientific data to translate complex evidence into simple and clear messages. Various experts indicate that the focus should continue to be on reduced consumption of products for which it has been proven that their consumption among an important percentage of the population has a negative effect on public health and there is a considerable overlap here with UPF[5,6,8,57]. It is still unclear to what extent the processing of food, independent of its composition, is related to diseases. Apart from the degree of processing, overconsumption (too much energy) should be avoided in any event. In recent years, the development and consumption of diet products has escalated significantly and many of these products fall under UPF. Due in part to the relatively high percentage of UPF in the dietary pattern in many countries, numerous unexpected effects can occur with a significant reduction in the consumption of UPF, such as food prices, food security and time constraints[9]. The advice to significantly limit the consumption of UPF may be in conflict with existing recommendations. Daas *et al.*[58] found that total mortality was more strongly explained by adherence to a plant-based diet than by the consumption of UPF, concluding that replacing animal products with healthy, plant-based foods could improve health.

Recommendations to limit the consumption of UPF may have counterproductive effects. Much food policy is focused on improving the product offering through reformulations. These reformulated products could end up being classified as UPF[31]. Most commercially available meat, dairy, egg, and fish substitutes fall under UPF, but according to McClements[59], substitutes can be designed in such a way that they offer a good nutritional composition and beneficial health effects.

Incorporating UPF into laws and regulations requires clear, verifiable, and precise operational definitions[34]. Anastasiou *et al.*[60] concluded that policymakers recommending limits on certain foods must ensure that this is based on definitions that consumers understand and can apply in practice. This includes a scientific basis and a clear explanation of the difference between processed and ultra-processed foods.

Consumers

Foods and ingredients can have effects on health in various ways. Therefore, it is important to have clear and unambiguous dietary advice for consumers[31]. From the definition section of this factsheet, it becomes clear that objectively defining UPF is difficult. Several studies have raised concerns about the NOVA classification because it uses complex, inconsistent, broad, and ambiguous definitions[61]. Translating the results of nutritional research into practical advice is hampered by confusion among consumers, due to alternative viewpoints and sensational reporting on individual studies[62].

Since 2014, the Brazilian population has been advised to limit the consumption of UPF. Around 82% are now familiar with the term UPF. Nevertheless, 78% consider "food made with many industrial processes" a better definition of UPF. Based on this, researchers conclude that the term UPF is still confusing for most Brazilians[61]. Another study showed that three-quarters were familiar with the term UPF, and just over half took it into account when making food choices. This was most common among those with higher education and income. However, most participants were unable to correctly classify UPF. Most Dutch people tend to associate food processing with additives, artificial ingredients, preparation methods, and non-fresh foods. Negative qualifications were more common among those with a negative attitude toward food processing[63].

A French intervention study with nutritional logos on packaging showed that participants were much better at recognizing ultra-processed products when the visual information was present compared to when it was absent[64]. A Brazilian study showed that consumers were better able to identify UPF products with a warning label about UPF, but this had no effect on purchase intentions or the perceived healthiness of the products[65]. Vegetarians/vegans appreciated the increase in the availability of substitutes for animal products but questioned the effect of industrial processing on the nutritional composition of these products[66].

The effectiveness of using a logo for UPF depends on correctly classifying UPF and on the importance that consumers place on the (health effects of) food processing. There are differences between various food types and consumer groups in this regard. The effect of the heuristic "processed food is unhealthy" had a greater impact on women and was stronger for vegetables, legumes, and fish & shellfish than for meat (products)[67].

These studies show that knowledge, perceptions, and behavioural intentions regarding UPF differ among consumer groups, which vary based on factors such as personality traits and socio-cultural context[68]. Differences are also likely to exist for other factors in food choices, such as taste, price, general health, convenience, and sustainability[31].

Conclusions

UPF is a broad and heterogenous group of foods, making it difficult to formulate a scientifically unambiguous definition. In spite of this, various cohort studies show a consistent relationship between the consumption of UPF and development of chronic diseases. There is increasing evidence that the well-known risk factors (sugary drinks, refined grains, and processed meats) contribute to the health effects of consuming UPF.

However, the mechanisms behind these associations are still unclear, and this is also the case, though to a lesser extent, for the link between the consumption of UPF and weight gain. Eating speed and energy density are important factors in this regard and have been the focus of various studies.

At present, it remains unclear what additional advice on UPF consumption offers to existing dietary guidelines. It is also uncertain to what extent specific advice about UPF helps consumers make better food choices. Consumer behaviour regarding UPF is not uniform, as it varies among different consumer groups and for different categories of foods, meaning there is no clear consensus. There is also no agreement among nutrition experts about advising to limit UPF consumption, partly because food processing can have beneficial effects, such as reducing food waste, which contributes to the sustainability of food chains.

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