The concept of ultra-processed food (UPF)

Background

Why have we produced this position statement?

Poor dietary habits are associated with a range of chronic diseases, and it is recognised that a food environment promoting diets high in energy, saturated fat, free sugars and salt is contributing to unacceptably high rates of obesity in children and adults within the UK population and elsewhere [1, 2].

In recent years research interest in the concept of 'ultra-processed food' (UPF) has increased. Headlines in the mainstream media have cautioned against their increased presence in the modern food system and highlighted research reporting that a range of adverse health outcomes are associated with their consumption. Some countries now advise the reduction of UPF intake as part of national dietary guidelines [3-9] and the concept is being considered for possible inclusion by others [10-12]. However, some researchers have questioned the usefulness of focussing on the 'extent of processing' beyond the conventional system of classification by nutritional quality [13-20].

This position statement aims to provide an informative and referenced consideration of the concept of UPF and its relevance as a framework for dietary advice in the UK. It was developed by the British Nutrition Foundation alone but informed by discussions held at a roundtable event of key stakeholders including representatives from academia, policy, behavioural science, communications, health, food science, retail and consumer interests in July 2022 [21]. It has been reviewed for scientific integrity by the Foundation's **Scientific Committee**.

Outlining the arguments for and against classifying foods by 'extent of processing'

Advocates of the concept argue that foods and drinks classified as UPF are 'non-nourishing' (i.e. typically lacking in intact, fresh ingredients, fibre and micronutrients) and should be avoided due to proposed direct and indirect harmful effects on heath. These include promotion of overeating, displacement of non-UPF foods in the diet and harmful effects of certain ingredients such as additives [22-26]. Proponents argue that it is the 'ultra-processing' properties of UPF over and above their nutritional attributes that are associated with harms. However, the classification of foods by their 'extent of processing' and whether or not there are any links between processing *per se* and health is a topic of debate in nutrition science. Critics argue that the focus should remain on high consumption of less healthy foods e.g. those classified as high in salt, sugar and fat (HFSS) (many of which will also be classified as UPF) where there is stronger evidence for links with poor health outcomes [13, 14, 16, 17, 19, 20]. The use of nutrients and nutrient profiling to determine the 'healthiness' of foods has therefore been suggested to remain the most evidence-based approach for the basis of dietary advice and policy.

Scientific summary

What are 'ultra-processed foods' (UPF)

- The NOVA (a name, not an acronym) classification system, developed by the Brazilian nutrition and health researcher Professor Carlos Monteiro and colleagues, is the most widely used classification of foods and drinks by their 'extent of processing' and provides a definition of UPF [27, 28].
- According to NOVA, food can be classified into four groups:
    - NOVA group 1, unprocessed or minimally processed foods (includes foods such as fruit and vegetables, meat, eggs, milk, grains, pulses).

    - NOVA group 2, processed culinary ingredients (described as substances obtained directly from group 1 foods or from nature, e.g. oils and fats, sugar and salt).
    - NOVA group 3, processed foods (described as industrial products made by adding salt, sugar or other substances found in group 2 to group 1 foods, using preservation methods such as canning and bottling, and, in the case of breads and cheeses, using non-alcoholic fermentation).
    - NOVA group 4, ultra-processed foods.
- NOVA group 4 UPF are described as 'formulations of ingredients, mostly of exclusive industrial use, typically created by a series of industrial techniques and processes (hence 'ultra-processed')', 'formulated mostly or entirely from substances extracted from foods or derived from food constituents' and '…made possible by use of many types of additives, including those that imitate or enhance the sensory qualities of foods or culinary preparations made from foods.'. The processes and ingredients used in the manufacture of ultra-processed foods have been described as making them highly convenient (ready-to-consume, almost imperishable) and attractive ('hyperpalatable'[1]). While this point of view may resonate more in the context of UPF such as biscuits, desserts, pastries, pies, processed meat products, confectionery or salty and fried snacks, it may be less clear how elements of these descriptions, for example 'hyperpalatable', apply to some non-HFSS UPF or those required for special diets (such as shop-bought wholewheat or rye bread, dairy alternatives, unsaturated fat spreads, textured soya protein and gluten-free bread).
- The NOVA definition of UPF is not universally accepted [13, 14, 19, 20, 29-31] and has been criticised as ambiguous and overly simplistic, with definitions that have changed over time. Some aspects of UPF definitions relate to formulation (i.e. the use of specific ingredients such as fats, sugars, salt, 'cosmetic' additives, notably flavours, colours and emulsifiers, as well as sweeteners), rather than processing *per se* [17, 31-34].
- Advocates argue that NOVA is fit-for-use within policy and that it is misunderstood by critics [22, 35]. However, there is evidence in the scientific literature to suggest that the NOVA categorisation of food data from dietary intake surveys is inconsistently applied. In some cases, the need to make assumptions because of a lack of information/ingredients list creates risk of misclassification [13, 17].

What is the evidence that consumption of UPF cause ill health?

- A large number of papers report statistically significant associations between the higher consumption of UPF and poor health outcomes including increased risk of obesity, type 2 diabetes, cardiovascular disease and all-cause mortality [36-38].
- The bulk of evidence linking higher intake of UPF with poor health outcomes is derived from observational studies, which cannot show cause and effect and have other limitations. For example, identifying UPF within dietary intakes can be particularly challenging from food frequency questionnaire data.
- Some evidence suggests that the highest UPF consumers are more likely to be younger, live in the most deprived areas and have lower physical activity levels [39].

[1] Some products that would be defined as ultra-processed are carbonated soft drinks; sweet, fatty or salty packaged snacks; candies (confectionery); mass produced packaged breads and buns, cookies (biscuits), pastries, cakes and cake mixes; margarine and other spreads; sweetened breakfast 'cereals' and fruit yoghurt and 'energy' drinks; pre-prepared meat, cheese, pasta and pizza dishes; poultry and fish 'nuggets' and 'sticks'; sausages, burgers, hot dogs and other reconstituted meat products; powdered and packaged 'instant' soups, noodles and desserts; baby formula; and many other types of product [27, 28].

- It has been suggested that diets higher in UPF could be indicative of a poor dietary pattern overall, which may explain associations with negative health outcomes. After adjusting for dietary quality, some observational studies have not shown significant associations between UPF and negative health outcomes, although the majority of studies have shown persistent effects [40].
- Evidence from randomised-controlled trials investigating the effect of UPF intake on human health is limited at present, though more studies are planned or currently underway.
- The residential study by Professor Kevin Hall et al. [41] represents an interesting and important contribution to the evidence base. This showed an 'ultra-processed diet' increased *ad libitum* energy intake and weight gain despite being matched to the 'unprocessed diet' for presented calories, sugar, fat, sodium, fibre and macronutrients. The eating rate (i.e. speed of eating, both expressed as calories consumed per minute and grams consumed per minute) and energy density (of the foods) were significantly greater for the UPF diet versus the unprocessed diet, but participants did not report significant differences in the pleasantness of the meals. Likewise, in a study combining data on 330 foods from four countries, on average, energy intake rate (kcal/min) from UPF was higher than from processed and minimally processed foods, though there was a large amount of variation within NOVA categories [42]. Several studies have indicated that both higher energy density and higher eating rate lead to increased energy intake [42-44].
- It has been suggested that categorising foods solely on nutrient content (referred to as 'nutritional levelling') ignores the effects of processing on food matrix integrity, form and texture [24] and such mechanisms may potentially underlie some of the reported associations between UPF and adverse health outcomes. Food form and texture can affect eating rate [42-44]. Foods with softer textures are typically consumed more quickly than foods with harder textures and liquids can be consumed more quickly than solid and semi-solid foods. Consideration of the potential impact of food processing on food structure and food intake in the context of energy balance is valid [45].
- It has also been suggested that UPF may promote energy overconsumption as 'ultra-processing' disrupts natural food matrices [46]. Changes to food matrix integrity as a result of processing (e.g. whole nuts vs chopped or ground nuts or nut butter; dairy fat within yogurt and cheese vs. butter; whole fruit vs. fruit juice; whole oats vs. oatmeal) can affect the release, absorption and metabolism of nutrients (e.g. fat, starch, sugars) and satiety [45, 47-53]. It should, however, be noted that processing encompasses a broad spectrum of many different techniques with wide-ranging effects on nutrient retention and food structure [42, 54-56].
- Other suggested mechanisms by which UPF have been postulated to negatively impact health include harmful effects of contaminants from packaging materials (e.g. bisphenols, phthalates, mineral oils, microplastics), contaminants produced during processing (acrylamide, acrolein) and 'cosmetic' additives (notably flavours, colours and emulsifiers, as well as sweeteners) [13, 22, 24, 57]. The latter are suggested to have wide-ranging effects including promoting inflammation, promoting overeating, presenting 'mismatched' flavour-nutrient signals to the brain or altering the gut microbiota [58-60].
- Food additives are added to many processed foods to modify flavour, colour, stability and texture but their use is regulated, with evidence of safety required prior to approval for use, which is kept under review and re-evaluated [61, 62]. It has been suggested that additives may have adverse health effects that are not captured by current safety assessments and unknown detrimental 'cocktail effects' [58, 63] but, as yet, there is

little evidence to support such concerns. Studies are underway to collect more data on exposure to additives in populations [58]. Additives must be declared on food labels and this information must be available within the ingredients list to consumers. Researchers have pointed out that some process contaminants can be generated when cooking in the home (whereas processes are controlled in an industrial setting) and that changes have been implemented within the food industry to reduce the concentrations of known contaminants [19, 33, 34, 64, 65]. While it is important that any suspected ill-effects of specific ingredients and processing techniques are investigated and monitored [66-68], at present evidence for these mechanisms in the context of UPF and health remains more limited [69].

- Currently, the only specific advice related to processed foods within the UK's healthy eating model, the Eatwell Guide, is that those who eat more than 90g of red or processed meat per day, should try to cut down to no more than 70g per day [70]. Evidence shows that high intakes of processed meat are associated with increased risk of colorectal cancer, based on systematic reviews undertaken by leading global health organisations, along with supporting mechanistic work [71, 72].

Does ultra-processing have a role in a modern food system?

- Food processing is essential for food safety and security, including extension of shelf life, which reduces food waste and improves durability for food distribution. Messaging to avoid or reduce consumption of UPF may raise concerns about all food processing and specifically, additives, among consumers. In a repeated YouGov survey commissioned by the British Nutrition Foundation[2] (n=2323 GB adults, March 2023), 44% stated that they were trying to reduce some kind of processed food[3] in their diet, compared to 36% in 2021 (n=2127 GB adults, January 2021) [73].
- The nutritional composition of foods and drinks classified as ultra-processed vary greatly. It is important to note that many of these are energy dense and nutrient poor, specifically being high in nutrients of concern (saturated fat, sugar or salt) and providing low amounts of nutrients that are lacking in the diet, including fibre, and should be limited. However, other UPF feature in many dietary guidelines as foods to be encouraged (e.g. wholemeal bread, lower sugar fruit yogurts, reduced sugar and salt baked beans, lower sugar wholegrain breakfast cereals, unsaturated fat spreads). Such foods can contribute significantly to intakes of some essential nutrients in the UK (see Appendix) and this has been highlighted in relation to other settings [74, 75]. Unintended consequences of advice to reduce UPF should therefore be considered. For example, intakes of pulses (commonly consumed as baked beans in the UK, contributing 53% to pulses intake by weight)[4] are already below those needed to bring UK diets in line with the Eatwell Guide [76]. Dietary advice to avoid all foods classified as UPF would therefore be at odds with some aspects of current guidance and could be detrimental to some nutrient intakes.
- Several foods classified as UPF are fortified with micronutrients (e.g. breakfast cereals, children's yogurts and fromage frais, dairy milk alternatives, packaged breads, fat

[2] The research was conducted by YouGov on behalf of the British Nutrition Foundation. 2323 adults from across Britain (49% male, 43% social grade C2DE) were surveyed between 22 – 23 March 2023. The survey was carried out online. The figures have been weighted and are representative of all GB adults (aged 18+).

[3] Processed food, ultra-processed food or both.

[4] Secondary analysis of National Diet and Nutrition Survey year 11 data conducted by the British Nutrition Foundation in December 2022.

spreads) and/or are needed for individuals required to follow a specific diet for medical or nutritional reasons (e.g. products suitable for those with coeliac disease, meal replacement products for older adults with reduced appetite, infant formula).

- Plant-based meat alternatives may be useful for some consumers adapting to a more plant-based diet. Many would be classified as UPF according to NOVA, but there will be a variation in the nutrient profile within this category. It is important to encourage consumers looking for these products to select those with a better nutritional profile (considering saturated fat, salt, fibre, protein and micronutrient composition) within a healthy, balanced and more sustainable diet.
- It has been estimated that foods that would be classified as UPF make up over half of our energy intake in the UK [77-79]. Removing UPF from diets completely would require a substantial change in eating patterns which would be unachievable for many. While cooking healthy meals from scratch and basing the diet on foods such as fruit and vegetables, wholegrain and higher fibre starchy foods is to be encouraged, an 'unprocessed' diet or a diet devoid of processed foods is likely to be inaccessible to a large number of people within the UK. This could include older adults with dexterity issues, those with poor access to cooking equipment, those with limited cooking skills, those struggling to afford energy and food, those with busy lifestyles. Some foods that would be classified as UPF, such as vegetable-based sauces and packaged breads, can help consumers put together healthier and more nutritious, home-cooked meals/packed lunches. Processed foods, including UPF, can offer significant benefits for consumers including reduced cooking times, affordability and convenience and advice to avoid UPFs may act to demonise all types of processed foods. It is also worth noting that homemade foods and meals are not always healthier; and ingredient selection and cooking method is key.
- Any changes to UK dietary advice must be carefully considered, particularly where there is a high risk of confusion and unintended consequences, including disengagement with other dietary advice.

Important considerations for future research

- Further mechanistic research is required in order to establish whether any particular components or attributes of foods/drinks classified as UPF (e.g. additives, packaging chemicals, 'hyperpalatability') or any particular processing techniques (e.g. those that produce a soft texture/reduce the integrity of the food matrix) explain the observed links between high consumption of such foods and poor health outcomes [80]. The health implications of any measured biological effects (e.g. changes in the gut microbiota) need to be more clearly established.
- Furthermore, research should consider whether there are other drivers of high consumption of some UPF, beyond possibly energy density and forms/textures, that may be contributing to the association between UPF and weight [81]. Some of the proposed mechanisms are still underexplored but such research may be particularly relevant to the food industry in consideration of innovation/new product development.
- Considering the characteristics (including nutritional, sensory, structural and formulation) that can differ between ultra-processed foods and their unprocessed equivalents and the fact that processing encompasses a broad spectrum of methods, designing randomised controlled trials to tease out which aspects of 'ultra-processing' might be responsible for observed impacts on health markers, is challenging. This is important to consider when interpreting the results of existing human studies and the design of future studies.

- It would be useful for data on the quantities of additives present in food and drink products to be available within comprehensive food composition databases for research purposes. This would support more information on exposure and monitoring of changes to the food supply as a result of reformulation efforts.
- Focussing on food processing over nutrient composition may discourage reformulation thereby hindering efforts to improve nutrient intakes and reduce energy density by stealth. It will be important to investigate whether countries that include avoiding/reducing UPF in population dietary guidelines observe any decline in industry reformulation activities.
- The demonisation of UPF could result in stigmatisation, guilt and shame among those who rely on processed foods as the basis of many meals, and the impact of such messaging should be a research consideration. It is important to explore the feasibility of limiting consumption of UPF for different groups and how they might interpret such advice.
- It would be useful to establish any potential effects of avoidance of UPF on nutrient intakes within the UK, as well as any environmental impacts, through modelling work, and to compare this to modelling work undertaken using HFSS nutrient profiling.

Appendix

Percentage contribution to nutrient intakes (where >5% in at least one age group) in the UK population from selected food types typically classified as UPF *						
White bread						
Age (years)	**1.5-3**	**4-10**	**11-18**	**19-64**	**65-74**	**75+**
Calcium	7	11	12	9	8	8
Fibre	7	9	10	7	6	7
Folate	5	7	8	5	4	4
Iron	7	9	10	7	6	7
Zinc	5	6	6	4	4	4
Sodium	10	12	11	8	8	7
Protein	6	8	8	5	5	5
Wholemeal, brown, granary and wheatgerm bread						
Age (years)	**1.5-3**	**4-10**	**11-18**	**19-64**	**65-74**	**75+**
Fibre	7	6	6	8	10	13
Iron	6	4	5	6	8	10
Sodium	5	4	5	6	8	9
High fibre breakfast cereals (NSP Englyst fibre ≥4g/100g or more)						
Age (years)	**1.5-3**	**4-10**	**11-18**	**19-64**	**65-74**	**75+**
Calcium	4	4	3	3	4	5
Fibre	9	7	5	6	9	10
Folate	10	9	6	5	6	7
Iron	15	12	8	8	11	12
Riboflavin	9	9	7	6	8	9
Vitamin D	4	6	5	3	3	3
Zinc	5	4	3	4	6	6
Other breakfast cereals (NSP Englyst fibre <4g/100g or more)						
Age (years)	**1.5-3**	**4-10**	**11-18**	**19-64**	**65-74**	**75+**
Folate	7	9	8	3	2	5
Iron	9	9	8	3	2	5
Riboflavin	5	7	7	3	2	4
Vitamin D	13	15	13	6	3	8
Free sugars	5	4	4	2	2	3
Yogurt, fromage frais and other dairy desserts						
Age (years)	**1.5-3**	**4-10**	**11-18**	**19-64**	**65-74**	**75+**
Calcium	8	6	3	5	6	6
Iodine	8	8	4	6	6	7
Riboflavin	7	6	3	4	4	4
Vitamin D	18	11	3	3	2	3
Free sugars	12	6	3	4	5	5
Fat spreads**						
Age (years)	**1.5-3**	**4-10**	**11-18**	**19-64**	**65-74**	**75+**

Vitamin A	5	5	5	4	4	4
Vitamin D	8	9	7	7	7	8
Saturated fat	3	4	3	4	5	4

Source: National Diet and Nutrition Survey years 2016/17-2018/19 [82]
*All or some of the foods captured within this food code would typically be classified as UPF, depending on their exact ingredient list [79, 83]
**Excluding butter

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