The concept of 'ultra-processed foods' (UPF)

Position statement April 2023

British Nutrition Foundation position statements set out our views on important areas in food and nutrition and provide guidance to researchers, regulatory agencies and policy makers, health professionals, the food industry and the media. Our position statements are produced by our team of expert nutrition scientists and reviewed by the Foundation's Scientific Committee, a group of independent experts that advises on the interpretation and translation of scientific information as part of our governance.

Our position

A number of countries advise the reduction or avoidance of 'ultra-processed foods' (UPF), a category of foods described within the NOVA classification system by the 'extent', 'purpose' and 'nature' of food processing, within national dietary guidelines. This is based on evidence, largely from observational studies, linking high intakes of foods that would be classified as ultra-processed according to NOVA group 4 with poor health outcomes including heart disease, type 2 diabetes, obesity and cancer. Although such studies have shown consistent associations, it is difficult to untangle the impact of less healthy dietary patterns and lifestyles and they do not provide clear evidence of a causal association between processing *per se* and health. At present in the UK there is no agreed definition for UPF and they are not referred to in government dietary recommendations. *Within this document, when reference is made to the concept of UPF the term refers to foods and drinks that would be classified as 'ultra-processed' according to the NOVA classification system.*

The NOVA UPF definition is broad and captures many foods that have a poor nutritional profile, are energy dense and high in fat, sugars and salt. Understanding of other mechanisms to explain adverse effects of 'ultra-processing' on health is limited. As the links between excess consumption of saturated fat, sugars and salt and poorer health outcomes are well established, the British Nutrition Foundation supports approaches to reduce their consumption. Reformulation, with the potential of improving nutritional intakes without changing consumer behaviour, should continue to be part of a suite of strategies to improve the quality of our diets. Alongside dietary advice to consume foods such as fruit and vegetables, wholegrains, pulses and other good protein sources, consumers need to be supported to choose healthier versions of processed foods and this can include some nutrient-dense, affordable UPF. In countries such as the UK, UPF are currently reported to make a significant contribution to total dietary intake. Whilst support to reduce intakes of less healthy processed foods is important, blanket advice to avoid all foods that would be classified as UPF may have unintended consequences that have not been fully investigated for different groups within the population.

Discussions on the concept of UPF bring a welcome opportunity to highlight the importance of healthier dietary patterns. SACN's recent review (July 2023) evaluated the classification and suitability of UPF as a dietary exposure. The Committee identified some concerns around the practical application of the NOVA classification in the UK. It suggested that it was not always possible to correctly classify foods to the NOVA categories based on current data from the National Diet and Nutrition Survey (NDNS). In particular, they raised concern about the classification of some foods not being consistent with existing UK dietary advice. SACN concluded that the observed associations between higher consumption of UPF and adverse health outcomes warrant further investigation. However, the limitations in the NOVA

classification system, the potential for confounding, and the possibility that the observed adverse associations with UPF are covered by existing UK dietary recommendations as these foods can be energy dense and high in fat, sugar and salt mean that the evidence to date needs to be treated with caution.

At present, the British Nutrition Foundation believes that due to the lack of agreed definition, the need for better understanding of mechanisms involved and concern about its usefulness as a tool to identify healthier products, the concept of UPF does not warrant inclusion within policy (e.g. national dietary guidelines). Strong and comprehensive action to improve the food environment is critical to reduce the high prevalence of obesity and non-communicable diseases. In addition, research to improve our understanding of the mechanisms linking 'ultra-processing' with adverse health outcomes is warranted to provide translatable advice to manufacturers and retailers in relation to any other aspects of foods/drinks, beyond their nutritional composition, that may influence healthier dietary choices.

- There is good evidence that energy-dense, nutrient poor dietary patterns, with high intakes of foods high in saturated fat, sugars or salt (HFSS), are detrimental to health. Dietary patterns higher in fibre, vitamins and minerals, based on nutrient-rich foods such as wholegrains, fruits and vegetables, fish, pulses, nuts, seeds and dairy foods, are associated with better health outcomes. Such diets are the basis of national and international dietary guidelines.

- In UK policy, HFSS foods and drinks are defined using the FSA nutrient profile model which also considers beneficial nutrients/food components (i.e. fibre, protein, fruit, vegetables and nuts). Many foods that would be classified as UPF have poor nutrient profiles, are high in ingredients widely recommended to be limited and low in ingredients we want to encourage (e.g. some biscuits, confectionary, cakes and fried/salty snacks). However, the definition of UPF can also include foods such as sliced wholemeal bread and lower sugar wholegrain breakfast cereals which can contribute to an affordable healthy, balanced diet.

- Classification systems that categorise foods based on the 'extent of processing', are not universally accepted. The most widely used and applied UPF definition is from the NOVA food classification system but this has been criticised for being too broad across and within categories. For example, a lower sugar wholegrain breakfast cereal with chicory inulin isolate, a high sugar refined breakfast cereal, a multi-seed sliced wholemeal loaf and a white sliced loaf would all be classified as UPF. It has been suggested by critics that NOVA is difficult to interpret, challenging to apply robustly to dietary data (e.g. food frequency questionnaires are usually not validated to assess UPF intake) and its scientific rationale has been questioned. As it can imply that expensive artisanal products are superior for health, the health equity of advice to limit intake of UPF in the current backdrop of rising food insecurity and the cost-of-living crisis is also an important consideration. The UPF NOVA 4 definition also includes foods and drinks needed for medical or nutritional purposes (e.g. gluten free products, fortified plant-based milk alternatives), for which there is often no accessible or convenient alternative.

- Research has linked high intakes of UPF with a range of adverse health conditions including obesity, cancer, type 2 diabetes and cardiovascular diseases, irritable bowel syndrome, depression and frailty conditions and all-cause mortality. However, this is largely based on observational studies that, by design, cannot demonstrate cause and effect. As much of the research is observational, good quality studies on possible mechanisms by which particular risk factors (e.g. aspects of processing, specific

ingredients or packaging types) may cause ill health are needed. Understanding why research has indicated diets high in UPF are linked with poor health is crucial, particularly as food processing encompasses a broad spectrum of processing techniques. For example, the impact of food texture and food matrix integrity on health could have relevance to healthier food innovation.

- The food environment is a key driver of diet-related poor health, facilitating the easy accessibility of unhealthy dietary patterns. There is an urgent need to increase the availability, affordability and desirability of healthier diets. Processing can play an important role here, as well as in food safety and in extending shelf life, a consideration in terms of access to affordable nutrition and reducing food waste.

- It has been estimated that over 50% of the calories we consume in the UK are from foods that would be classified as UPF. Whilst industry has a responsibility to develop, market and promote healthier options, blanket messaging to consumers, via policy tools or nutrition communications, to avoid or reduce UPF may have unintended consequences. Demonising all processed foods could foster feelings of guilt and stigma around food choices, adversely impacting intake of more affordable sources of nutrients. Increasing cooking skills is undoubtedly to be encouraged, but negative messaging could imply we have to spend more money on unprocessed foods and more time in the kitchen to prepare healthier meals completely from scratch, when this is not the case. Some foods that would be classified as UPF such as vegetable-based sauces can aid the preparation of low-cost nutritious home-cooked meals, by combining these with basic ingredients such as a protein source (e.g. canned fish/pulses), wholegrain or higher fibre starchy foods and vegetables. Alongside improvement to the food environment, we would like to see innovative, inclusive and actionable support to help consumers identify and prepare nutrient-dense, healthier meals and snacks, which can include healthier processed foods.

- It is useful to consider whether messaging to avoid UPF might discourage industry from reformulation to improve the nutritional profile of products.

- As food processing plays a relevant role in food system sustainability and ensuring food security, consideration also needs to be given to the environmental impact of different UPF to support advice on healthier and more sustainable dietary choices.

The British Nutrition Foundation receives no direct financial contribution towards its Position Statements, and the final content reflects the views of the authors alone.

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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 intake of foods that would be classified as UPF (according to NOVA group 4) 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 foods that would be classified as UPF (NOVA group 4) 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 offers 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 some foods that would be classified as 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 foods 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 foods that would be classified as 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.

[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.

- 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 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 UPF 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

References

1. Butland, B., et al. *Foresight Tackling Obesities: Future Choices – Project report*. 2007. Accessed 14/12/22; Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/287937/07-1184x-tackling-obesities-future-choices-report.pdf.
2. PHE. *Health matters: obesity and the food environment*. 2018. Accessed 17/04/23; Available from: https://www.gov.uk/government/publications/health-matters-obesity-and-the-food-environment/health-matters-obesity-and-the-food-environment--2.
3. Ministry of Health of Brazil. *Dietary Guidelines for the Brazilian population*. 2015. Accessed 19/08/22; Available from: https://bvsms.saude.gov.br/bvs/publicacoes/dietary_guidelines_brazilian_population.pdf.
4. FAO. *Food-based dietary guidelines - Uruguay*. 2016. Accessed 19/08/22; Available from: https://www.fao.org/nutrition/education/food-dietary-guidelines/regions/countries/uruguay/en/.
5. FAO. *Food-based dietary guidelines - Peru*. 2019. Accessed 19/08/22; Available from: https://www.fao.org/nutrition/education/food-dietary-guidelines/regions/countries/peru/en/.
6. FAO. *Food-based dietary guidelines - Ecuador*. 2020. Accessed 19/08/22; Available from: https://www.fao.org/nutrition/education/food-dietary-guidelines/regions/countries/ecuador/en/.
7. FAO. *Food-based dietary guidelines - Belgium*. 2017. Accessed 19/08/22; Available from: https://www.fao.org/nutrition/education/food-dietary-guidelines/regions/countries/belgium/en/.
8. Sante Publique France. *Recommendations on diet, physical activity and sedentary lifestyle*. 2022. Accessed 07/11/22; Available from: https://www.mangerbouger.fr/l-essentiel/les-recommandations-sur-l-alimentation-l-activite-physique-et-la-sedentarite.
9. State of Israel Ministry of Health. *Processed food*. 2022. Accessed 19/08/22; Available from: https://www.health.gov.il/English/Topics/FoodAndNutrition/Nutrition/Adequate_nutrition/processed_food/Pages/default.aspx.
10. Juul, F. and E. Bere. *Nordic Nutrition Recommendations 2022 - public consultation - Ultra-processed foods*. 2022. Accessed 14/12/22; Available from: https://www.helsedirektoratet.no/horinger/nordic-nutrition-recommendations-2022-nnr2022/NNR2022%20Ultra-processed%20foods%20Public%20Consultation.pdf/_/attachment/inline/bfe05751-9378-4d2a-a8ea-3c974ad98903:c9d03423c9f9d273cf206b5917613792bbb50f67/NNR2022%20Ultra-processed%20foods%20Public%20Consultation.pdf.
11. SACN. *SACN meetings*. 2022. Accessed 16/03/23; Available from: https://www.gov.uk/government/groups/scientific-advisory-committee-on-nutrition#sacn-meetings.

12. 2025 Dietary Guidelines Advisory Committee. *Proposed Scientific Questions*. 2022. Accessed 19/08/22; Available from: https://www.dietaryguidelines.gov/sites/default/files/2022-07/Proposed%20Scientific%20Questions_508c_Final.pdf.
13. Astrup, A. and C. Monteiro, *Does the concept of "ultra-processed foods" help inform dietary guidelines, beyond conventional classification systems? NO.* The American Journal of Clinical Nutrition, 2022.
14. Drewnowski, A., S. Gupta, and N. Darmon, *An Overlap Between "Ultraprocessed" Foods and the Preexisting Nutrient Rich Foods Index?* Nutrition Today, 2020. **55**(2).
15. Fraanje, W. and T. Garnet. *What is ultra-processed food? And why do people disagree about its utility as a concept?* 2019. Accessed 09/12/22; Available from: https://www.tabledebates.org/building-blocks/what-ultra-processed-food-and-why-do-people-disagree-about-its-utility-concept.
16. Gibney, M.J., et al., *Ultra-processed foods in human health: a critical appraisal.* The American Journal of Clinical Nutrition, 2017. **106**(3): p. 717-724.
17. Jones, J.M., *Food processing: criteria for dietary guidance and public health?* Proceedings of the Nutrition Society, 2019. **78**(1): p. 4-18.
18. Kelly, A. *Demonising processed food undermines our trust in science*. 2022. Accessed 15/09/22; Available from: https://theconversation.com/demonising-processed-food-undermines-our-trust-in-science-128442.
19. Visioli, F., et al., *The ultra-processed foods hypothesis: a product processed well beyond the basic ingredients in the package.* Nutrition Research Reviews, 2022: p. 1-11.
20. Monteiro Cordeiro de Azeredo, H. and E. Monteiro Cordeiro de Azeredo, *Ultraprocessed Foods: Bad Nutrition or Bad Definition?* ACS Food Science & Technology, 2022. **2**(4): p. 613-615.
21. Lockyer, S., et al., *How do we differentiate not demonise – is there a role for healthier processed foods in an age of food insecurity? Proceedings of a roundtable event.* Nutrition Bulletin, in press.
22. Monteiro, C.A. and A. Astrup, *Does the concept of "ultra-processed foods" help inform dietary guidelines, beyond conventional classification systems? YES.* The American Journal of Clinical Nutrition, 2022.
23. Popkin, B.M. and S.W. Ng, *The nutrition transition to a stage of high obesity and noncommunicable disease prevalence dominated by ultra-processed foods is not inevitable.* Obesity Reviews, 2022. **23**(1): p. e13366.
24. Scrinis, G. and C. Monteiro, *From ultra-processed foods to ultra-processed dietary patterns.* Nature Food, 2022. **3**(9): p. 671-673.
25. Swinburn, B.A., et al., *The Global Syndemic of Obesity, Undernutrition, and Climate Change: The Lancet Commission report.* The Lancet, 2019. **393**(10173): p. 791-846.
26. Dicken, S.J. and R.L. Batterham, *Ultra-processed food: a global problem requiring a global solution.* The Lancet Diabetes & Endocrinology, 2022.
27. Monteiro, C.A., et al., *Ultra-processed foods, diet quality, and health using the NOVA classification system.* Rome: FAO, 2019. **49**.
28. Monteiro, C.A., et al., *Ultra-processed foods: what they are and how to identify them.* Public Health Nutrition, 2019. **22**(5): p. 936-941.
29. Gibney, M.J., *Ultra-processed foods in public health nutrition: the unanswered questions.* British Journal of Nutrition, 2022: p. 1-4.
30. Knorr, D. and M.A. Augustin, *Food processing needs, advantages and misconceptions.* Trends in Food Science & Technology, 2021. **108**: p. 103-110.
31. Petrus, R.R., et al., *The NOVA classification system: A critical perspective in food science.* Trends in Food Science & Technology, 2021. **116**: p. 603-608.
32. Botelho, R., W. Araújo, and L. Pineli, *Food formulation and not processing level: Conceptual divergences between public health and food science and technology sectors.* Crit Rev Food Sci Nutr, 2018. **58**(4): p. 639-650.

33. Forde, C.G. and E.A. Decker, *The Importance of Food Processing and Eating Behavior in Promoting Healthy and Sustainable Diets.* Annual Review of Nutrition, 2022. **42**(1): p. 377-399.
34. Levine, A.S. and J. Ubbink, *Ultra-Processed Foods: Processing vs. Formulation.* Obesity Science & Practice, 2022: p. 1-5.
35. Lawrence, M., *Ultra-processed foods: a fit-for-purpose concept for nutrition policy activities to tackle unhealthy and unsustainable diets.* Public Health Nutrition, 2022: p. 1-5.
36. Delpino, F.M., et al., *Ultra-processed food and risk of type 2 diabetes: a systematic review and meta-analysis of longitudinal studies.* International Journal of Epidemiology, 2021. **51**(4): p. 1120-1141.
37. Pagliai, G., et al., *Consumption of ultra-processed foods and health status: a systematic review and meta-analysis.* British Journal of Nutrition, 2021. **125**(3): p. 308-318.
38. Suksatan, W., et al., *Ultra-processed food consumption and adult mortality risk: a systematic review and dose–response meta-analysis of 207,291 participants.* Nutrients, 2021. **14**(1): p. 174.
39. Rauber, F., et al., *Ultra-processed food consumption and risk of obesity: a prospective cohort study of UK Biobank.* European journal of nutrition, 2021. **60**(4): p. 2169-2180.
40. Dicken, S.J. and R.L. Batterham, *The Role of Diet Quality in Mediating the Association between Ultra-Processed Food Intake, Obesity and Health-Related Outcomes: A Review of Prospective Cohort Studies.* Nutrients, 2022. **14**(1): p. 23.
41. Hall, K.D., et al., *Ultra-Processed Diets Cause Excess Calorie Intake and Weight Gain: An Inpatient Randomized Controlled Trial of Ad Libitum Food Intake.* Cell Metab, 2019. **30**(1): p. 67-77.e3.
42. Forde, C.G., M. Mars, and K. de Graaf, *Ultra-Processing or Oral Processing? A Role for Energy Density and Eating Rate in Moderating Energy Intake from Processed Foods.* Curr Dev Nutr, 2020. **4**(3): p. nzaa019.
43. Argyrakopoulou, G., et al., *How important is eating rate in the physiological response to food intake, control of body weight, and glycemia?* Nutrients, 2020. **12**(6): p. 1734.
44. Teo, P.S., et al., *Texture-based differences in eating rate influence energy intake for minimally processed and ultra-processed meals.* The American Journal of Clinical Nutrition, 2022. **116**(1): p. 244-254.
45. Forde, C.G. and D. Bolhuis, *Interrelations Between Food Form, Texture, and Matrix Influence Energy Intake and Metabolic Responses.* Current Nutrition Reports, 2022. **11**(2): p. 124-132.
46. Srour, B. and M. Touvier, *Ultra-processed foods and human health: What do we already know and what will further research tell us?* EClinicalMedicine, 2021. **32**.
47. Givens, D.I., *Saturated fats, dairy foods and cardiovascular health: No longer a curious paradox?* Nutrition Bulletin, 2022. **47**(4): p. 407-422.
48. Grundy, M.M.-L., et al., *Processing of oat: the impact on oat's cholesterol lowering effect.* Food & function, 2018. **9**(3): p. 1328-1343.
49. Li, C.H., G.V. Shelp, and A.J. Wright, *Influence of nut structure and processing on lipid bioaccessibility and absorption.* Current Opinion in Food Science, 2023. **49**: p. 100966.
50. Mulet-Cabero, A.I., et al., *Dairy structures and physiological responses: a matter of gastric digestion.* Crit Rev Food Sci Nutr, 2020. **60**(22): p. 3737-3752.
51. Musa-Veloso, K., et al., *A Systematic Review and Meta-Analysis of Randomized Controlled Trials on the Effects of Oats and Oat Processing on Postprandial Blood Glucose and Insulin Responses.* The Journal of Nutrition, 2020. **151**(2): p. 341-351.
52. Sundborn, G., et al., *Are Liquid Sugars Different from Solid Sugar in Their Ability to Cause Metabolic Syndrome?* Obesity, 2019. **27**(6): p. 879-887.
53. Thorning, T.K., et al., *Whole dairy matrix or single nutrients in assessment of health effects: current evidence and knowledge gaps.* The American Journal of Clinical Nutrition, 2017. **105**(5): p. 1033-1045.

54. Aguilera, J.M., *The food matrix: implications in processing, nutrition and health.* Critical Reviews in Food Science and Nutrition, 2019. **59**(22): p. 3612-3629.
55. Stribiţcaia, E., et al., *Food texture influences on satiety: systematic review and meta-analysis.* Scientific Reports, 2020. **10**(1): p. 12929.
56. Wahlqvist, M.L., *Food structure is critical for optimal health.* Food & Function, 2016. **7**(3): p. 1245-1250.
57. Srour, B., et al., *Ultra-processed foods and human health: from epidemiological evidence to mechanistic insights.* The Lancet Gastroenterology & Hepatology, 2022.
58. Chazelas, E., et al., *Food additives: distribution and co-occurrence in 126,000 food products of the French market.* Scientific Reports, 2020. **10**.
59. Neumann, N.J. and M. Fasshauer, *Added flavors: potential contributors to body weight gain and obesity?* BMC Medicine, 2022. **20**(1): p. 417.
60. Small, D.M. and A.G. DiFeliceantonio, *Processed foods and food reward.* Science, 2019. **363**(6425): p. 346-347.
61. Food Standards Agency. *Food additives authorisation guidance*. 2022. Accessed 15/03/23; Available from: https://www.food.gov.uk/business-guidance/regulated-products/food-additives-guidance.
62. EC. *Regulation (EC) No 1333/2008 of the European Parliament and of the Council of 16 December 2008 on food additives*. 2008. Accessed 09/11/22; Available from: https://www.legislation.gov.uk/eur/2008/1333/contents.
63. Zinöcker, M.K. and I.A. Lindseth, *The Western Diet–Microbiome-Host Interaction and Its Role in Metabolic Disease.* Nutrients, 2018. **10**(3): p. 365.
64. Fitzgerald, M., *It is time to appreciate the value of processed foods.* Trends in Food Science & Technology, 2023. **134**: p. 222-229.
65. Göncüoğlu Taş, N., T. Kocadağlı, and V. Gökmen, *Safety concerns of processed foods in terms of neo-formed contaminants and NOVA classification.* Current Opinion in Food Science, 2022. **47**: p. 100876.
66. German Federal Institute for Risk Assessment Department of Food Safety Unit, et al., *Risk assessment and toxicological research on micro- and nanoplastics after oral exposure via food products.* EFSA Journal, 2020. **18**(S1): p. e181102.
67. EFSA Panel on Contaminants in the Food Chain, *Presence of microplastics and nanoplastics in food, with particular focus on seafood.* EFSA Journal, 2016. **14**(6): p. e04501.
68. Food Standards Agency. *Acrylamide legislation*. 2021. Accessed 17/03/23; Available from: https://www.food.gov.uk/business-guidance/acrylamide-legislation.
69. Juul, F., G. Vaidean, and N. Parekh, *Ultra-processed Foods and Cardiovascular Diseases: Potential Mechanisms of Action.* Advances in Nutrition, 2021. **12**(5): p. 1673-1680.
70. PHE. *The Eatwell Guide*. 2018. Accessed 12/09/22; Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/742750/Eatwell_Guide_booklet_2018v4.pdf.
71. World Cancer Research Fund/American Institute for Cancer Research. *Continuous Update Project Expert Report 2018. Diet, nutrition, physical activity and colorectal cancer*. 2018. Accessed 15/03/23; Available from: https://www.wcrf.org/wp-content/uploads/2021/02/Colorectal-cancer-report.pdf.
72. International Agency for Research on Cancer (IARC) Working Group on the Evaluation of Carcinogenic Risks to Humans, *IARC monographs on the evaluation of carcinogenic risks to humans; volume 114 - Red meat and processed meat.* 2015.
73. British Nutrition Foundation. *British Nutrition Foundation survey reveals confusion about ultra-processed foods*. 2021. Accessed 23/10/22; Available from: https://www.nutrition.org.uk/putting-it-into-practice/make-healthier-choices/perspectives-on-processed-foods/british-nutrition-foundation-survey-reveals-confusion-about-ultra-processed-foods/.

74. Hallinan, S., et al., *Some Ultra-Processed Foods Are Needed for Nutrient Adequate Diets: Linear Programming Analyses of the Seattle Obesity Study.* Nutrients, 2021. **13**(11): p. 3838.
75. Estell, M.L., et al., *Fortification of grain foods and NOVA: the potential for altered nutrient intakes while avoiding ultra-processed foods.* European Journal of Nutrition, 2022. **61**(2): p. 935-945.
76. Scarborough, P., et al., *Eatwell Guide: modelling the dietary and cost implications of incorporating new sugar and fibre guidelines.* BMJ Open, 2016. **6**(12): p. e013182.
77. Lee, J.Y., et al., *The association between ultra-processed food consumption and obesity in the ZOE PREDICT 1 cohort in the United Kingdom.* Proceedings of the Nutrition Society, 2022. **81**(OCE1): p. E5.
78. Marino, M., et al., *A Systematic Review of Worldwide Consumption of Ultra-Processed Foods: Findings and Criticisms.* Nutrients, 2021. **13**(8): p. 2778.
79. Rauber, F., et al., *Ultra-processed foods and excessive free sugar intake in the UK: a nationally representative cross-sectional study.* BMJ Open, 2019. **9**(10): p. e027546.
80. Tobias, D.K. and K.D. Hall, *Eliminate or reformulate ultra-processed foods? Biological mechanisms matter.* Cell Metabolism, 2021. **33**(12): p. 2314-2315.
81. Rolls, B.J., P.M. Cunningham, and H.E. Diktas, *Properties of ultraprocessed foods that can drive excess intake.* Nutrition Today, 2020. **55**(3): p. 109-115.
82. PHE. *National Diet and Nutrition Survey Rolling programme Years 9 to 11 (2016/2017 to 2018/2019)*. 2020. Accessed 08/12/22; Available from: https://www.gov.uk/government/statistics/ndns-results-from-years-9-to-11-2016-to-2017-and-2018-to-2019.
83. Adams, J. and M. White, *Characterisation of UK diets according to degree of food processing and associations with socio-demographics and obesity: cross-sectional analysis of UK National Diet and Nutrition Survey (2008–12).* International Journal of Behavioral Nutrition and Physical Activity, 2015. **12**(1): p. 160.