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Beyond NOVA: Reimagining Food Processing Classification with the CHIPS (Combining Health, Intuition, Processing and Science) Framework

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Abstract

Background/Objectives: Classifying foods by processing has gained traction, with NOVA the most widely used framework. NOVA helped shift focus away from nutrients toward food processing, but has been critiqued for rigidity, inconsistent classifications, and weak links to health outcomes. This paper introduces the CHIPS (Combining Health, Intuition, Processing and Science) framework (previously known as the Human Interference Scoring System (HISS)), which retains NOVA's food-based perspective while addressing these limitations by integrating processing level with health evidence. **Methods**: CHIPS was developed through critique synthesis, epidemiological evidence, and expert input from nutrition professionals. Foods were classified using a three-layered approach: (1) baseline placement by processing level, (2) adjustment based on evidence of health benefit or harm, and (3) an intuition check to ensure pragmatic classification. Key divergences from NOVA were recorded. **Results**: CHIPS places foods with demonstrated benefits in lower categories and those with consistent evidence of harm in higher ones, while also resolving common inconsistencies and better aligning classifications with real-world understanding. **Conclusions**: A CHIPS builds on NOVA's strengths while addressing its limitations by combining processing level, health evidence, and a pragmatic or intuitive lens. This approach resolves inconsistencies in existing systems and better reflects how foods contribute to health in real-world contexts. The framework has been successfully integrated into an AI enabled tool, demonstrating feasibility for reliable food classification and potential for further validation in diverse populations.

Keywords: food processing classification; NOVA framework; CHIPS (Combining Health, Intuition Processing and Science) framework; Human Interference Scoring System (HISS); diet quality; health outcomes; artificial intelligence

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1. Introduction

The classification of foods based on their degree of processing has gained significant attention in recent years, particularly in the context of public health, nutrition research, and consumer guidance [1]. Among the various frameworks developed to assess food processing, the NOVA system [2,3] has emerged as the most widely adopted globally. Originally introduced as a critique of the growing dominance of ultra-processed foods (UPFs) in Brazil and to inform national dietary guidelines, the NOVA classification also enabled epidemiological analyses and helped shift discourse away from nutrient-level assessments toward a more holistic view of food and food systems. Its influence has been especially prominent in research, where it has become a dominant framework for studying food processing and health [4–7], and has served as a reference point for emerging approaches, including machine learning and AI-based food classification systems [8–10].

Despite its innovation and reach, NOVA has attracted extensive critique [11–20] with researchers and practitioners highlighting inconsistencies in how foods are classified and conceptual vagueness in the definition of "ultra-processing". Additionally, NOVA does not integrate evidence of health impact into its categorisation logic, meaning some foods with demonstrated health benefits, such as yogurts, or wholegrain breads, are classified alongside confectionary and soft drinks [13,15]. These limitations raise concerns about the system's relevance for practical dietary guidance where more evidence-based distinctions and a pragmatic, or intuitive lens are needed to avoid misleading consumers, especially in contexts where affordability and access are key considerations.

While NOVA remains the most influential framework, several alternative systems have been proposed to address its shortcomings. These include the International Food Information Council Foundation (IFIC) classification [21], the SIGA system developed in France [22], and various other adaptations that attempt to account for processing [23,24]. However, these alternatives are less widely used and have not yet gained the same traction or policy integration. As a result, NOVA continues to be treated, often by default, as the gold standard, despite growing awareness of its limitations.

This paper presents the CHIPS (Combining Health, Intuition, Processing, and Science) framework, which evolves from and extends the previously developed Human Interference Scoring System (HISS) [25]. Rather than representing a simple name change, CHIPS reflects the next stage of HISS's development, retaining its foundations while broadening scope and application. CHIPS is a refined classification framework that builds on NOVA's core strength of focussing on foods rather than nutrients, while directly addressing its conceptual and practical limitations. CHIPS introduces a more flexible, health-informed approach to categorising foods by taking a three-pronged approach. It considers both the degree of processing and the strength of evidence linking foods to health outcomes, while also applying an intuition check and a pragmatic lens to ensure that food placement is reasonable and logical for the general public. In doing so, it aims to support more nuanced, inclusive, and evidence-aligned dietary guidance that reflects real-world eating patterns and the practical needs of public health, clinical nutrition, and digital health tools. Here, we describe the development and rationale of the CHIPS framework, highlight key divergences from NOVA and illustrate its potential applications. Designed as a public health intervention, CHIPS is integrated into an artificial intelligence (AI) enabled technology via a mobile application, to guide individuals with low food literacy toward healthier choices through clear, evidence-based food classifications.

2. Materials and Methods

2.1 Framework Refinement and Development Process

The CHIPS was originally developed and validated as a food processing classification system called HISS (Human Interference Scoring System) designed to quantify food quality based on the degree of processing and food matrix integrity (defined as the retention of a food's natural structure and nutrient interactions). The initial validation study (described in detail in Section 2.2) involved trained nutrition professionals classifying foods using digital photos of 24-hour recalls, demonstrating high inter-rater reliability, particularly in identifying unprocessed and ultra-processed items.

Building on this foundational work, we undertook a structured process of framework refinement to enhance the system's utility, clarity, and alignment with public health nutrition principles. This process was iterative and drew on three main sources of input: (1) detailed qualitative feedback from the original expert raters and subsequent reviewers of the initial framework; (2) a synthesis of academic critiques of the NOVA system and other food processing classification tools; and (3) group consensus discussions within our interdisciplinary team of nutrition researchers, public health experts, and a practising dietitian.

Foods were reviewed from first principles, starting with their degree of processing as a baseline for classification. Adjustments were made when consistent evidence of health benefit or harm existed, and a third-level intuition check, or pragmatic lens was applied to ensure classifications aligned with

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everyday understanding and were grounded in reality. This three-layered approach was designed to produce classifications that are both scientifically robust and intuitive for public use.

Foods with mixed components were typically broken into individual components for classification, with each component assigned to its appropriate group. However, certain composite products were classified as a single item based on their dominant characteristics. This additive approach ensured flexibility while maintaining consistency in assessing complex dishes. Importantly, the CHIPS maintains a food-based rather than nutrient-based approach, preserving the core strength of the NOVA framework while aiming to reduce inconsistencies, improve transparency, and support better alignment with dietary guidance and real-world food choices.

As part of the refinement process, we also simplified the four-category structure to three categories, with detailed definitions and examples presented in the Results. The original framework included an additional intermediate category, but feedback indicated that this added complexity did not enhance clarity or usability. Combining the intermediate categories allowed us to better capture a spectrum of processing that acknowledges beneficial and traditional methods (e.g., fermentation, preservation) while clearly distinguishing these from highly industrial formulations. This change improved consistency in group boundaries and supported a more intuitive user experience in both research and consumer-facing applications. CHIPS was also designed to integrate with an AI enabled tool, which has been pilot-tested for accurate classification of foods from digital imagery, as described in Section 2.2.

2.2. Reliability Studies: User Testing of the HISS Classification System and AI Enabled Tool

The initial framework (i.e., HISS), consisting of four groups, was validated in a previously published study [25]. In this study, 13 New Zealand-based nutrition health professionals classified foods from five hypothetical 24-hour food recalls, captured via digital photographs, into the four categories. High inter-rater reliability was achieved, particularly for unprocessed and ultra-processed foods. Based on study feedback, critiques of the NOVA system, and emerging literature on individual foods and their health impacts, HISS was refined from four to three groups. Classifications were adjusted to better align with health evidence and improve usability.

A mobile AI tool was developed to implement the refined three-group framework and was pilot tested with three participant groups to assess usability and functionality [26,27]. Classification accuracy was evaluated by manually checking food images, with the AI tool correctly categorizing foods into the three HISS groups in 93% of cases. These findings confirm the app's reliability and support the application of the framework in dietary assessment.

3. Results

Applying this three-layered process yielded three food categories, termed Groups. Their definitions and examples are outlined below to illustrate the logic of the refined framework. Table 1 summarises these categories, presenting their definitions alongside representative examples of foods. This provides a consolidated overview of the framework, while the narrative descriptions highlight the principles guiding category assignment.

Group 1: Unprocessed and Minimally Processed Whole Foods

These are raw or lightly altered foods, including fruits, vegetables (whether fresh, frozen, canned, or fermented), intact whole grains such as groats and berries, legumes (dried or tinned), unprocessed meats and fish, eggs, plain soy products (e.g., tofu, tempeh), and similar items such as plain tea, coffee and cacao.

Group 2: Processed Foods

This group includes foods that are recognizably derived from whole foods and processed by methods such as fermentation or milling. They are foods that typically would have been available to pre-industrial societies (e.g., hummus, rice, pasta, soups, wholegrain breads, fermented dairy). Health-promoting supplemental products such as protein powders are also included.

Group 3: Ultra-Processed and Junk Foods

Items that are highly industrially formulated, typically with little resemblance to their original food source. This includes sugar-sweetened beverages, sweet and savoury packaged snacks, and processed and reconstituted meats such as hot dogs and chicken nuggets. Unlike NOVA, however, this group also includes foods that are widely acknowledged to have negative impacts on health regardless of whether they are homemade or store-bought. CHIPS does not assume that homemade foods are inherently healthier than commercially prepared items. For example, homemade confectionary, pastries, or alcohol are still classified as Group 3, regardless of preparation setting.

Table 1. The CHIPS framework with examples of foods in each category.

Food categories (Groups) and definition	Examples
Group 1: Unprocessed and minimally processed whole foods. Raw and whole foods that were alive recently with little or no processing. Foods that are fresh, chilled, canned, frozen, or dried to enhance nutrients and freshness at their peak. Unprocessed foods are of plant and animal origin. Minimally processed foods are natural foods that are altered with removal of inedible or unwanted parts and preserved for storage.	Fruit and vegetables of all types including canned and frozen vegetables, pure juices and pure smoothies (whether fortified or not) and dried fruit; red and white meats (beef, chicken, lamb, pork, venison) and fish including canned and smoked fish (where meat or fish are breaded or battered, count the meat/fish in group 1 plus a serving of bread coating/batter from group 2/3); eggs; all legumes (beans, chickpeas, lentils) either dried or canned; natto, tofu & tempeh; all nuts and seeds (including desiccated coconut and ground nuts/seeds but not candy coated nuts); honey; water (including soda water); herbs and spices; grains that were traditionally available to pre industrial societies as whole kernels or groats (e.g. buckwheat groats, rye berries, millet, wheat berries, barley groats); tea, herbal tea, cacao and coffee (ground or instant but not pre-mixed sachets).
Group 2. Processed foods Food products that were typically available for consumption in pre-industrial societies. Includes a wide variety of foods that may be domestically prepared or industrially prepared but that still resemble/ are recognizable as real foods. Foods may be processing (by culturing, preserving, heating etc.) or may be made by combining several ingredients from group 1 (e.g., lasagna- homemade or store bought).	Dairy products including butter, most cheeses (hard, soft or cream cheese but not processed slices) cream, and yogurts; milk of all types (plant and animal); coconut creams; alternative dairy products such as coconut or soy yogurt; most breads including rye, brown, wholewheat, sourdough, pitta, baguettes etc. (not including cake like products such as crumpets, muffins, scones and croissants or processed sliced white bread/burger buns etc); bread coatings on e.g. meat/fish; processed grains including corn tortillas; pasta; couscous; pearl barley; rice; polenta; noodles (not instant); oats and oatmeal; muesli; granolas; simple one ingredient cereals including shredded wheat/puffed spelt or corn; kombucha; miso paste; soups; ready meals; nut and seed butters; simple/traditional meat alternatives such as falafel, plain Quorn, and textured vegetable protein; hummus;

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Other items that are widely regarded as being beneficial dietary supplements e.g. protein powder.	pesto; aioli; pasta sauces; vegetable and seed oils of all types (flaxseed, sunflower etc.); animal fats (lard, butter); protein powders; cocoa and plain dark chocolate with >80% cocoa.
Group 3: Ultra processed and junk foods a) Industrially prepared items that are packaged ready to eat at home or at fast food outlets. Foods that have undergone high degrees of processing with little or no whole foods present. b) Foods with consistent associations of negative health impacts including: I. Cakes, biscuits, pastries, pies, confectionary and syrups whether homemade or purchased. II. Chips, fries and potato wedges/ hash browns III. All alcohol IV. Processed sliced white bread and white bread cake-like products V. Processed meats	Cakes; biscuits; confectionary (chocolate, candy, candy coated nuts); ready mixed coffee sachets and frappes; ice cream; sweetened condensed milks; jams; sugar and syrups; cake-like bread products including scones, crumpets and croissants; savory crackers (for cheese, rice crackers etc.); packaged sliced white bread including hamburger buns and hot dog rolls; pies and pastry products such as spring rolls; batter coatings (e.g. on fish); breakfast cereals that are highly colored/flavored/molded into shapes where raw/constituent ingredients are not evident; processed breakfast cereal drinks; packaged snack products (e.g., crisps, pretzels etc.); chips and fries; soda (including diet soda) and energy drinks; sugar sweetened beverages including flavored milks and sugar sweetened juice drinks; powdered and packaged desserts; instant noodles; muesli bars; margarine; ready-to-drink alcoholic beverages; processed/cured/smoked meats and pre-prepared ready-to-heat meat products including poultry and fish 'nuggets' and 'sticks;' sausages, burgers, hot dogs, bacon, salami and other reconstituted meats; fast food (e.g. anything from McDonalds, Burger King, Taco Bell, KFC etc.); processed cheese slices/snacks.

Table 2 provides detailed examples of foods where CHIPS diverges from NOVA, illustrating how the revised classifications better align with both scientific evidence and everyday understanding. This table highlights key divergences between the two systems, showing how CHIPS incorporates both health evidence and a pragmatic perspective to avoid penalising foods that are nutritionally beneficial or culturally relevant, while ensuring items with consistent evidence of harm remain in the highest group. It should be noted that Group 3 in CHIPS (the highest category, to be largely avoided) is not equivalent to Group 3 in NOVA, as NOVA is a four-group system while CHIPS uses three. In addition, NOVA often assigns foods to different groups depending on exact ingredients or whether an item is home-prepared or commercially produced. Rather than listing all potential groupings, the table shows the category in which most commercially available products would typically fall.

Table 2. Examples of CHIPS food classifications compared with NOVA, with rationale and supporting evidence.

Food Item	CHIPS Group	NOVA Group	Rationale for HISS Placement	Health Evidence Summary / processing notes	References
Canned fruits and vegetables	Group 1	Group 3*	Minimally processed whole food; processing is primarily for preservation. Serve as nutritional options that can be more economical than fresh produce.	Fruits and vegetables are associated with a huge array of health benefits and canned varieties can contribute to individuals increasing their daily consumption.	[13,28–30]
Canned beans, lentils and chickpeas	Group 1	Group 3*	Minimally processed whole food; processing is primarily for preservation. Canned pulses retain many of the same nutritional benefits as those cooked from dried. Even when canned in brine, most of this can be washed off when rinsing.	Pulses are associated with a wide variety of health benefits including reduced blood pressure, body weight, LDL cholesterol, and lower rates of cancer and heart disease. These benefits extend to canned pulses, not only those cooked from dried.	[31,32]
Soy and other plant milks (plain, fortified)	Group 2	Group 4*	Industrially processed but shown to be neutral to beneficial for health and are used as a dairy alternative to fill nutritional gaps that may result for those avoiding dairy/animal products. Currently, NOVA penalises those eating plant-based which is not evidence based.	Neural to favourable effects on total and LDL cholesterol, bone health, body weight, blood pressure and glycaemic response compared to dairy milk. Possible anti-cancer benefits for some e.g. soy milk. Effects don't seem to differ between milk made with whole soybean vs soy protein isolate.	[14,33–39]
Tofu, natto, miso and tempeh	Group 1	Group 3/4	Traditional, minimally processed soy product with consistent health associations.	Soy products including tofu and tempeh have been linked with reduced cancer risks, lower rates of cardiovascular disease, reduced blood pressure, LDL and total	[40–42]

				cholesterol, assistance with symptoms of menopause and several other health benefits.	
Quorn (mycoprotein) and textured vegetable protein (TVP)	Group 2	Group 4	Nutritionally valuable meat alternatives for plant-based individuals, minimal additives, evidence of positive impact on health.	RCTs on mycoprotein show lower total cholesterol, lower LDL, lower triglycerides, neutral to positive effects on blood glucose and insulin responses, positive effects on satiety/energy balance, and positive effects on muscle protein synthesis. Few studies directly only TVP but there is plentiful evidence on the benefits of soy protein (see previous row).	[43–48]
Cacao	Group 1	Group 4	Comparable to coffee roasting, not an ultra-processed product but instead a traditional ingredient in e.g. Samoan Cuisine.	Plentiful evidence of health benefits of cacao products (see next row) but raw cacao is classified based on minimal processing.	[49]
Cocoa powder, and plain dark chocolate with over 80% cocoa	Group 2	Group 4	Can be moderately rather than ultra-processed with few ingredients. Neutral to beneficial for health and distinct from sugary hot chocolate powders and bars.	Neutral to beneficial impacts on cardiovascular health, through the reduction of blood pressure, reduced LDL and total cholesterol, improvement of vascular and endothelial health and reduction of platelet aggregation.	[50–54]
Wholegrain bread (including mass produced)	Group 2	Group 3–4	Despite being mass produced, wholewheat breads have been associated with beneficial rather than detrimental effects on health in many studies looking both specifically at	Whole grains including wholewheat bread are associated with lower risk of type 2 diabetes, coronary heart disease, cardiovascular disease, cancer, lower all-cause	[55–57]

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	Group 2	Group 1	UPFs, and those addressing whole grain consumption.	mortality and lower mortality from respiratory disease and diseases of the nervous system.	
Processed grains (brown rice, white rice, quinoa, puffed millet, flaked millet, puffed teff, flaked teff, couscous, bulgur, pearl barley, rolled oats, instant oats, pasta, noodles, soba, udon, polenta, puffed quinoa, puffed wheat, flaked spelt, cracked wheat, semolina, polenta, pearled farro)	Group 2	Group 1	Separated from minimally processed grains (e.g. groats, berries and whole millet) due to additional levels of processing.	Grains are processed into flaked, puffed, pearled, cracked, rolled, or milled forms (sometimes cooked and dried, like pasta/couscous) compared to group 1 whole intact grains. Grains have been moved to group 2 based on processing rather than health outcomes**.	[58]
Flavoured and low-fat yoghurts	Group 2	Group 4	Fermented whole food with some added components; judged on healthfulness and base ingredients.	Yoghurts, including those classed as UPFs have been associated with lower incidence of type 2 diabetes, cardiovascular disease, and have favourable to neutral effects on metabolic markers.	[55,56,59]
Milk and plain yoghurt	Group 2	Group 1	Classified as group 2 rather than group 1 as modern milk is moderately processed including heat treatment and homogenisation before yogurt/butter/cheese production.	Milk is filtered, standardised, homogenised, heat-treated, possibly fortified, and then packaged. We believe this is better characterised as moderate processing.	[60]
Protein powder	Group 2	Group 4	Beneficial food supplement that can increase protein intake and digestibility.	No evidence of harm and overall evidence of being health supportive,	[61–64]

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				especially for older adults, plant-based individuals, athletes, and people recovering from illness.	
All alcohol	Group 3***	Group 3***	Regardless of fermentation method, alcohol is classified as Group 3 due to consistent evidence of harm.	In 2019, 2.6 million deaths were attributed to alcohol consumption. Evidence consistently shows harm, including increased risk of liver disease and several cancers.	[65–68]
Plant based meat alternatives (PBMA)	Group 3	Group 4	Lack of evidence regarding health means PBMA are left in CHIPS 3, however with a caveat in the AI tool and could be moved in future CHIPS versions.	From short term trials so far conducted, PBMA appear to be neutral to beneficial. However, long term data is absent. The AI tool will note that these can be useful sources of protein for those eating plant-based and the decision to choose PBMA or whole plant sources of protein is individual and based on e.g. protein requirements, body composition etc.	[43,69,70]
Zero alcohol beer and wine	Group 2	Group 4	Given the known harms associated with alcohol, these options represent a better choice than alcoholic beverages, while still containing beneficial compounds such as polyphenols and being lower sugar than sugar sweetened beverages.	Several trials have shown neutral to beneficial effects on oxidative markers (beer and wine), markers of inflammation (beer and wine) and infection (beer), blood pressure (wine) and gut health (wine).	[71,72]
Cured and smoked meats (processed meats) including bacon, ham, sausages,	Group 3	Group 3 (or 4 if when additives present)	Despite being only moderately processed and pre-industrial, there is abundant evidence of negative health impacts.	Increased risk of cancers, heart disease, type two diabetes and chronic obstructive pulmonary disease, even when	[73–75]

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salami, luncheon meat etc				controlling for confounding factors including fruit and vegetable intake.	
Sugar (all types)	Group 3	Group 2	Despite being only moderately processed, evidence of negative impacts on health are clear.	High levels of free sugars in the diet are associated with increased energy intake, body fatness/weight gain, and worse cardiometabolic health.	[76,77]
Fruit drinks and juice with added sugar	Group 3	Group 3	Moderately processed but strong evidence of harm.	Sugar sweetened beverages are associated with increased body fatness/weight gain and cardiometabolic diseases.	[76,78–80]
Confectionary and cakes (including homemade)	Group 3	Group 3 when homemade	Moderately processed but nevertheless clear that cakes and confectionary are associated with negative impacts on health.	High levels of free sugars in the diet (including from cakes and confectionary) are associated with increased energy intake, body fatness/weight gain, and worse cardiometabolic health.	[76,77]
Hummus, pesto, guacamole, pasta sauce and similar products, including when store bought	Group 2	Group 4	Traditional foods that are part of healthful eating patterns, despite potential for the presence of additives. This takes a pragmatic approach to eating.	Pulses, and ingredients such as olive oil, tomato, and avocado are associated with a wide range of health benefits and are staples in traditional diets such as Mediterranean.	[18,81–83]

*NOVA often assigns foods to different categories depending on exact ingredients or whether an item is home-prepared or commercially produced. Rather than listing all potential groupings, the table shows the category in which most commercially available products would typically fall. **While wholegrain pasta provides greater fibre and micronutrient content (and will be promoted within the app), evidence does not suggest that white pasta is harmful when consumed as part of traditional dietary patterns such as Mediterranean cuisine [18,83,84]. By contrast, high intakes of white rice are consistently associated with increased risk of type 2 diabetes [85]. For reasons of practicality and cultural inclusivity, CHIPS classifies all rice and pasta as processed grains (Group 2). However, the AI tool provides stronger prompts encouraging substitution of white rice with brown rice or other wholegrains, while offering gentler nudges for choosing wholegrain pasta. *** Note that Group 3 in CHIPS (the highest category, to be largely avoided) is not equivalent to Group 3 in NOVA, as NOVA is a four-group system while CHIPS uses three.

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4. Discussion

This paper presents CHIPS, a food classification framework that integrates degree of processing with evidence of health impact and a pragmatic/intuition check. Developed in response to widespread critiques of the NOVA system [11–20], CHIPS aims to offer a more flexible and evidence-aligned alternative that remains grounded in a food-based, rather than nutrient-based, approach.

NOVA was a groundbreaking contribution to public health nutrition, and it deserves credit for shifting global discourse toward the role of food processing in shaping dietary patterns and health outcomes. It challenged the reductionist focus on isolated nutrients and gave structure to discussions of UPFs, catalysing research, policy, and the modification of dietary guidelines around the world, where it has even been incorporated into several national guidelines [86]. As such, it has been enormously useful as a starting point for communicating the importance of food processing to both policymakers and the public. However, as its influence has grown, NOVA is increasingly treated as a fixed, objective standard, despite conceptual ambiguities and emerging evidence that not all UPFs are equally harmful [20,55,87,88]. While NOVA has been highly influential, its dominance risks stalling progress. Scientific tools should evolve, and there is now a clear need for competition in this space. Other frameworks, such as SIGA, UNC, IFIC and IARC, also illustrate the trade-offs in this area: SIGA adds detailed additive markers and nutrient thresholds and is highly evidence-based, but too complex for use outside research contexts, while most other systems fail to account for food quality or demonstrated impact on health [24]. These limitations highlight why a pragmatic, evidence-aligned alternative is needed. CHIPS represents not only an alternative but a necessary next-generation framework, retaining NOVA's strength of focusing on foods rather than nutrients, while advancing the field through evidence integration, usability, and cultural relevance.

A distinctive feature of CHIPS is its pragmatic layer of an 'intuition check', designed not only to align with how people commonly perceive foods but also to safeguard face validity by preventing classifications that are technically defensible yet counterintuitive. This prevents counterintuitive results that undermine trust and makes the framework more usable in both public health and digital applications. For example, while some studies report negative associations between confectionary or biscuit consumption and health concerns [89], a rational approach suggests these findings may reflect inaccurate reporting or reverse causation; people already managing diabetes or trying to lose weight often avoid such items, rather than the foods themselves being protective. Epidemiological studies that rely on food diaries or food frequency questionnaires are prone to substantial misreporting [90–93], which can distort associations, making it all the more important to incorporate an intuition or logic check when interpreting and applying classifications.

The CHIPS classification itself does not incorporate contextual considerations; however, the CHIPS AI tool is designed to address this. It acknowledges that not all foods fall neatly into one category, and that some items are context dependent, with evidence that cuts both ways. For example, in agreement with NOVA, flavoured milks were placed in Group 3, reflecting research linking them with higher energy intake and weight gain in children, even though they may also provide calcium, an important nutrient of concern for some [94]. Similarly, while both sugar-sweetened and sugar-free sodas are classified as Group 3, replacing the former with the latter represents a positive change [95]. These grey areas highlight challenges inherent in any categorical system, not just CHIPS. The CHIPS technology is designed to address this by providing context-specific prompts. For instance, in the case of soda, the AI tool suggests swaps such as water or tea but also acknowledges that switching from sugar-sweetened to sugar-free varieties is a beneficial step.

By distinguishing processed foods with health benefits (e.g., wholegrain breads, fermented dairy, plant milks) [55,56,88] from truly harmful ultra-processed products (e.g. biscuits, chips, sweets), CHIPS reframes the role of processing. It emphasises that processing is not inherently negative and can enhance accessibility and shelf life without compromising health [11]. Importantly, it is neither realistic nor equitable to expect complete removal of all processed products from diets [13,18,20]. Foods such as tinned vegetables and legumes, for example, can be cost-efficient, time-saving, and nutritionally valuable [28–32], and are therefore placed in CHIPS Group 1. Recognising this ensures the framework supports feasible dietary improvements that are accessible across income levels and everyday circumstances. Equally, cultural context matters: foods such as cacao or tofu are minimally processed and have long-standing roles in traditional diets [42,96], yet in Western contexts they are sometimes conflated with ultra-processed chocolate or meat substitutes. CHIPS avoids this conflation by grounding classifications in both evidence and cultural relevance.

Future validation studies will test whether diets with varying proportions of CHIPS Group 3 foods correlate with differences in macro- and micronutrient profiles compared to manual database analysis. While CHIPS classifications are expected to correlate with nutrient-based indicators of diet quality, this is an advantage rather than a limitation. Demonstrating such overlap will provide further evidence that the CHIPS framework captures dietary quality in a way that aligns with nutrient-based indicators. This allows public health guidance to reflect nutrient quality indirectly, without requiring nutrient counting, thereby improving usability. At the same time, CHIPS offers a simpler, food-based approach that avoids controversies over specific cut-off points for nutrients and is easier for the public to apply. Further, it is designed to be inclusive of diverse dietary preferences and patterns, so it can meaningfully support individuals following traditional, vegetarian, vegan, or reduced-carbohydrate diets, rather than privileging one model of "healthy eating" over another. This positions CHIPS as a practical public health tool, particularly valuable for people with lower food literacy, by moving the focus away from nutrient tracking and towards straightforward, real-food guidance.

Limitations

No classification system is without limitations, and CHIPS is no exception. Any attempt to categorise foods inevitably simplifies complexity, and some nuance will be lost. For instance, products such as peanut butter vary widely in ingredient quality, from 100% ground nuts to versions with added sugar, salt, and oils; yet all are classified uniformly as Group 2. Similarly, the CHIPS AI tool relies on digital imagery and cannot always detect subtle formulation differences. While this may occasionally lead to misclassification at the product level, the framework was deliberately designed to prioritise population-level dietary patterns over fine-grained distinctions between individual brands or formulations. In addition, because CHIPS incorporates evolving evidence, there may be times when foods need to shift between categories as new science emerges. While this flexibility can be seen as a limitation compared to NOVA's fixed, processing-based logic, it is also a strength: it allows CHIPS to adapt in line with evidence, a trade-off that far outweighs the criticisms currently levelled at NOVA.

The drivers of poor diet quality and obesity are not marginal ingredient choices but the widespread overconsumption of highly processed, highly palatable energy dense and nutrient-poor foods [97–100]. CHIPS therefore aims to encourage broad shifts away from Group 3 products and toward more whole and minimally processed foods, without getting lost in minor variations. As noted above, some foods will always remain borderline or context dependent, and CHIPS acknowledges these grey areas while still prioritising population-level guidance. As with any classification tool, ongoing refinement will be needed as new foods emerge, evidence evolves, and digital tools improve in their ability to detect formulation detail.

5. Conclusions

NOVA initiated an important shift by drawing attention to the role of food processing in public health nutrition. But like any scientific tool, it should evolve in light of new evidence. CHIPS represents a next-generation framework which builds on NOVA's strengths while addressing its limitations to better reflect the complexity of modern food environments, health outcomes, and practical dietary needs. By integrating processing level with health evidence, CHIPS supports more inclusive and usable guidance for individuals, researchers, and policymakers. In doing so, CHIPS positions itself as a flexible, evidence-aligned system capable of supporting research, policy, and digital health applications in ways that NOVA cannot. Future work will focus on validating CHIPS across diverse populations, exploring its integration into national dietary guidelines, and refining its digital implementation through continued testing and user engagement.

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Abbreviations

The following abbreviations are used in this manuscript:

UPF Ultra Processed Food
CHIPS Combining Health, Intuition, Processing and Science
HISS Human Interference Scoring System

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