Mapping ultra-processed foods (UPFs) in India: A formative research to adapt and inform a UPF consumption screening tool for India

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Abstract

Background

Increased consumption of ultra-processed foods (UPFs) which are usually high in salt, sugar, fats, preservatives and additives are associated with diet-related non-communicable diseases. In India, there are no standard criteria for identifying UPFs that are similar to Nova food classification (based on extent and purpose of industrial processing). Scientific literature in India classifies foods as unhealthy based on the presence of excessive amounts of specific nutrients which makes it difficult to distinguish UPFs from other commercially available processed foods. The purpose of this paper is to map UPFs in the Indian food market and assess their consumption by Indian population.

Methods

A literature review and online grocery market survey were conducted to map the types of UPFs in the Indian food market, their availability and consumption. In online grocery market survey, the ingredient list of the foods provided on their label were scrutinized for the presence of ultra-processed ingredients. All UPFs identified were free-listed, followed by saliency analysis to understand preferred UPFs by Indian consumers. Findings were then triangulated to develop Indian UPF sub-categories to inform a UPF screening tool.

Results

UPFs lack uniform definition in India; hence proxy names such as *junk-foods, fast-foods, ready-to-eat foods, instant-foods, processed-foods, packaged-foods, high-fat-sugar-and-salt foods* are used for denoting UPFs. Our data showed that the current literature from India does not clearly differentiate between processed culinary ingredients (Nova food group 2), processed foods (Nova food group 3) and UPFs (Nova food group 4). Saliency analysis showed sugar-sweetened beverages (e.g. sodas and cold-drinks) are the most preferred UPFs while frozen ready-to-cook/eat foods (e.g. chicken nuggets and frozen kebabs) are least preferred. Online grocery market survey also revealed that traditional recipes are transitioning into UPFs. Based on our data, a screening tool for UPF consumption consisting of twenty-four UPF sub-categories were listed and divided into three sections: drinks and beverages, ready-to-eat and ready-to-cook foods was developed.

Conclusion

India needs to adapt Nova food classification and systematically define Indian food categories based on level of processing, followed by an assessment of the extent of UPF consumption in India. Clear policy guidelines and regulations around UPF consumption should be devised to address the impact of UPF consumption on NCDs.

Background

Non-communicable diseases (NCDs), one of the leading causes of premature morbidity and mortality across the globe, kills about 41 million people each year i.e. equivalent to over 7 out of 10 deaths worldwide (1). Deaths due to NCDs have been on the rise in India from 37.9% in 1990 to 61.8% in 2016 (2, 3), which is largely attributed to one of the major risk factors i.e. overweight/obesity (4). The recent national-level data shows an increasing prevalence of overweight and obesity among all segments of the Indian population (5, 6) Additionally, due to their thin fat phenotype‡, Indian infants and children, who comprise almost ¼ of the total population, are also predisposed to obesity (7, 8). These risk factors are further amplified by changing food environments and behavioural variables such as tobacco, alcohol, drug use and low

physical activity (9). Exposure to unhealthy food environments in genetically predisposed children further increases their risk of developing obesity and diet-related non-communicable diseases (DR-NCDs) in the long term (10).

The rapidly changing food environment is characterized by diets transitioning from minimally-processed staple foods (such as pulses and coarse cereals) high in vitamins, minerals and fibre to refined, processed and ultra-processed foods (UPFs) (11, 12). The Indian population is exposed to a wide variety of ultra-processed food products which are hyper-palatable, packaged, convenient, affordable and have a longer shelf life such as sugar-sweetened beverages, chips, commercial bakery products such as biscuits and bread, and ready-to-cook meals. These food products have increased in the food supply and are widely advertised and targeted towards vulnerable sections of the population including children and youth (13, 14). In addition, consumer demand for convenience foods has also increased due to the increased incomes, the number of nuclear families, single-member households and working women (15, 16). Further, these commercial UPFs have largely penetrated the rural boundaries of the country and are likely making their way into households of diverse geographic and socio-economic attributes (17, 18).

To identify UPFs from a wide range of food products available, a food classification system called the "Nova food classification system" based on the purpose and the level of processing was developed by Monteiro et. al. 2009 (19). The Nova system categorizes foods into four categories: (1) unprocessed/ minimally processed foods, (2) processed culinary ingredients, (3) processed foods and (4) ultra-processed foods (19). A series of industrial processes, chemical preservatives, additives, artificial colours and/ or flavours are used to produce the highly palatable and attractive UPFs (20). Several of these food products are high in saturated fats or trans-fats, added sugars, and salt and low in dietary fibre, various micronutrients and other bioactive compounds (21, 22, 23, 24, 25, 26, 27, 28, 29).

Overconsumption of UPFs has been associated with higher body mass index (BMI), obesity and DR-NCDs including type-2 diabetes, hypertension, cardiovascular diseases, and certain types of cancers (30, 31, 32). Given their potential role in contributing to the NCD burden in India, it is crucial to understand the range of UPFs available in the Indian market and their consumption. Therefore, this paper aimed at (i) mapping the types of UPFs in the Indian food markets, (ii) assessing the composition of these food products to confirm that they qualify as UPFs (iii) assessing their consumption among Indian consumers, (iv) listing the UPFs in order of their preference among the Indian consumers. This exercise provided vital information for developing India-specific UPF sub-categories to inform a tool that would be used for screening UPF consumption in the Indian population.

Methods

The present study was based on a secondary review of available literature complemented by an online grocery market survey that was conducted between April 2021 and February 2022. The literature review was conducted in phase I to map the various types of UPFs reported in different studies assessing their consumption and availability among various population groups and regions in India. It also aimed at collating proxy nomenclatures used for UPFs (any food classification such as *junk food, or convenience food* that is used to identify foods and beverages with characteristics of UPFs as defined by the Nova food classification system) in peer-reviewed research on food intake in India. Articles for review were searched from three electronic databases (Medline, NCBI and Google Scholar). Based on the proxy names for UPFs used in the policy documents (33, 34, 35, 36, 37, 38) a literature search was conducted by using a combination of the following key terms while incorporating the Boolean logic: *junk food*, fast food*, modern food*, westernized food*, ultra-processed food*, UPF*, convenience food*, ready-to-eat food*, ready-to-eat snack*, ready-to-cook food*, RTE instant food*, frozen food*, canned food*, tinned food*, processed food*, packaged food*, high fat, sugar and salt food* and HFSS*.* Search limiters such as India for location and publication dates between January 2012 and December 2022 were used.

The inclusion criteria were, studies: (i) that included well-defined UPFs or their proxy nomenclature with examples, (ii) conducted in rural and/or urban areas of India, (iii) published in the English language, (iv) published between 2012 and 2022 (based on the high growth in UPFs sales during this decade) (39, 40). Publications that did not define the food

category studied such as processed food, UPF, HFSS food or citing any examples of foods under the category were excluded from the review. This study did not include review articles on the consumption or availability of UPFs in India. Data from articles reviewed were collated into MS-Excel to record key variables such as proxy terms for UPFs, their examples, location of the study (national/specific state), geographical area (urban/rural), sample size, sampling method/study design, age group (years) consuming the food category and data collection tool (Additional file 2).

An online grocery market survey for extracting detailed information on the UPFs identified in the mapping exercise was also conducted which complemented the literature review. The objective was to review the specific food labels (particularly the ingredient lists) and confirm if the products qualified as UPFs. For this online survey, three researchers reviewed the most popular Indian online grocery stores like Big Basket, Grofers, and Amazon which are considered as largest grocery retail brands (41). During the survey, the preliminary free list of foods and beverages considered as UPFs prepared from the literature review were cross-checked for their composition and processing techniques based on their food labels. This activity confirmed that the food product under question qualified as UPF. All the food products were scrutinized for the steps of processing and use of ingredients such as sugars (fructose, invert sugar, maltodextrin, dextrose, lactose, high fructose corn syrup, fruit juice concentrates), modified oils (hydrogenated fats, interesterified fats), extracted proteins (hydrolysed proteins, soy protein isolate, gluten, casein, whey protein, mechanically separated meat), additives (flavours, flavour enhancers, colours, emulsifiers, emulsifying salts, artificial sweeteners, thickeners, acidity regulators and foaming, anti-foaming, bulking, carbonating, gelling, glazing, leavening and anticaking agents,) and class II preservatives (such as benzoic acid, sorbic acid, sodium and calcium propionate, sodium diacetate) which classified them as UPFS (19, 42).

Using the data from the literature reviewed, a saliency analysis was conducted to determine the commonly purchased, preferred and/or consumed (collectively referred to as 'preferred' in this paper) UPFs in India. Indicators including purchasing trends, consumer preferences and frequency of consumption of UPFs amongst Indian consumers were extracted. Saliency is a statistical accounting of items for rank and frequency of mention, across all respondents within a given domain (for example, a colour chosen most often from a free list of ten colours by a study population, is referred to as most salient) (43). For this, the UPFs identified were sub-categorized and sorted out as 'most to the least preferred' UPFs by consumers (Additional file 1). Accordingly, a saliency score was calculated for each sub-category of UPFs using a set of steps and formulas (43), as illustrated in Fig. 1. The UPF sub-categories were then classified (as per consumer preference) according to the composite salience score cut-offs (defined after dividing the distribution of the composite salience scores obtained for each sub-category into thirds) as follows: (i) ≥ 0.61 as commonly preferred, (ii) 0.61 – 0.51 as moderately preferred, and (iii) < 0.51 as rarely preferred UPFs.

Results

The literature search and selection process is illustrated in Fig. 2. A total of twenty-three research articles that matched the inclusion criteria were included in the final review. An overview of the articles with information on variables such as the proxy nomenclature for UPFs used, examples of food products under the proxy nomenclature, location, geography (rural and/or urban) where the study was conducted, age groups of the study participants, sample size, sampling methodology and data collection method is provided in Additional File 2. These studies were conducted in both rural and/or urban areas of different regions of the country among a diverse population aged between 9 to 69 years (Table 1).

Table 1
Demographic characteristics of the participants from the reviewed studies (n = 23)

Region	Number of studies	Geographical area				Age group (years)
		Rural	Urban	Both	Not Defined	
East	2	0	1	1	0	12−18
West	3	0	3	0	0	10−24
North	5	1	4	0	0	9−20
South	9	1	5	0	3	11−60
PAN India	4	0	1	2	1	10−69
TOTAL	23	2	14	3	4	9−69

Several proxy nomenclatures and classifications such as fast foods, junk foods, instant foods, processed foods etc. used for UPFs in the Indian context were identified in peer-reviewed literature. Table 2 details the proxy nomenclature used along with the food items listed under those categories. Several processed foods (Nova group 3) and culinary ingredients (Nova group 2) were clubbed under these proxy nomenclatures of UPF.

Table 2
Nomenclature and examples of foods considered as UPFs and their proxies in Indian studies (n = 23)

UPF and its proxy nomenclature	Foods and beverages identified as UPF	Non-UPFs items clubbed with UPF	References
Ultra-processed foods	Chips, cake, ready-to-serve beverages, beverage concentrates, bakery products and confectionery		44
HFSS	*Namkeen, papad*, packaged chips, soya or mustard sauce, processed or packaged cheese, butter	*Papad, namkeen* (if freshly prepared)	45
Processed foods	**Sweet snacks**: chocolate, honey, biscuits, cookies, jams, peanut butter, chocolate spread, *rusk* (excludes prepared sweets and cakes) **Salty snacks**: crackers, potato chips, banana chips, and other salty snacks **Soft drinks**: carbonated drinks, juices, milk-based drinks, squashes and powdered drinks **Milk**: liquid milk and milk powder **Dairy products**: butter, *ghee* (clarified butter) and cheese **Edible oils**: edible oils and *vanaspati* (partially hydrogenated vegetable oil) **Processed wheat**: *atta* (wheat flour), bread, vermicelli and pasta **Other processed foods**: soup, ready-to-eat meals, ready-to-cook mix, frozen food, breakfast cereals, noodles, ketchup, table sauces	Honey Liquid milk Butter, *ghee* Edible oils *Atta* (Processed wheat), vermicelli, pasta Breakfast cereals (if not coated/extruded)	46
	Masala puri, churmuri, panipuri, noodles, *gobi manchurian*, fried rice, coffee, tea, cola beverages, fruit beverages, *kharasev, kodubale, chakli, bajji, bonda, vada*, chips, puffs, cake, bread, *rusk*, bun, puffed rice	*Masala puri, churmuri, panipuri*, fried rice (if freshly prepared), coffee, tea, *kharasev, kodubale, chakli, bajji, bonda, vada*, (if freshly prepared), puffed rice	17
Packaged foods	Edible oils, ready meals, sauces, dressings and condiments, soup, sweet spreads, baby foods, dairy Confectionery, ice cream and frozen, desserts, savoury, snacks, sweet biscuits, snack bars and fruit snacks, baked goods, breakfast cereals, processed fruit and vegetables, processed meat and seafood Rice, pasta and noodles	Edible oils Plain breakfast cereals, processed fruits and vegetables Rice, pasta, and noodles	40
Junk foods	Burger, pizza, pasta, instant noodles	-	6
	Chips, chocolates, bakery products (pastries, cream rolls, patties), soft drinks, sweetened beverages (squashes, sweet juices), sweets (*ladoo, jalebi, barfi*), ice cream	Sweets (*ladoo, jalebi, barfi*) and *samosa* (if freshly prepared)	18

UPF and its proxy nomenclature	Foods and beverages identified as UPF	Non-UPFs items clubbed with UPF	References
	South Indian: *Idli, dosa, vada, uttapam* **Bakery items**: Biscuits, bread, cake, pastry, patties **Italian food**: Pizza, pasta, macaroni **Chinese**: *Maggi, manchurian*, noodles, spring roll **Sweet dish**: Chocolate, *halwa*, ice cream, *mithai* **Fried food**: bread *pakora*, burger, *chaat, kachori, kulcha chana*, potato chips, *samosa, tikki* **Beverages**: tea, coffee, carbonated drinks, juices	*Idli, dosa, vada, uttapam* (if freshly prepared) Bread *pakora, chaat, kachori, kulcha chana*, potato chips, *samosa, tikki* Tea, coffee	47
	Ice-creams, sweets, chocolates, fried foods, bakery foods, pizza, fruits, carbonated beverages	Fried and bakery foods (if freshly prepared)	48
	Pizza, burger, puffs, pastry, cake, biscuits, french fries, noodles, doughnuts, Pepsi, Coca-Cola, Slice, 7-UP, Bovonto, Sprite	-	49
	Cakes, chocolates, ice-creams, sweets, chips, *Kurkure*, street fast foods, Indian deep-fried foods, noodles	Sweets, Indian deep-fried foods, street fast foods (if freshly prepared)	50
Indian fast foods	*Chat, pakora, samosa*, patties, *panipuri, puri-kachori, chole bhature*, stuffed *paratha, idli, dosa, vada, upma, poha, jalebi*, sweets, non-veg items, roasted veg and non-veg items	*Chat, pakora, samosa*, patties, *panipuri, puri-kachori, chole bhature*, stuffed *paratha, idli, dosa, bada, upma, poha, jalebi*, sweets, non-veg items, roasted veg and non-veg items	51
Fast foods	Carbonated drinks, fruit juice, milk and shakes	Fruit Juices (if freshly prepared), milk	52
	Pizza, burger, chocolate, ice cream, cookies/cake, *chowmien*, pasta and *Maggi*.	Pasta	53
	Chocolates/pastries/sweets, *papads* and pickles, biscuits or other bakery items like bread, toast, buns, cold drinks/soft drinks, potato chips/*namkeens*/deep-fried snacks, ice cream/milkshakes, *paneer*, cheese/butter, pizza/burger/frankie or any other fast food including Chinese food	Sweets, *papads* and pickles (if freshly prepared), *namkeens*/deep-fried snacks, *paneer*, butter	54
	Pizza, burger, *samosa*, chocolates	*Samosa* (if freshly prepared)	55
	Fizzy drinks, tea, coffee, mocktails, slushy, milkshakes, pizza, french fries, burger, sub, rolls, cakes/pastries	Tea, coffee	56
	Pastries, pizza, french fries, cheese items, Chinese food, soft drinks, coffee/tea, sweetened fruit drinks, energy drinks	Coffee/tea	57
Fast foods, Junk foods, Instant foods, street foods	**Fast foods**: Burgers, pizzas, fries, hamburgers, patties, and nuggets, Indian foods like *pakora, samosa, namkeen* etc.	*Pakora, samosa, namkeen* etc (if freshly prepared) Corn flakes	58

UPF and its proxy nomenclature	Foods and beverages identified as UPF	Non-UPFs items clubbed with UPF	References
	Junk foods: Chips, chocolate, ice cream, soft drinks, and sandwich	*Chaat, gol gappa, samosa, tikki*, (if freshly prepared)	
	Instant foods: Noodles, corn flakes, and soup powder		
	Street foods: *Chaat, gol gappa, samosa, tikki*, noodles, *chowmein*, and *vada pav*		
Convenience foods	Ready-to-eat (RTE) *dosa*, RTE *idli*, RTE *chapathi* and RTE *parathas*, RTE *upma*	-	59
Modern foods	Bread, fruits and juices, cereals, eggs and oats	Fruits and juices (freshly prepared), cereals, eggs, oats	59
Western fast foods	Pizza, burger, french fries, doughnuts, hot dog, noodles	-	51
Food, snacks and beverage	Breakfast cereal, bread/toast, biscuits/cookies, cake/pastries, french fries, packaged potato chips, pizza, burger, ice cream, ice candy, chocolates, vegetable roll/wrap, chicken roll/wrap/nuggets, egg roll, popcorn, noodles, tea (black tea/milk tea/Irish tea, coffee (cold coffee/black coffee), health drinks (*Bournvita/Horlicks*), soft drink (Sprite, Coke, Pepsi), energy drink (Red Bull, Gatorade)	Breakfast cereal (plain), tea (black tea/milk tea/Irish tea), coffee (cold coffee/black coffee)	60
Instant food products	*Rasam* mix, lemon rice mix, *puliyogare*, brinjal *kulambu* mix, pasta, *sambhar* rice and masala, *pulao* mix and *paneer* butter masala	-	61
Soft drinks	Pepsi, Fanta, Slice, Maaza, Coca-Cola	-	62

Table 2 demonstrates a lack of standard and uniform definitions for UPFs in India. Nova food classification categories were merged and addressed with proxy nomenclatures of UPFs such as junk, modern, westernized, convenience, ready-to-eat/cook, HFSS, packaged and processed foods in included studies. Thus, with this limited data with no clear-cut definition for UPFs, the actual estimation of the consumption of UPFs in the Indian context is difficult.

The online grocery market survey supplemented the information derived from the literature review and complemented information on the preliminary free list of UPFs identified in the Indian food environment. Packaged Indian traditional foods and snacks such as bottled and packaged pickles, *namkeens* (cereal and pulse-based extruded snacks), *papads*, frozen non-vegetarian meals and snacks, and frozen ready-to-eat meals (like *rajmah curry* and rice, *biryani, dal makhni*, etc.) were specifically checked for ultra-processing, and presence of ingredients and additives that qualified them as UPFs. Table 3 presents the ingredients found in these traditional snacks that confirmed their UPF classification. Ready-to-eat meals were excluded from the list of UPFs as their composition did not include ingredients that qualify them as UPFs. Label readings of 375 packaged food items were completed and 81 foods were identified as UPFs. Extensive label reading provided more clarity on the ingredients of the identified UPFs and their correct classification.

Table 3
List of traditional Indian snacks/meals and ingredients that qualify them as UPFs

Traditional Indian snacks/meals	Ingredients that qualify for UPFs
Pickles	Acidity Regulator (INS 330, 260), Preservative (INS 211), Capsicum Extract, Paprika Extract
Namkeens	Maltodextrin, Dextrose, Milk Solids, Acidity Regulators (INS 330 & 296), Flavor Enhancers (INS 627 and INS 631), Citric Acid (INS 330), Paprika Extract (INS 160 C), Tomato Powder, Tamarind Powder, Date Powder, Anticaking Agent (INS 551), Spinach Powder, Edible Starch, Potato Solids, Natural [E100 and E141(ii)] and Synthetic food colour (E133 / FD & C Blue No.1) and Added flavour (Nature identical flavouring), Leavening Agent (INS 500 (I), Synthetic Food Colours (INS 133), Compounded Asafoetida [Carrier (INS 414), Soy Lecithin (E322), Antioxidant (E319)
Frozen non-vegetarian foods/snacks	Emulsifiers [INS 451 & INS 450], Sugar, Antioxidant [INS 250], Milk Solids, Modified Starch, Milk Protein, Stabiliser (sodium triphosphate), Onion extract, Spice extracts, Preservative (sodium nitrite), Soya Protein, Texturizer (INS 451), Preservative (INS 250), Color Fixative (INS 250), Raising Agent (INS 500), Maltodextrin, Wheat Fibre
Papads	Raising agent [INS 500 (ii)], Preservatives (INS 200), Raising agent [INS 500 (i) and INS 500 (ii)], Sodium bicarbonate [E 500 (ii)]

Several food items were also found to be in transition from processed foods to UPFs. This was because some brands of these foods belonged to the processed foods category while other brands fitted into the category of UPFs as per the Nova food classification system. Such foods include ready-to-eat (RTE) breakfast cereals (e.g. *poha, upma*, etc.), RTE Indian curries (e.g. *paneer makhani, butter chicken*, etc.), RTE meals (such as *biryani*, etc.), Indian RTE bread (e.g. *thepla*, *paratha*, etc.), ready-to-cook mixes (e.g. *idli* mix, *dal vada* mix, etc.) and many more. Traditional packaged foods like *poha*, instant *idli* or *dosa* or *sambhar* or *dhokla* mixes, etc. qualified as UPFs after screening their labels based on their level of processing and the presence of additives.

Following this, the specific UPFs identified were sub-categorised and consumer preferences were assessed using saliency scores. Table 5 shows the order of preference towards different UPF sub-categories based on the saliency scores. The last column in the table indicates 'commonly', 'moderately' or 'rarely' preferred UPFs by consumers in India. The commonly preferred UPFs were sugar-sweetened beverages (such as cold drinks, diet coke, sodas, and energy drinks) followed by extruded snacks (such as potato chips, cheese balls, puff corns, etc.) and breads. Meanwhile, the three rarely preferred UPFs were margarine and frozen/ packaged vegetarian and non-vegetarian snacks and meals (such as stuffed/plain *parantha, naan, palak paneer, rajma*, cutlets, fish/seafood snacks, salami, sausages).

The outcome of this extensive exercise of literature review, online grocery market survey and saliency analysis was the development of 24 sub-categories of UPFs for India (Table 4).

Table 4
Sub-categories of UPFs (n = 24), divided into three sections

Section A – Drinks and Beverages

A1. Aerated/cold/soft drinks; Diet drinks

A2. Energy drinks; Sports drinks (like clear drinks with added electrolytes, vitamins, minerals)

A3. Packaged and branded, bottled or tetra packs fruit/vegetable-based juices (like mango juice, orange juice, vegetable juice); Packaged and branded drink concentrates (like *sherbets, thandai);* Packaged and branded powdered drink mixes (like fruit flavoured mixes, iced tea mix)

A4. Packaged and branded flavoured milk (like chocolate milk); Packaged and branded milk or malt-based powdered health drinks, Protein powder; Packaged and branded yogurt/curd-based drinks (like flavoured *lassi*, probiotic drinks); Packaged and branded milk substitutes (like soymilk, almond milk); Ready-to-drink tea/coffee mixes (like masala tea, choco mocha); Dairy whiteners

Section B – Ready-to-eat

B1. Packaged and branded bread (like sliced bread, pao, burger buns, pizza base, tortillas)

B2. Packaged and branded biscuits, cream biscuits, cookies, cream puffs/rolls

B3. Packaged and branded Indian namkeens (like aloo bhujia, mixtures, murukku, flavoured and coated nuts)

B4. Packaged and branded chips (plain and flavoured), nachos, puffs

B5. Pizza, burgers, french fries, wraps from fast-food chains

B6. Packaged and branded extruded coated breakfast cereals (like sugar-coated cornflakes, chocolate breakfast cereals, ragi bites); Packaged, and branded cereal bars (like granola bars, energy bars)

B7. Packaged and branded cakes, muffins, waffles, donuts; Packaged and branded Indian sweets (like flavoured *sonpapadi, gulab jamun)*

B8. Packaged, branded and flavoured yogurt, fruit yogurt, *kheer/ payasam*

B9. Packaged and branded ice creams, flavoured ice bars, *kulfi*

B10. Packaged and branded fruit-based preserves (like jams, marmalades, jellies)

B11. Chocolates; Toffees; Lollipops; Chewing gums; Fruit candies; *Aam papad/* Fruit leathers/ bars; Flavoured mouth fresheners

B12. Packaged and branded ketchup, chutneys/ instant chutney powders/tastemakers (like tamarind chutney, green chutney, lemon rice spice mix); Packaged and branded pickles (veg./ non-veg.), sauces (like pasta-pizza sauce), instant gravies/curries/pastes (like mustard paste, puliyogare paste, ginger-garlic paste)

B13. Packaged and branded milk-based spreads, mayonnaise, dips, cheese products (like cheese slices/cubes/spreads), salad dressings, nut spreads (like hazelnut spread, peanut butter), chocolate spreads

B14. Margarine; Packaged and branded flavoured butter (like garlic butter), coconut cream/milk

Section C – Ready-to-cook

C1. Packaged and branded instant soups, instant noodles/ pasta

C2. Packaged and branded instant dishes/snacks (like *poha, upma*, savoury oats); Packaged and branded ready-to-cook powdered mixes (like *idli, dosa, dhokla, aloo bonda, dahi vada)*

C3. Packaged, branded and frozen ready-to-cook vegetarian snacks (like french fries, paneer snacks, vegetarian burger patty, *aloo tikki, veg. samosas/pizza);* Packaged and branded frozen *parathas*, puff pastry/spring roll sheets

C4. Packaged, branded and frozen ready-to-cook non-vegetarian snacks (like chicken nuggets, chicken tikka, kebabs, seafood/fish snacks, sausages, salami, non- veg. pizza/momos)

C5. Packaged and branded ready-to-cook meals in cups (like *rajma chawal, biryani, idli sambar, bisi-belle bath*, schezwan rice)

Section A – Drinks and Beverages
C6. Packaged and branded bread mixes; Packaged and branded dessert mixes (like jelly, custard, ice cream, *gulab jamun*, cake, brownie, pancake)

Discussion

The present study documents the findings of a literature review and an online grocery market survey to map UPFs available in Indian food markets and their consumption. No standard nomenclature was followed in the studies for identifying categories of UPFs consumed in India during the literature review period, (2012–2022). Studies have merged several food categories under proxy names to provide a profile of the UPF environment in India. Evidence from other countries such as Argentina, Ecuador and Brazil also indicates the need for a standard, clear-cut definition of UPFs to prevent their misclassification (63, 64). Saliency analysis identified the preferred UPFs among the Indian population with Sugar-sweetened beverages being the most preferred UPFs and frozen non-vegetarian snacks being the least preferred. This could also be attributed to the fact that sugar-sweetened beverages have been present in the Indian market for a long period of time while frozen snacks are relatively a new entry into the Indian market. After analysing the ingredient list of UPFs, it was observed that product formulation of several traditional Indian foods has transitioned from unprocessed or minimally processed ingredients to ultra-processed ingredients. Thus, the new version of traditional Indian foods has transitioned into UPFs with the addition of synthetic ingredients such as artificial colours, flavours, anti-caking agents, etc. The study findings contributed towards the development of 24 sub-categories of UPFs for India based on the principles of the Nova food classification system.

In India, there are several proxy terms used for UPFs and there is a lack of clarity in the classification of foods, with 'fast foods' and 'junk foods' being the most used terms to indicate UPF foods. The presence of unhealthy foods in the Indian food environment has been associated with overweight, obesity and NCDs (30, 65, 66, 67, 68). Therefore, it is crucial to understand the actual consumption of UPFs and its health consequences in India. The Indian UPF market is slowly expanding with increasing sales of ready-to-eat meals, savoury snacks, processed fruits, vegetables, meats and other packaged foods as per the packaged food sales data from 2015-19 (40). However, for exploring these associations in the context of UPFs, a food classification system needs to be adapted in India as in the Indian food policy environment, 'HFSS foods' is still the most commonly used terminology, a large majority of which are UPFs (60, 61, 63, 69, 70, 71). Therefore, the Nova food classification system can serve this purpose and can be accepted by the food regulatory authorities. The Nova food classification system has been well accepted and used to assess dietary patterns in several high and middle-income countries such as Canada, The United Kingdom, The United States, Chile, Sweden, New Zealand, Australia, Mexico, Norway, Spain, Belgium, Colombia, France and Taiwan (19, 72).

The present paper identified only a limited number of Indian studies which were primarily reported from 2 geographical regions. More such surveys on the consumption of UPFs are desirable to identify common regional UPFs. In the Indian context, several UPFs are indigenously produced by local retailers apart from the huge market share of renowned branded UPFs. These locally accessible UPFs have better penetration into the local markets. Regulations are highly desirable to identify these sources of UPFs. An appropriate regulatory environment can protect consumers against the marketing of these potentially unhealthy foods. Consumer education regarding these UPFs is also desirable.

Saliency analysis indicated the preference of Indian consumers towards specific UPFs including sugar-sweetened beverages, extruded snacks, breads, fruit-based preserves, cookies and biscuits, Indian sweet mixes, sauces and pickles, instant noodles/soups/ pasta and savoury puff rolls. Studies from other Low and Middle-Income Countries (LMICs) demonstrated similar trends in preference towards packaged confectioneries, savoury snacks, deep-fried foods, biscuits, candy/ chocolate, savoury snacks, canned red and luncheon meats, pre-fried french fries, mayonnaise, ketchup, fast-food such as sandwiches and pizzas, chips and salty snacks (including tortillas and pretzels), sweets and sweetened beverages

and sausages (including canned) (73, 74). Increasing sales of packaged foods in various countries including several LMICs has been highlighted by the Euromonitor data (40).

Indian food industries are converting traditional recipes into UPFs which are being marketed as convenience foods. Consumers need to be made aware of the negative health effects of consuming these modified traditional foods that are ultra-processed. Additionally, regulatory measures should be implemented to monitor misleading claims, such as labelling these modified traditional foods as 'healthy'. These modified versions of traditional foods contain UPF ingredients, are highly processed and often sold and perceived as "healthy foods". To safeguard consumer health, it is important to appropriately identify UPFs associated with the rising incidence of DR-NCDs in India. Attention is needed to prevent other traditional foods, which are also gradually transitioning into UPFs.

Conclusions

There is a need to define UPFs, specify sub-categories and devise robust guidelines for defining UPFs in the Indian context. A national survey based on an exhaustive categorization of UPFs may provide crucial information on UPF consumption patterns in India. This is likely to inform policies on regulating the Indian UPFs market, undertake consumer education initiatives and create nutrition literacy around UPFs and thus contain their indiscriminate consumption.

Strengths

This review is one of the first attempts to explore the UPFs in the Indian food market and understand their availability and consumption along with the proxy nomenclatures used for UPFs in India. This review highlights gaps in the Indian food regulatory environment on the availability and sales of UPFs, which will direct the attention of food, nutrition, and public health diaspora to make efforts in channelling and strengthening the food regulatory environment towards UPFs.

Study limitations

There is an unavailability of representative data from PAN India on UPF consumption to extrapolate the findings. Most of the studies were documented from the Southern part of India and largely represent the urban population, hence the data is not representative of the rural population. Currently, several UPFs are referred to as junk foods, fast foods, western foods, processed foods, HFSS, etc. Due to the lack of a standard definition of UPFs, culinary ingredients (category 2 of Nova food classification) and processed foods (category 3 of Nova food classification) were clubbed under proxy categories of UPFs and therefore, the findings of various studies were difficult to interpret and compare. We also could not look into the packaging of the foods and beverages explored as this information is not usually declared on the packages.

List Of Abbreviations

UPFs - Ultra-processed foods

NCDs - Non-communicable diseases

DR-NCDs - Diet-related non-communicable diseases

HFSS - High Fat Sugar Salt

LMICs - Low and Middle-Income Countries

RTE - Ready-to-eat

Declarations

Ethics approval and consent to participate

Approval was obtained from the Institutional Ethics Committee at the Public Foundation of India, and the ethics committee of University of Sao Paulo. Informed consent was obtained from all participants.

Consent for publication

Not applicable

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Competing interests

The authors declare that they have no competing interests.

Author's contribution

The study was conceptualized by KSR, SGJ, NK and FHML. The literature review and market survey were conducted by MS, GK, IKB. The first draft of the manuscript was prepared by MS, GK, IKB, SK and SGJ. The manuscript was critiqued and edited by SGJ, NK, FHML and KSR. SG-J had primary responsibility for final content; and all authors read and approved the final manuscript.

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Footnotes

‡ Thin fat phenotype is the excessive fat accumulation in an individual having normal Body Mass Index (4, 5).

Tables

Table 5 is available in the Supplementary Files section.

Figures

Step 1
Rank each UPF sub-category from each research article included in the final literature review.

↓

Step 2
Reverse rank each UPF sub-category to assign it a score. This step is done to give weightage to each sub-category.

↓

Step 3
Reverse ranks of sub-categories are then divided by the total number of UPF sub-categories mentioned in the respective studies.

$$\text{Salience score} = \frac{\text{Score/reverse rank of sub-category in a study}}{\text{Total number of sub-categories in that respective research study}}$$

↓

Step 4
Calculate salience scores for each sub-category under each study

↓

Step 5
Calculate composite salience score for all sub-categories by taking average of salience scores obtained in each study for each sub-category

$$\text{Composite score} = \frac{\text{Sum of all salience scores of a sub-category}}{\text{Total number of scores for the sub-category}}$$

↓

Step 6
Sort UPFs sub-categories as per composite salience scores based on 'most to least' commonly consumed manner
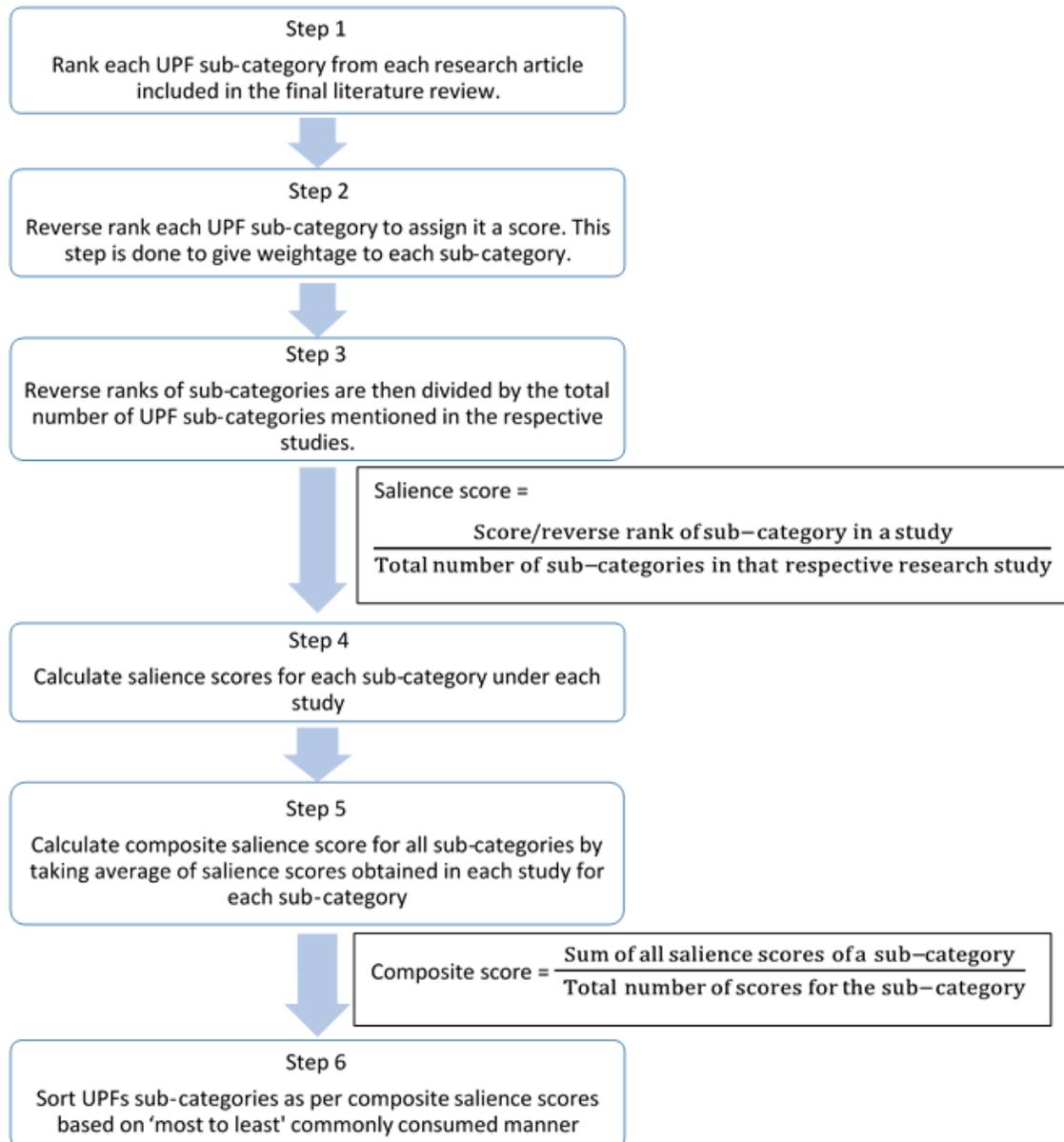
Figure 1

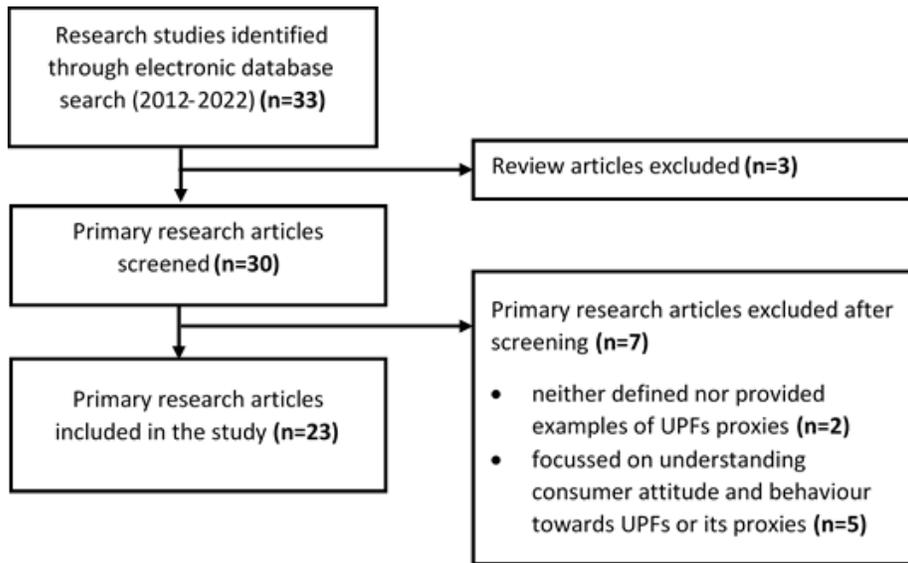Saliency analysis method for free-listed UPF sub-categories

Figure 2

Flow diagram reporting the screening and selection of studies reporting consumption and availability of UPFs in India

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- AdditionalFile1.xlsx
- AdditionalFile2.xlsx
- Table5.docx