

Supplemental Materials

Supplemental Text

The NOVA classification: classification of foods according to processing

The NOVA categorizes all foods and food products into 4 groups based on the nature, extent and purpose of the physical, biological and chemical processes they have undergone following separation from nature [1].

Group 1. Unprocessed or minimally processed foods

Unprocessed foods or minimally processed foods are foods that have not been altered from their natural state, or have only undergone processes like removal of inedible or unwanted parts, fractioning, grinding, drying, fermentation, pasteurization, roasting, boiling, cooling, or freezing. The purpose of these processing are to preserve or keep the freshness of natural foods, to make foods safe or edible or more pleasant to consume. These foods do not contain added substances such as salt, sugar, oils, or fats, but may infrequently contain preservatives. Many unprocessed or minimally processed foods are prepared and cooked at home or in restaurant kitchens in combination with processed culinary ingredients as dishes or meals. Examples include whole grains, millets, wheat flour, fresh or frozen fruits and vegetables, unprocessed meats and poultry, eggs, fish, fresh and pasteurized milk, unflavored yogurt, legumes, nuts and seeds.

Unprocessed or minimally processed foods were further classified into the following subgroups:

- Grains
- Fruits and freshly squeezed fruit juices (including 100% fruit juices and baby food juices)
- Vegetables
- Meat (includes poultry)
- Milk and plain yoghurt
- Eggs
- Fish and seafood
- Other unprocessed or minimally processed foods

Group 2. Processed culinary ingredients

Processed culinary ingredients are substances extracted from the first group or from nature by processes such as pressing, grinding, crushing, pulverizing and refining. These ingredients are used for seasoning and cooking foods in the first group. Examples include salt, sugar, honey, vegetable oils, butter, lard, and vinegar, maple syrup (100%), molasses and honey.

Processed culinary ingredients were further classified into the following subgroups:

- Grains
- Sugar
- Plant oils
- Animal fats
- Other processed culinary ingredients

Group 3. Processed foods

Processed foods are products manufactured by industry by adding salt, sugar, oil or other group 2 ingredients to unprocessed or minimally processed foods to preserve or make them more palatable. These foods may contain preservatives, antioxidant, and stabilizers. Examples include canned/bottled vegetables and legumes, fruits in syrup, canned fish and meats, cheeses, salted or sugared nuts and seeds, breads made of ingredients used in culinary preparations (i.e. wheat flour, yeast, water, salt, butter or sugar).

Processed foods were further classified into the following subgroups:

- Cheese
- Ham and other salted, smoked or canned meat or fish
- Vegetables, fruits and other plant foods preserved in brine, sugar or syrup
- Other processed foods (including wine and beer)

Group 4. Ultra-processed foods

Ultra-processed foods are ready to eat/drink/heat industrial formulations that are made with multiple industrial ingredients extracted from foods or synthesized in laboratories, while containing little whole foods. Besides salt, sugar, oils and fats, and preservatives, ultra-processed foods include ingredients not used in culinary preparations, in particular, flavors, colors, sweeteners, emulsifiers and other additives used to imitate sensorial qualities of unprocessed or minimally processed foods or to disguise undesirable aspects of the final product. The processes for making ingredients or final products of ultra-processed foods may include hydrogenation and hydroxylation, extrusion and molding, and pre-processing for frying. The overall purpose of ultra-processing is to create highly profitable, hyper-palatable ready to consume products with long shelf-life. Ultra-processed food products are usually packaged attractively and marketed intensively. Examples include carbonated drinks, fruit flavored drinks, sausages, biscuits, sweet/savory packaged snacks, candies, ready to eat/heat pizza, sandwich, or burger, frozen or shelf-stable dishes, instant soups/noodles.

The detailed UPF subgroups and examples of foods and beverages included in each subgroup are described in Supplemental Table 1.

Supplemental Table 1. Ultra-Processed Food Subgroups

Ultra-processed Foods	Foods or beverages included
Snacks and Sweets	
Savory snacks	Crackers; flavored popcorns (excluding plain air-popped popcorn); chips (potato/vegetable/corn/tortilla/other); pretzels/snack mix
Sweet bakery products	Ready-to-eat or dry-mixed cakes and pies; cookies and brownies; doughnuts, sweet rolls, and pastries
Candies	Candies, chocolate, chewing gums
Cereal or nutrition bars	Cereal or nutrition bars (cereal/energy/protein/meal replacement bars)
Ice cream and desserts	Ice creams and other frozen dairy desserts; ready-to-eat or dry mixed dairy desserts (such as pudding); fruit desserts; jellies and jams and preserves; toppings; gelatin desserts
Sugar-sweetened and diet beverages	
Sugar-sweetened and diet soft drinks	Sugar sweetened and diet soft drinks
Fruit drinks and other sweetened drinks	Fruit drinks, sport /energy drinks, nutrition drinks
Ready-to-eat/heat mixed dishes	
Ready-to-eat/heat pizza	Fast food pizza, pizza prepared from frozen or from school lunch
Ready-to-eat/heat sandwiches and burgers	Fast food or ready-to-eat/eat sandwiches or burgers (cheeseburger, hamburger or chicken burger)
Other ready-to-eat/heat mixed dishes	Frozen or shelf-stable meat/seafood/poultry/egg mixed dishes, grain based mixed dishes (pasta dishes, rice dishes, macaroni and cheese, turnovers, and other), Mexican mixed dishes, Asia mixed dishes, and soups
Industrial grain foods	

Breads, rolls and tortillas	Yeast breads (white/whole wheat/wheat/rye/oat/multigrain bread), rolls, buns, bagels, English muffins, tortillas, pita bread, taco shells (baked) that are not homemade or acquired from bakery store
Biscuits, muffins, and quick breads	Biscuits, cornbread, muffins and other quick breads that are not homemade or obtained from bakery stores
Pancakes, waffles and French toasts	Pancakes, waffles and French toasts that are not homemade or obtained from bakery stores
Ready-to-eat breakfast cereals	Ready-to-eat cereals
Flavored dairy foods and dairy substitutes	
Flavored milk	Flavored milk
Flavored yogurts	Flavored yogurts
Dairy drinks and dairy substitutes	Milk shake and other dairy drinks, dairy substitutes such as almond milk, coconut milk, rice drink, soy milk
Other	
Fast-food or reconstituted meat, poultry, and fish products	Fast food meat patties/fried chicken/fish sticks, patties, or fillets; chicken nugget; sausages, ham, lunchmeats; meat spreads; beef/port/other meat jerky
Fast food or pre-prepared potato products	Fast food /pre-prepared /frozen French fries, hash browns, potato puffs, stuffed potatoes
Fats, condiment and sauces	Industrial fats, margarine, light or fat free cream /whipped cream, cream substitutes, light or fat free cream cheese, cheese spread; salad dressings, tomato based/soy-based/other condiments; dips, gravies, and other sauces
Other ultra-processed foods	Including soy products such as meatless patties and fish sticks; sweeteners, and all syrups (excluding 100% maple syrup); distilled alcoholic drinks, baby formula. and onion rings

Supplemental Table 2. Current UPF Consumption and Estimated Reduction in Total Calorie Intake among US Children Ages 7-18 years After Replacing UPFs with Non-UPFs in Their Diet

	Calories from UPFs (kcal/d)	% Calories from UPFs	Total Daily Calories (kcal/d)		
	Mean (95%CI)	Mean (95% CI)	Current	Post-Change	Difference
	Current	Current	Current	Post-Change	Difference
All US children (7-18 years)	1315 (1284, 1345)	66.4 (65.6, 67.2)	1967 (1934, 1999)	1690 (1563, 1836)	-276 (-131, -404)
Sex					
Boys	1447 (1411, 1484)	66.8 (66.0, 67.6)	2156 (2110, 2201)	1851 (1711, 2012)	-304 (-144, -445)
Girls	1180 (1146, 1214)	65.9 (64.8, 67.0)	1774 (1743, 1805)	1526 (1412, 1657)	-248 (-117, -362)
Age					
Children (7-11 years)	1300 (1271, 1329)	66.2 (65.3, 67.0)	1946 (1911, 1981)	1673 (1547, 1817)	-273 (-129, -399)
Adolescents (12-18 years)	1324 (1282, 1366)	66.5 (65.5, 67.5)	1980 (1935, 2024)	1701 (1573, 1848)	-278 (-132, -407)
Race/ethnicity					
Non-Hispanic white	1356 (1309, 1403)	68.2 (67.0, 69.3)	1985 (1933, 2037)	1700 (1568, 1850)	-285 (-135, -417)
Non-Hispanic black	1351 (1313, 1389)	69.2 (68.0, 70.4)	1927 (1882, 1971)	1643 (1512, 1793)	-284 (-134, -415)
Hispanic	1241 (1202, 1281)	63.0 (62.1, 63.9)	1949 (1900, 1999)	1689 (1568, 1826)	-261 (-124, -381)
Other	1192 (1129, 1255)	59.6 (57.7, 61.4)	1961 (1899, 2024)	1711 (1595, 1843)	-250 (-119, -366)
Parental educational level					
< High school	1255 (1211, 1300)	65.4 (64.1, 66.8)	1902 (1851, 1953)	1638 (1516, 1777)	-264 (-125, -386)
High school or GED	1308 (1246, 1369)	68.0 (66.5, 69.4)	1906 (1835, 1977)	1632 (1505, 1776)	-275 (-130, -402)
Some college	1357 (1319, 1394)	68.0 (66.9, 69.0)	1986 (1933, 2039)	1701 (1569, 1851)	-285 (-135, -417)
College graduate	1312 (1248, 1376)	64.3 (62.4, 66.1)	2026 (1972, 2081)	1751 (1623, 1896)	-276 (-131, -403)
Family income to poverty ratio (FIPR)^d					
<1.3	1270 (1236, 1303)	66.0 (64.9, 67.1)	1913 (1869, 1957)	1646 (1523, 1787)	-267 (-126, -390)
1.3 - 3	1333 (1291, 1376)	67.4 (66.4, 68.4)	1965 (1904, 2026)	1685 (1555, 1832)	-280 (-133, -410)
≥ 3	1346 (1288, 1404)	65.9 (64.5, 67.3)	2024 (1963, 2084)	1741 (1610, 1890)	-283 (-134, -414)

Abbreviation: BMI, body mass index; GED, general equivalency diploma; NHANES, National Health and Nutrition Examination Survey; UPF, ultra-processed foods

^a Prevalence of overweight and obesity was adjusted for survey weights.

^b Hispanic includes respondents self-identified as “American Mexican” or as “Hispanic” ethnicity. “Other” includes race/ethnicity other than non-Hispanic white, non-Hispanic black, and Hispanic, including multiracial

^b Parental education represents the educational level of the household reference person.

^d Family income to poverty ratio represents the ratio of family income to the federal poverty threshold. A higher ratio indicates a higher level of income.

Supplemental References

1. Monteiro, C.A., et al., *Ultra-processed foods: what they are and how to identify them*. Public Health Nutr, 2019. **22**(5): p. 936-941.

