Understanding Whole Grain Food Processing and the Limitations of the NOVA Classification System

April 30, 2025

Learning Objectives

- Correctly identify whole-grain foods considered as ultra-processed using the Nova classification system.
- Evaluate different ultra-processed foods' relationship with overall diet quality.
- Describe how whole grains are processed and how this processing impacts accessibility and diet quality.

Housekeeping

- Attendees will receive an email within ONE WEEK with **CPEU certificate**, **slides**, and **recording**
- Please submit any questions using the Q&A function in Zoom.
- Stay tuned for the interactive assessment

Disclosures

- No commercial support or funding was provided for this webinar.

Understanding Whole Grain Food Processing and the Limitations of the Nova Classification System

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Accredited Practising Dietitian, PhD Candidate

No financial conflicts to declare

UNSW
THE UNIVERSITY OF NEW SOUTH WALES

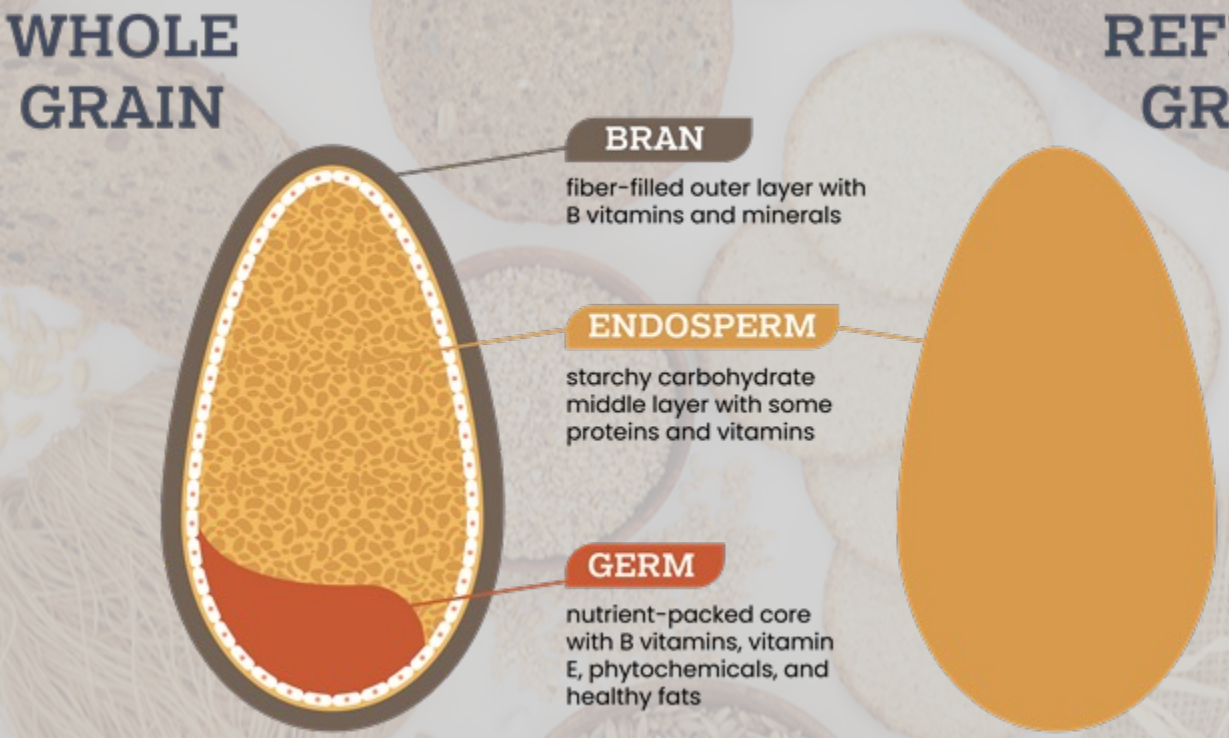
Learning outcomes

Correctly identify whole-grain foods considered as ultra-processed using the Nova classification system

Evaluate ultra-processed foods' relationship with overall diet quality

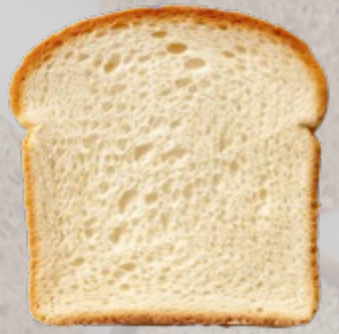
Describe how whole grains are processed and how this processing impacts accessibility and diet quality

What is a whole grain?

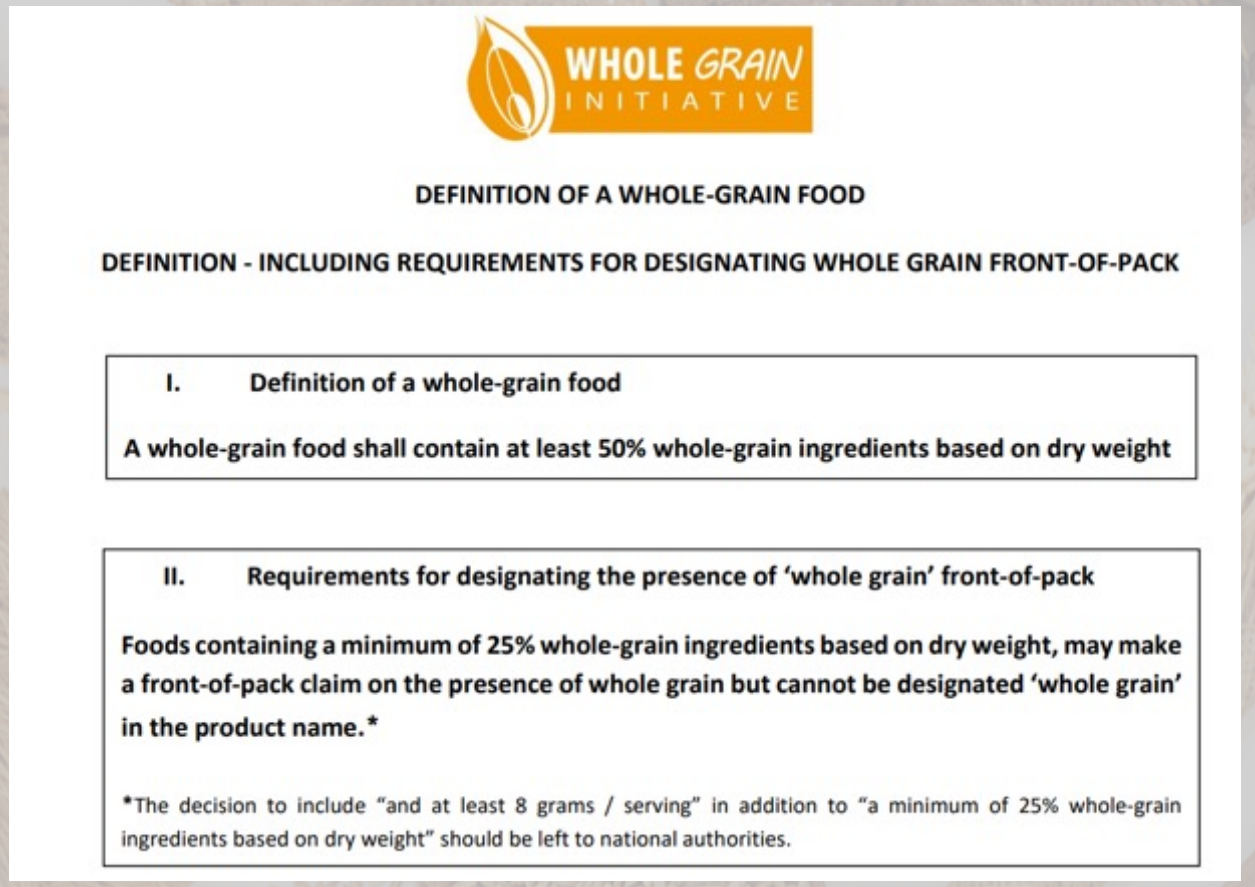


Foundation Health Partners, 2021

Whole-grain content in foods



What is a whole-grain food?



WHOLE GRAIN INITIATIVE

DEFINITION OF A WHOLE-GRAIN FOOD

DEFINITION - INCLUDING REQUIREMENTS FOR DESIGNATING WHOLE GRAIN FRONT-OF-PACK

I. Definition of a whole-grain food

A whole-grain food shall contain at least 50% whole-grain ingredients based on dry weight

II. Requirements for designating the presence of 'whole grain' front-of-pack

Foods containing a minimum of 25% whole-grain ingredients based on dry weight, may make a front-of-pack claim on the presence of whole grain but cannot be designated 'whole grain' in the product name.*

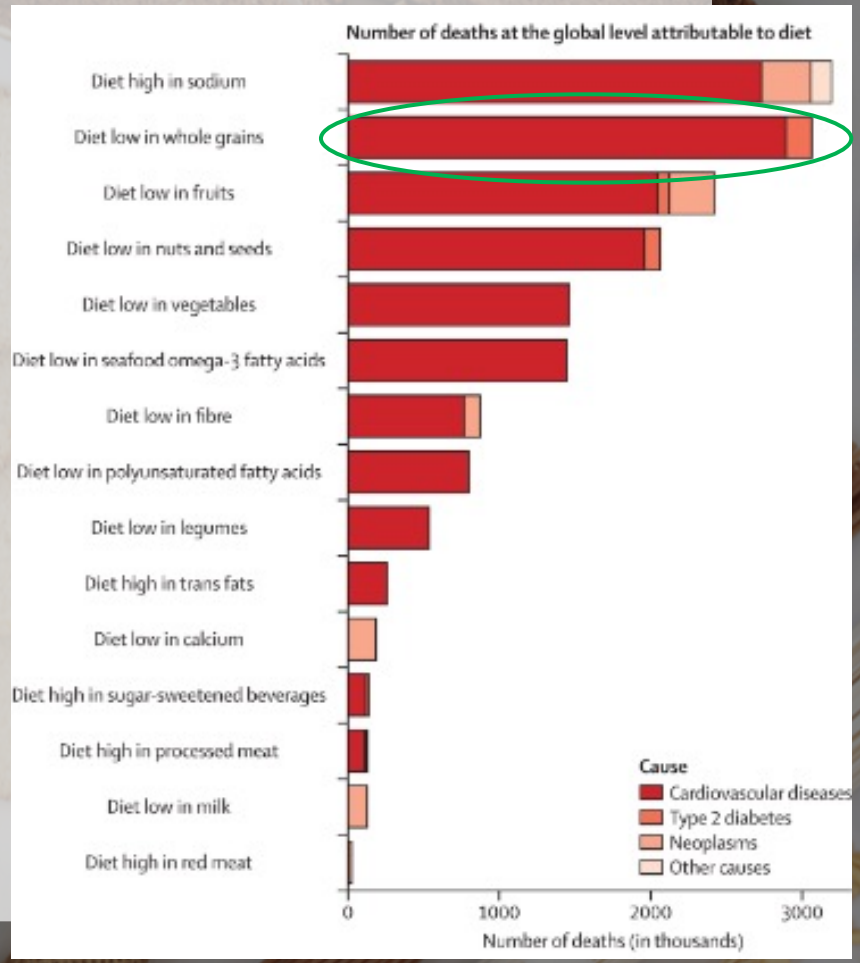
*The decision to include "and at least 8 grams / serving" in addition to "a minimum of 25% whole-grain ingredients based on dry weight" should be left to national authorities.

van der Kamp, J. W. et al., 2022

Health benefits of whole grains

Whole grain intake reduces risk of:

- Cardiovascular disease
- Total cancer
- Mortality from all causes
- Type 2 diabetes
- Colon cancer



Aune et al., 2016
GBD 2017 Diet Collaborators

Whole grains in national dietary guidelines

"Enjoy a wide variety of nutritious foods from these five food groups every day:

- Grain (cereal) foods, mostly whole grain and/or high cereal fibre varieties, such as breads, cereals, rice, pasta, noodles, polenta, couscous, oats, quinoa and barley"

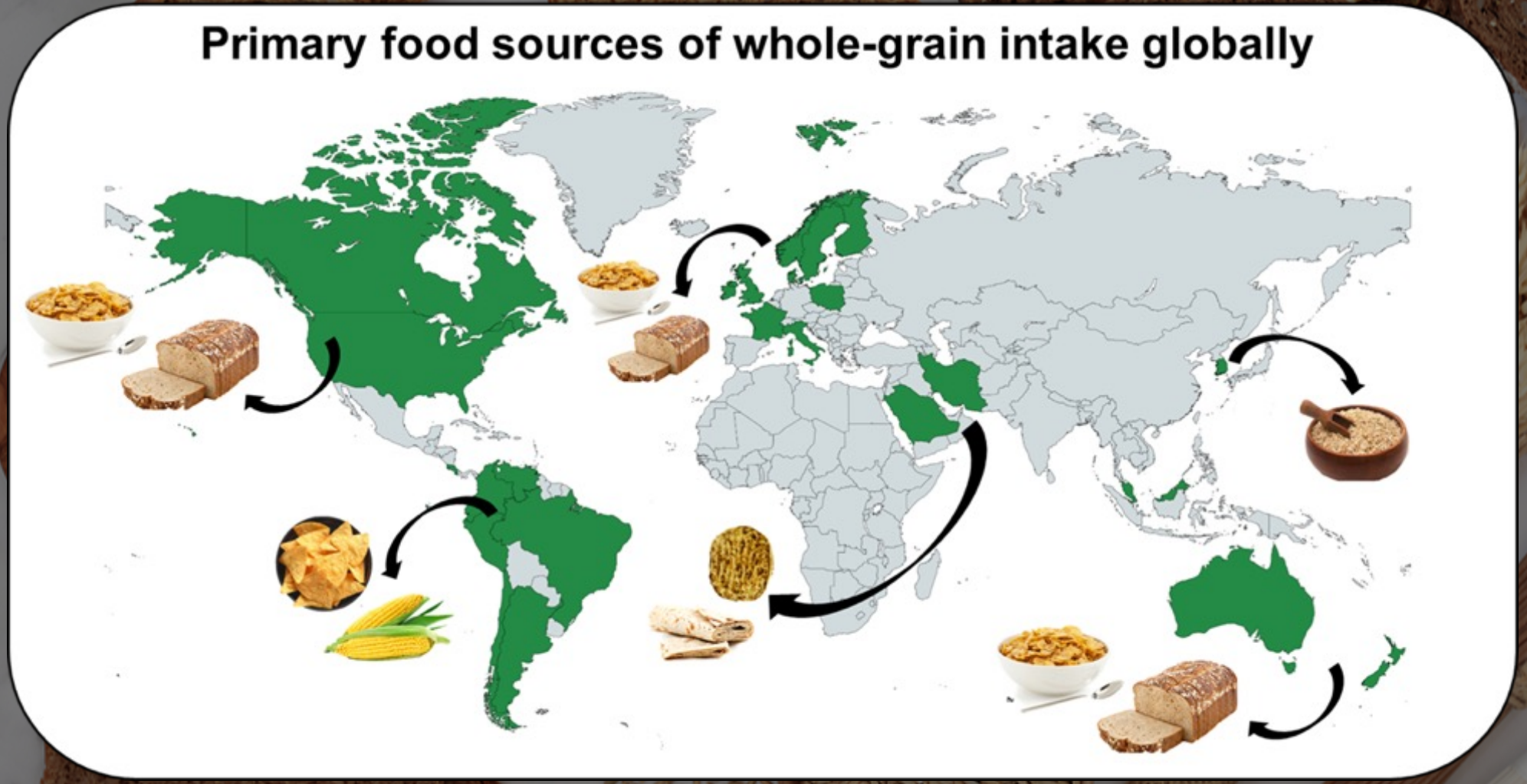
"Healthy dietary patterns include whole grains and limit the intake of refined grains. At least half of total grains should be whole grains. Individuals who eat refined grains should choose enriched grains. Individuals who consume all of their grains as whole grains should include some that have been fortified with folic acid."

NHRMC, Australian Dietary Guidelines, 2013
USDA, Dietary Guidelines for Americans, 2020

Exploring the reporting, intake and recommendations of primary food sources of whole grains globally: a scoping review

Elissa J. Price[1], Eden M. Barrett[1,2], Marijka J. Batterham[3] and Eleanor J. Beck[1,4]

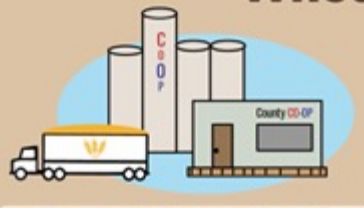
Cite this article: Price EJ, Barrett EM, Batterham MJ, and Beck EJ (2024) Exploring the reporting, intake and recommendations of primary food sources of whole grains globally: a scoping review. *British Journal of Nutrition* **132**: 1365–1376. doi: 10.1017/S0007114524002678



From Field to Table

The Journey of Texas Wheat

Farmers spend time planting seeds, checking for disease and monitoring plant health until harvest. Combines harvest the wheat kernels, which are then loaded into a semi-truck. 1

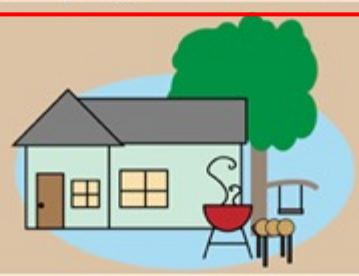


2 The harvested grain is sold at market price to a local grain elevator, known as a country elevator. The elevator can store the grain until the right market price, or it can sell it.

Country elevators sell their grain to terminal elevators, which clean, separate and maintain the value of the grain. The grain is then sold to flour millers for domestic consumption, or it is loaded onto ships bound for overseas markets. 3

4 The flour mills grind the grain into different types of flour – whole wheat, all-purpose, bread flour, etc. The mills can also use the flour to make ready-to-eat products. Both the flour and wheat products are shipped to grocery stores and other food retailers.

Bakers and chefs also use flour to make a wide variety of delicacies. Consumers can either buy these products, or buy flour produced by the flour mills to make their own creations at home. 5



6 Finally, the wheat products make their way to your table. These products are essential to many holidays and celebrations and go through a safe process to get to you. Whenever you open that next package of hamburger buns for a weekend cookout, think of a wheat farmer and all of those in between.

Processing of whole grains

Increase nutritional value and edibility

- Dehulling and cutting – oat into steel cut oats
- Dehulling and polishing – brown rice

Grain Millers, 2020

Improve ease of preparation (reduce cooking time)

- Parboiling or steaming then drying – more porous
- Rolling, flaking, or flattening – larger surface area, faster liquid absorption
- Cracking or grinding – smaller particles

Increase diversity of preparation

- Milling – flour

Prevent cooking

- Puffing or extrusion – high heat and pressure (puffed grains) or pressure applied to mold shapes

Decker, 2020

Varying extent of whole-grain processing

Getty images

Sallys Baking Recipes, 2021

AUSTRALIAN FOOD & GROCERY COUNCIL

How a loaf of bread is made

It all starts with wheat.

The composition of wheat varies from season to season with climate and growing conditions.
The protein in wheat is critical for the desired characteristics of bread.
In Australia we manufacture with Australian wheat where possible.

1. Milling

Wheat is harvested and milled into flour. The flour may be wholemeal or white, depending on the type of bread. Other grains are also milled into flour including rye and barley for use in a range of bread varieties.

2. Fortification

After milling, the flour is fortified by the addition of Thiamin (Vitamin B1) and Folic Acid (Vitamin B9) to meet the Australian regulations for bread making flour and ensure these essential vitamins are available to the community.

3. Making a dough

The wheat flour is combined with yeast, iodised salt, vegetable oil, vinegar and water to make a dough. Ingredients to aid dough development and additions including whole grains, grain flours (such as rye or barley), seeds or fruit and spices are also added, depending on the intended bread variety.

4. Mixing

The bread dough is mixed to develop the proteins in the flour that provide the bread with structure and texture. This is a critical step in the process as without the development of the wheat proteins (primarily gluten) the bread will not maintain its volume during subsequent process steps.

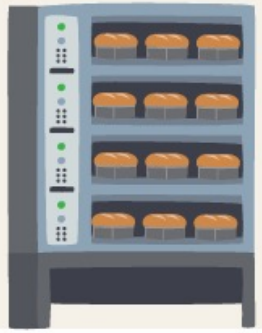
AUSTRALIAN FOOD & GROCERY COUNCIL

5. Proofing

The dough is cut to size and placed in bread tins, which are transported through a proofer, set to specific temperature and humidity conditions to allow the yeast to multiply and produce gas that is entrapped in the dough, resulting in a risen bread dough that now fills the bread tin.

6. Baking

The bread is baked under optimal time and temperature conditions to produce a fully cooked and golden-brown loaf.



7. Depanning, Cooling, Slicing & Packaging

Each baked loaf is removed from its tin and cooled.
Once cool, the bread is sliced and placed into its bread bag, ready for sale.

FOOD PROCESSING EXPLAINED

AUSTRALIAN FOOD & GROCERY COUNCIL

How a muesli bar is made

It all starts with cereal crops such as oats and wheat harvested from the field.

1. Harvesting,cleaning and rolling

Australian-grown **oats** are harvested in late spring and early summer. The harvested oats are cleaned with the inedible outer layer removed. Oats are then dried, steamed and rolled into whole grain flakes.

Australian whole grain **wheat** undergoes a cleaning process after harvest, then steamed and rolled into flakes.

2. Blending

Whole grains, fruit and binding ingredients are blended.

3. Pressing

The delicious blended whole grains and fruit mixture is pressed into a flat uniform layer.

4. Decorating (optional)

Choc Chips are placed on top or chocolate drizzled on top of the pressed layer.

5. Cooling and cutting

The pressed layer of muesli bar mixture is cooled and cut into individual bars.

6. Packaging

Individual bars are wrapped to ensure the freshness of the final muesli bar and packed into cartons for transportation and sale.

Why do we process whole grains?

→ chat function

- Removal of inedible components (hull)
- To produce foods that deliver nutrients (fibre, healthy fats etc.)
- Improve preparation and cooking times (accessibility)
- Fortification in Australia (iron, iodine, folic acid)
- Stability and shelf life… Sensory improvements…

Processing of whole-grain foods for functionality and acceptance

Addition of emulsifiers

- Decrease spoilage and increase loaf volume

Addition of mould inhibitors

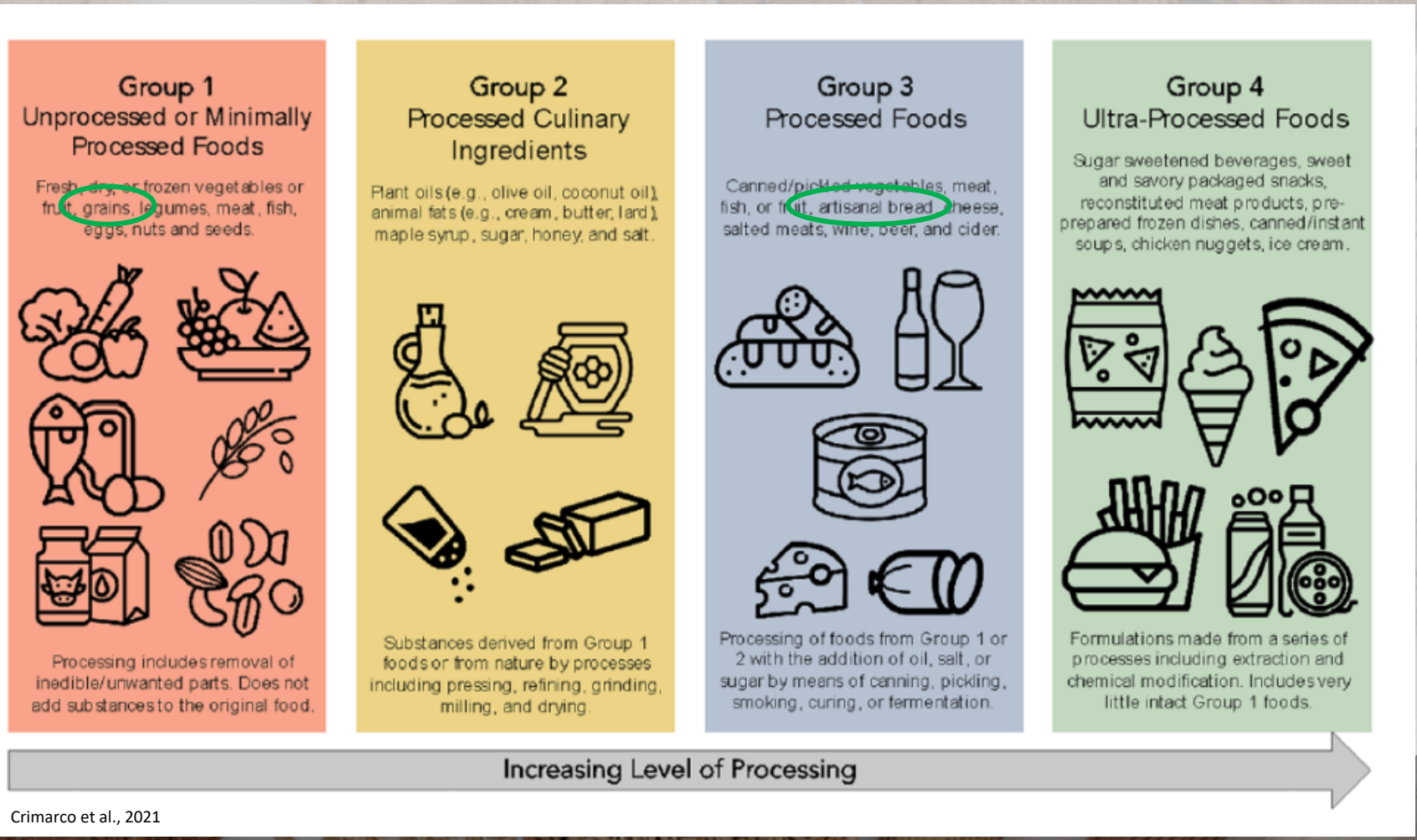
- Breads are susceptible – higher moisture content in whole wheat types

Added sugars

- Enhance sensory properties
  - Outweigh whole-grain benefits?

Decker, 2020

The Nova Classification System



Crimarco et al., 2021

Principles of “ultra-processed foods”

Industrial formulations that contain five or more ingredients

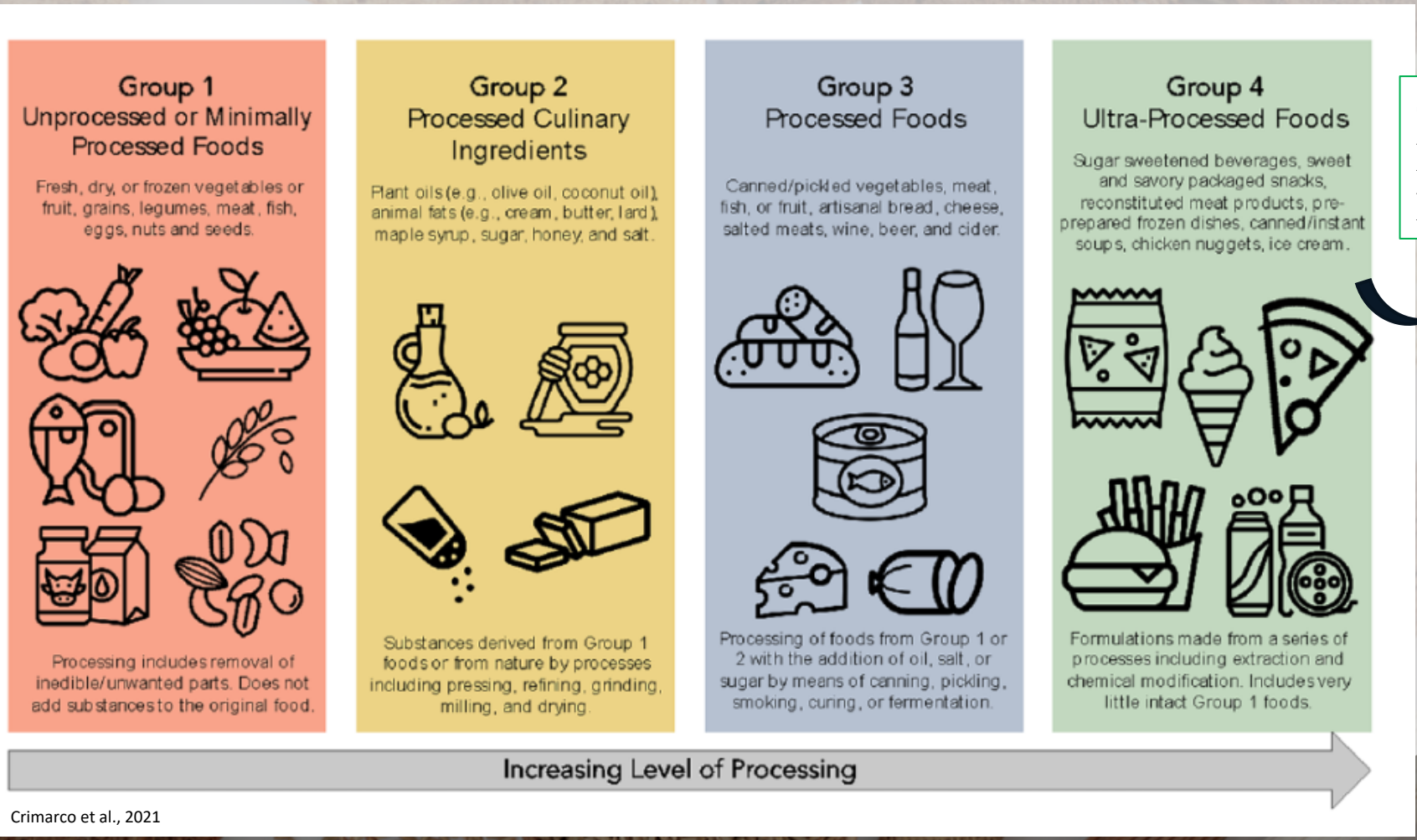
Inclusion of additives such as sugars, oils, fats, salt, antioxidants, stabilisers, and preservatives

Inclusion of additives for sensory improvements such as flavours, colours, and sweeteners

Inclusion of ingredients not typically found in home cooking such as hydrolysed proteins, soy isolates etc.

Industrial processing techniques like extrusion and moulding not used in home cooking

The Nova Classification System



Commercial bread
Ready-to-cereals
Muesli bars etc.

Crimarco et al., 2021

What is it about “ultra-processed foods”?

Lancet Gastroenterol Hepatol
2022; 7: 1128–40
Published Online
August 8, 2022
https://doi.org/10.1016/
S2468-1253(22)00169-8

Ultra-processed foods and human health: from epidemiological evidence to mechanistic insights

Bernard Srour*, Melissa C Kordahi*, Erica Bonazzi*, Mélanie Deschasaux-Tanguy, Mathilde Touvier†, Benoit Chassaing†

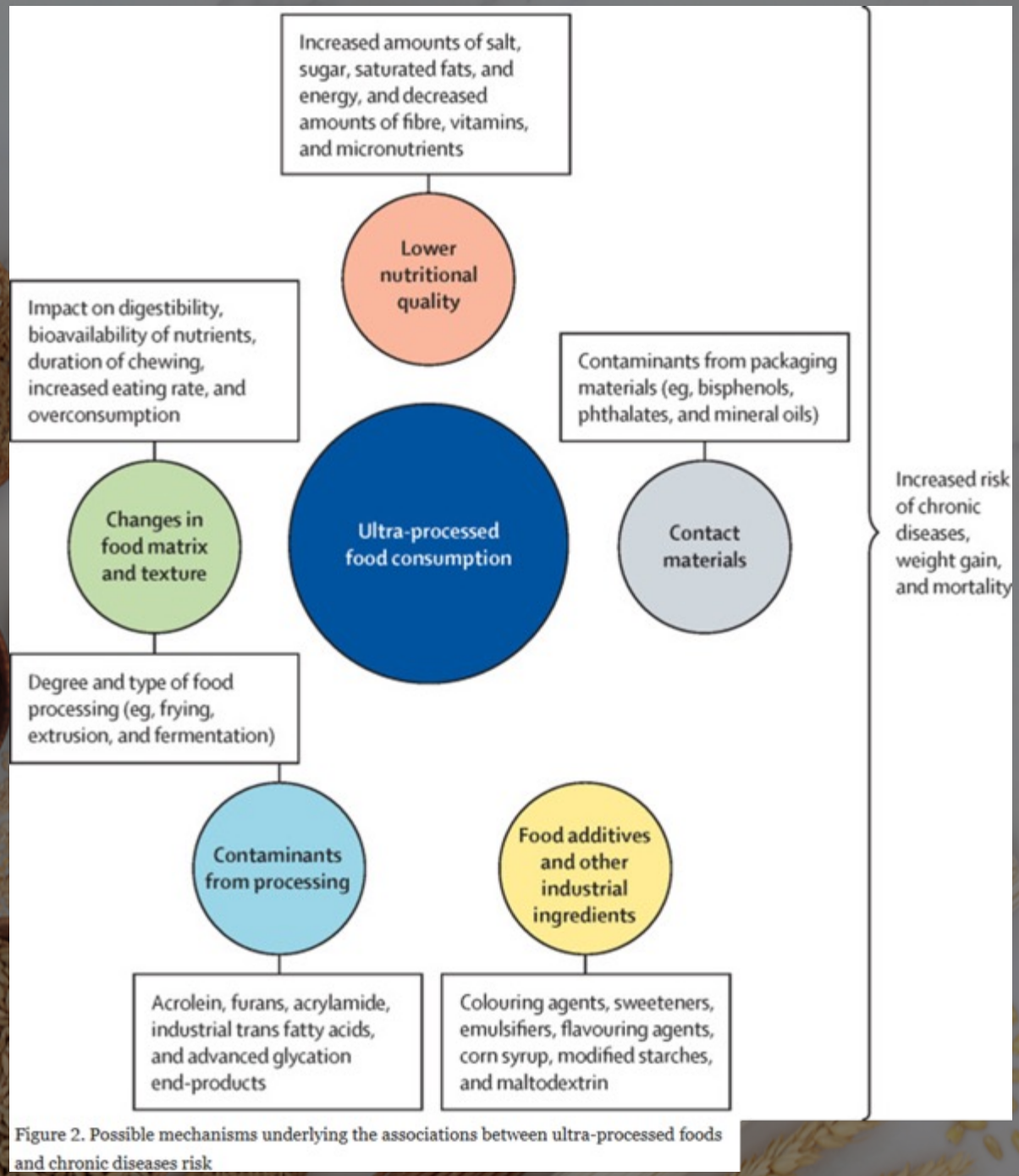
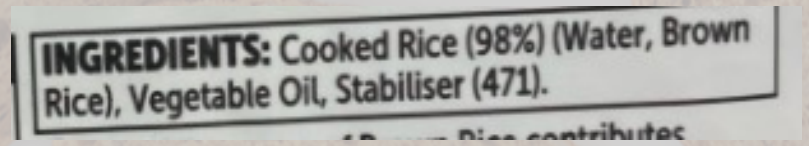
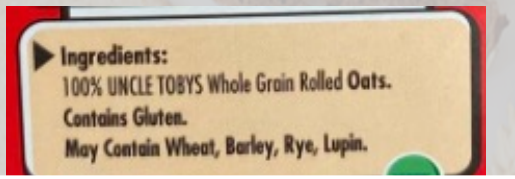


Figure 2. Possible mechanisms underlying the associations between ultra-processed foods and chronic diseases risk

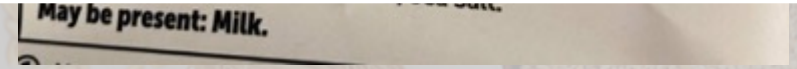
Identifying “ultra-processed” whole-grain foods

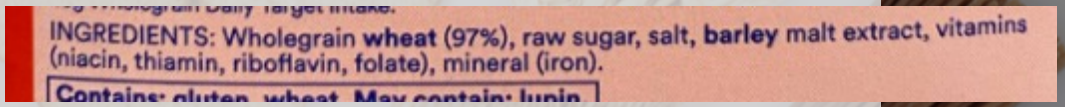
→ chat function

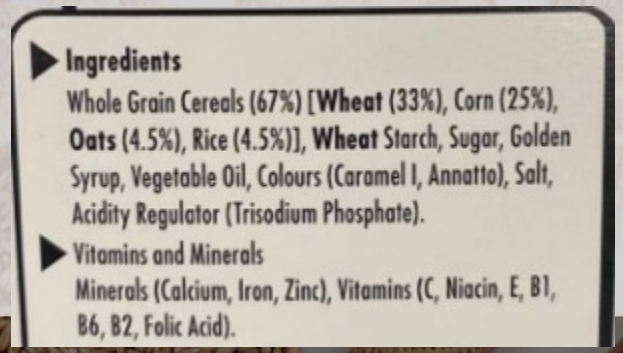




Is it a measure of processing or ingredients or nutrients?







Homemade bread?

Dietitians understanding of whole grains in the Nova Classification System

nutrients

MDPI

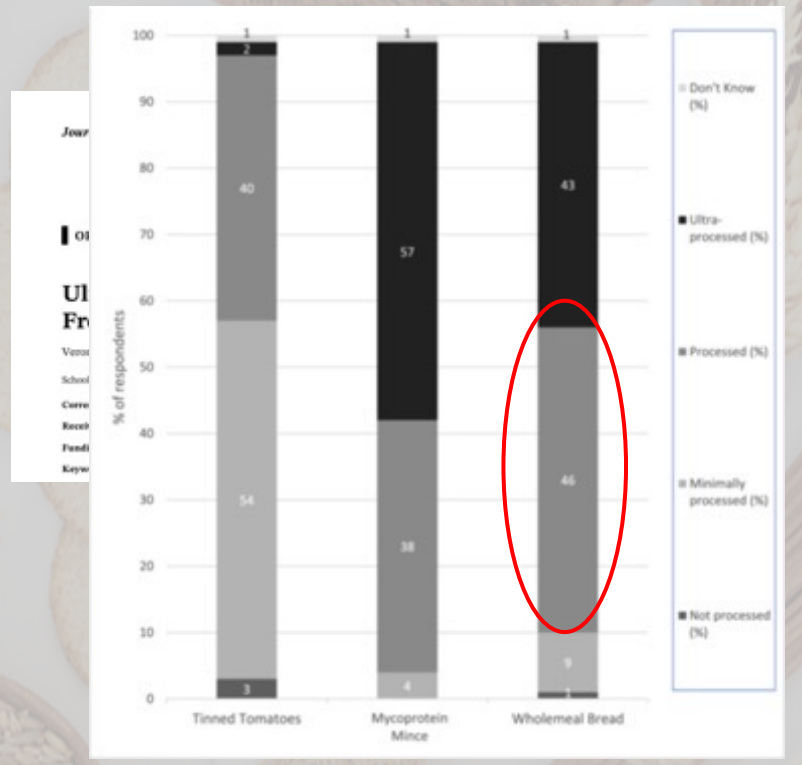
Article

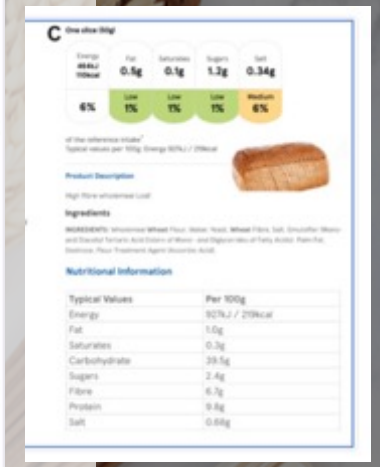
Dietitians' Attitudes and Understanding of the Promotion of Grains, Whole Grains, and Ultra-Processed Foods

Natasha Krois [1], Jaimee Hughes [2] and Sara Grafenauer [3,*]

Citation: Krois, N.; Hughes, J.; Grafenauer, S. Dietitians' Attitudes and Understanding of the Promotion of Grains, Whole Grains, and Ultra-Processed Foods. *Nutrients* **2022**, *14*, 3026. https://doi.org/10.3390/nu14153026

"**The dietitians tended not to consider whole-grain breads and ready-to-eat breakfast cereals as excessively processed**, although most generally agreed with the classification system based on the extent of processing."





“Ultra-processed food” intake associated with poorer health outcomes

Machado et al. *Nutrition and Diabetes* (2020)10:39
https://doi.org/10.1038/s41387-020-00141-0

Nutrition & Diabetes

ARTICLE Open Access

Ultra-processed food consumption and obesity in the Australian adult population

Priscila Pereira Machado[1,2], Eurídice Martinez Steele[2], Renata Bertazzi Levy[2,3], Maria Laura da Costa Louzada[2,4], Anna Rangan[5], Julie Woods[1], Timothy Gill[6], Gyorgy Scrinis[7] and Carlos Augusto Monteiro[2,4]

Table 2 Association of dietary share of ultra-processed foods (% of total energy) with BMI and WC among Australians aged ≥20 years (NNPAS 2011–2012), $n = 7411$.

Quintiles of the dietary contribution of ultra-processed foods (% of total dietary energy)[a]	BMI (kg/m^2)					WC (cm)				
	Mean	Mean difference	(95% CI)	Mean difference, adjusted[b]	(95% CI)	Mean	Mean difference	(95% CI)	Mean difference, adjusted[b]	(95% CI)
Q1 (lowest)	26.7	0.00	Ref.	0.00	Ref.	91.1	0.00	Ref.	0.00	Ref.
Q2	27.3	0.66	(0.21; 1.12)	0.52	(0.07; 0.95	92.9	1.73	(0.48; 2.97)	1.26	(0.19; 2.33)
Q3	27.6	0.86	(0.38; 1.32)	0.66	(0.20; 1.11	93.2	2.00	(0.71; 3.29)	1.42	(0.30; 2.54)
Q4	27.9	1.26	(0.77; 1.75)	0.96	(0.47; 1.45	94.8	3.63	(2.31; 4.94)	2.66	(1.46; 3.87)
Q5 (highest)	27.7	1.06*	(0.50; 1.61)	0.97*	(0.42; 1.51	92.9	1.77*	(0.29; 3.26)	1.92*	(0.57; 3.27)
Total	27.4	–	–	–	–	92.8	–	–	–	–

BMI body mass index, *WC* waist circumference, *CI* confidence interval, *Ref.* reference group.
*P-trend ≤ 0.001.
[a]See previous table.
[b]Adjusted for sex, age, educational attainment, income, zones, country of birth, level of physical activity and smoking status.

Are more highly processed whole grains less healthy?

Whole-grain modified Nova ultra-processed food definitions: a cross-sectional analysis of the impact on cardiometabolic risk measures when excluding high whole-grain foods from the ultra-processed food category in Australia

Elissa J. Price[1], Katrina R. Kissock[1,2], Eden M. Barrett[1,2], Marijka J. Batterham[3] and Eleanor J. Beck[1,4]

Cite this article: Price EJ, Kissock KR, Barrett EM, Batterham MJ, and Beck EJ (2025). Whole-grain modified Nova ultra-processed food definitions: a cross-sectional analysis of the impact on cardiometabolic risk measures when excluding high whole-grain foods from the ultra-processed food category in Australia. *British Journal of Nutrition*, page 1 of 11. doi: 10.1017/S0007114524002952

Table 3. Association between quintiles of energy intake (%E) from ultra-processed food (UPF) and cardiometabolic risk measures for whole-grain modified UPF definitions in Australian adults with 1d of intake

	Proportion of energy intake from UPF (%)*												
	Q1		Q2		Q3		Q4		Q5		P for linear trend†	P for sig. difference‡	Adjusted R-squared
	x̄	SEM	x̄	SEM	x̄	SEM	x̄	SEM	x̄	SEM			
Body weight (kg)§ (*n* 6003)													
Adjusted													
Approach 1	75·1	0·6^{A}	75·9	0·6^{AB}	76·8	0·6^{AB}	76·9	0·6^{AB}	78·1	0·6^{B}	0·0003	0·0116	0·2235
Approach 2	74·8	0·6^{A}	76·5	0·7^{AB}	76·5	0·6^{AB}	77·2	0·6^{B}	77·8	0·6^{B}	0·0007	0·0077	0·2236
Approach 3	75·0	0·6^{A}	76·2	0·6^{AB}	76·4	0·5^{AB}	77·1	0·6^{AB}	78·1	0·6^{B}	0·0007	0·0122	0·2236

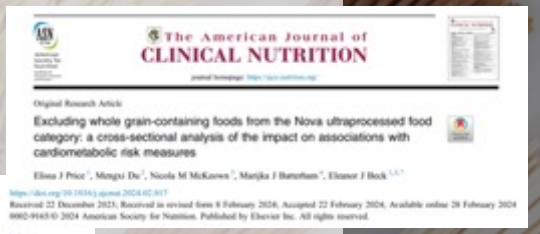


TABLE 4

Association between quintiles of energy intake (%E) from ultraprocessed food (UPF) and cardiometabolic risk measures for whole grain modified UPF definitions in United States adults

	Proportion of energy intake from UPF (%)[1,2]					*P* value for linear trend[3]	*P* value for significant difference[4]	Adjusted R^2
	Q1	Q2	Q3	Q4	Q5			
Body weight (kg)[5] (*n* = 7261)								
Adjusted								
Approach 1	80.0 (0.91)^{A}	81.9 (0.9)^{AB}	82.4 (0.9)^{AB}	83.8 (0.8)^{B}	83.6 (0.8)^{B}	0.0003	<0.0001	0.1405
Approach 2	80.1 (0.9)^{A}	82.1 (1.2)^{AB}	81.4 (0.8)^{AB}	83.7 (0.9)^{B}	84.2 (0.8)^{B}	0.0001	<0.0001	0.1413
Approach 3	82.2 (1.0)^{A}	83.8 (1.0)^{AB}	84.2 (0.7)^{AB}	85.6 (0.9)^{B}	85.9 (0.7)^{B}	0.0005	<0.0001	0.1404

Are more highly processed whole grains less healthy?

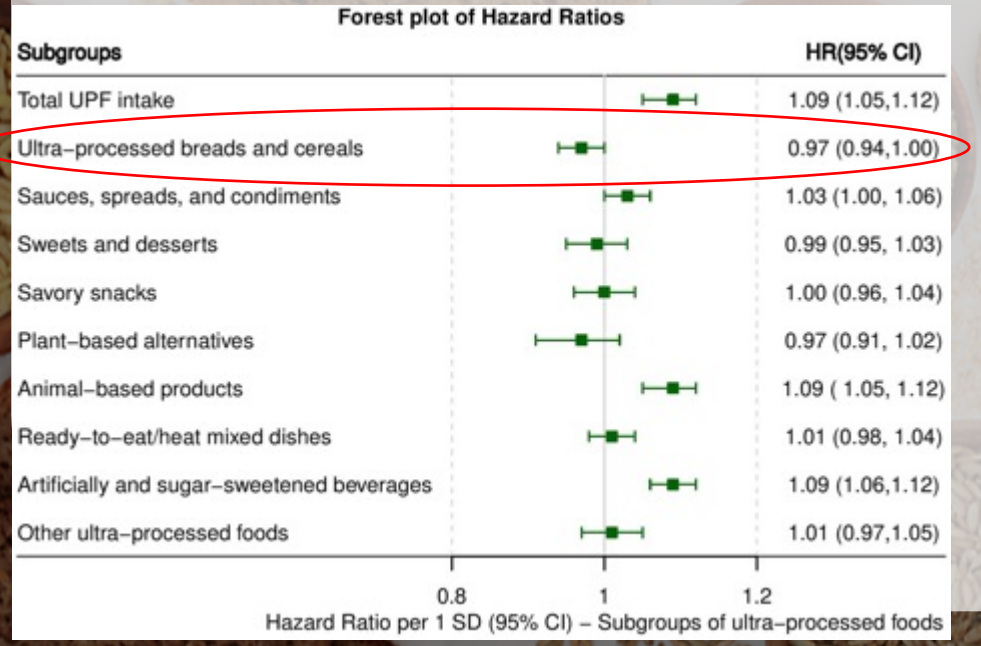
The Lancet Regional Health - Europe 2023;35: 100771

Published Online 14 November 2023 https://doi.org/10.1016/j.lanepe.2023.100771

Consumption of ultra-processed foods and risk of multimorbidity of cancer and cardiometabolic diseases: a multinational cohort study

Reynalda Cordova,[a,b] Vivian Viallon,[a] Emma Fontvieille,[a] Laia Peruchet-Noray,[a] Anna Jansana,[a] Karl-Heinz Wagner,[b] Cecilie Kyrø,[c] Anne Tjønneland,[c,d] Verena Katzke,[e] Rashmita Bajracharya,[a] Matthias B. Schulze,[f,g] Giovanna Masala,[h] Sabina Sieri,[i] Salvatore Panico,[j] Fulvio Ricceri,[k] Rosario Tumino,[l] Jolanda M. A. Boer,[m] W. M. Monique Verschuren,[m,n] Yvonne T. van der Schouw,[n] Paulo Jakszyn,[o,p] Daniel Redondo-Sánchez,[q,r,s] Pilar Amiano,[s,t,u] José María Huerta,[s,v] Marcela Guevara,[s,w,x] Yan Borné,[y] Emily Sonestedt,[z] Konstantinos K. Tsilidis,[a,aa] Christopher Millett,[ab,ac] Alicia K. Heath,[ab] Elom K. Aglago,[ab] Dagfinn Aune,[ab,ad,ae] Marc J. Gunter,[a,ab] Pietro Ferrari,[a] Inge Huybrechts,[a] and Heinz Freisling[a,*]

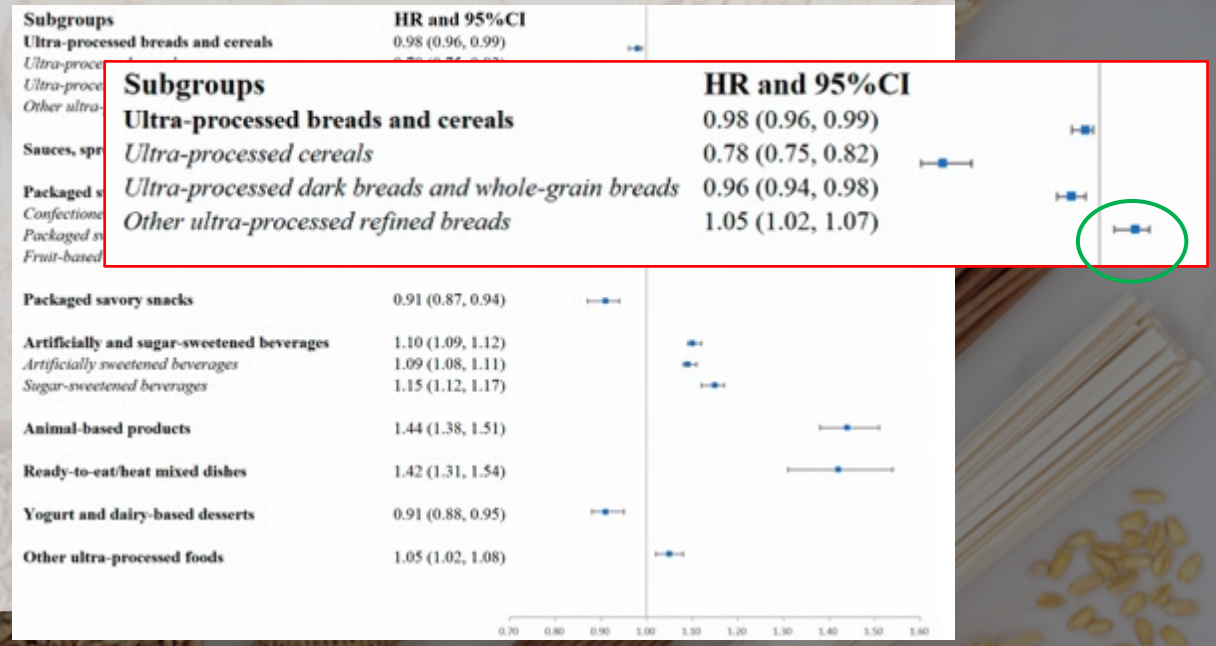
[a]International Agency for Research on Cancer (IARC-WHO), Lyon, France



Diabetes Care. American Diabetes Association.

Ultra-Processed Food Consumption and Risk of Type 2 Diabetes: Three Large Prospective U.S. Cohort Studies

Zhangling Chen, Neha Khandpur, Clémence Desjardins, Lu Wang, Carlos A. Monteiro, Sinara L. Rossato, Teresa T. Fung, JoAnn E. Manson, Walter C. Willett, Eric B. Rimm, Frank B. Hu, Qi Sun, and Jean-Philippe Drouin-Chartier



Ultra-processed foods and diet quality

nutrients

Review

Ultra-Processed Foods and
A Meta-Analysis of Nationa

Daniela Martini [1,†], Justyna Godos [2,*,†], Mari

MDPI

Citation: Martini, D.; Godos, J.;
Bonaccio, M.; Vitaglione, P.; Grosso,

Table 3. Variation in specific nutrient intake by contribution of ultra-processed foods to total energy consumption and slope of nationally representative samples. Slopes represent the variation in intake of a specific food item when the share of %E from UPFs increased by 1%.

Variable	Datasets (Studies)	Estimates (95% CI) in Categories of UPF Contribution				*p* for Slope
Ultra-Processed Foods (%)		15% UPF	50% UPF	75% UPF	Slope	
Micronutrients						
Sodium (mg/1000 kcal)	12 (10)	1914.70 (1504.16; 2325.23)	1977.65 (1551.45; 2403.84)	2022.61 (1566.01; 2479.21)	1.80 (−1.62; 5.21)	0.302
Potassium (mg/1000 kcal)	11 (10)	2228.24 (1735.90; 2720.58)	1881.86 (1456.07; 2307.65)	1634.45 (1248.90; 2019.99)	−9.90 (−12.60; −7.19)	<0.001
Iron (mg/1000 kcal)	4 (4)	10.09 (4.22; 15.95)	9.04 (4.42; 13.66)	8.30 (4.53; 12.06)	−0.03 (−0.07; 0.01)	0.120
Magnesium (mg/1000 kcal)	4 (4)	200.63 (141.17; 260.09)	161.53 (113.10; 209.96)	133.60 (92.75; 174.46)	−1.12 (−1.46; −0.78)	<0.001
Calcium (mg/1000 kcal)	5 (5)	433.84 (299.41; 568.26)	401.01 (299.50; 502.52)	377.57 (294.55; 460.58)	−0.94 (−2.13; 0.26)	0.123
Vitamin A (µg/1000 kcal)	5 (5)	431.11 (232.39; 629.83)	332.65 (221.80; 443.50)	262.32 (203.20; 321.43)	−2.81 (−5.48; −0.15)	0.038
Vitamin C (mg/1000 kcal)	5 (5)	79.17 (47.78; 110.57)	66.79 (39.07; 94.52)	57.95 (32.05; 83.85)	−0.35 (−0.55; −0.16)	<0.001
Vitamin D (µg/1000 kcal)	4 (4)	3.73 (2.25; 5.21)	2.81 (1.75; 3.86)	2.14 (1.39; 2.90)	−0.03 (−0.04; −0.01)	<0.001
Zinc (mg/1000 kcal)	3 (3)	6.60 (6.12; 7.08)	5.46 (5.01; 5.91)	4.64 (4.10; 5.19)	−0.03 (−0.04; −0.02)	<0.001
Phosphorus (mg/1000 kcal)	4 (4)	666.55 (527.35; 805.76)	582.91 (475.76; 690.07)	523.17 (436.17; 610.17)	−2.39 (−3.46; −1.32)	<0.001
Vitamin E (mg/1000 kcal)	3 (3)	5.41 (1.12; 9.69)	4.68 (0.99; 8.37)	4.16 (0.89; 7.43)	−0.02 (−0.04; 0.00)	0.016
Vitamin B12 (µg/1000 kcal)	3 (3)	3.78 (2.10; 5.45)	2.95 (1.33; 4.57)	2.36 (0.77; 3.95)	−0.02 (−0.03; −0.02)	<0.001
Thiamin (mg/1000 kcal)	3 (3)	1.06 (0.49; 1.63)	0.93 (0.65; 1.21)	0.84 (0.76; 0.93)	0.00 (−0.01; 0.00)	0.406
Riboflavin (mg/1000 kcal)	3 (3)	1.18 (0.84; 1.53)	1.07 (0.79; 1.35)	0.99 (0.72; 1.26)	0.00 (−0.01; 0.00)	0.074
Niacin (mg/1000 kcal)	4 (4)	16.97 (9.26; 24.68)	14.18 (8.38; 19.99)	12.19 (7.72; 16.65)	−0.08 (−0.14; −0.02)	0.005

Whole grains and diet quality

American Dietetic Association

RESEARCH

Original Research

Whole-Grain Consumption Is Associated with Diet Quality and Nutrient Intake in Adults: The National Health and Nutrition Examination Survey, 1999-2004

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Manuscript accepted: April 19, 2010.

0002-8223/$36.00

doi: 10.1016/j.jada.2010.07.012

Table 2. Diet quality and adjusted[a] nutrient intake of adults aged 19 to 50 y by whole-grain consumption group, according to data from the 1999-2004 National Health and Nutrition Examination Survey

			No. of Servings								
	Total Population		≥0 to <0.6		≥0.6 to <1.5		≥1.5 to <3.0		≥3.0		
	n=7,039		n=5,077		n=943		n=678		n=341		
Nutrient	LSM[b]	LSSE[c]	LSM	LSSE	LSM	LSSE	LSM	LSSE	LSM	LSSE	*P* for trend
Macronutrient											
Whole-grain servings	0.71	0.02	0.09	0.00	1.01	0.01	2.12	0.02	4.65	0.11	—
Healthy Eating Index	49.19	0.19	46.49	0.21	53.04	0.48	55.45	0.56	59.23	0.89	<0.0001
Energy[d] (kcal)	2,413.02	14.07	2,340.46	17.26	2,468.56	36.78	2,609.04	41.75	2,753.48	56.92	<0.0001
Protein (g)	87.79	0.41	88.01	0.53	88.52	1.01	86.69	1.32	85.33	1.73	0.1162
Carbohydrate (gm)	297.59	1.06	292.37	1.39	302.28	2.61	307.04	3.12	329.43	4.46	<0.0001
Fiber (g)	15.67	0.13	13.85	0.13	16.89	0.30	20.33	0.51	25.11	0.69	<0.0001
Total sugar (g)	145.16	1.07	146.72	1.42	144.29	2.70	139.15	3.00	140.54	4.25	0.0090
Added sugar (g)	25.86	0.27	27.09	0.36	24.71	0.66	22.25	0.70	21.20	1.05	<0.0001
Total fat (g)	89.17	0.38	89.42	0.48	89.96	0.95	88.21	1.26	85.97	1.71	0.0525
Saturated fatty acids (g)	29.58	0.16	29.82	0.20	30.08	0.41	29.00	0.52	26.63	0.69	<0.0001
Monounsaturated fatty acids (g)	33.65	0.16	33.80	0.21	34.30	0.41	33.05	0.53	31.37	0.72	0.0011
Polyunsaturated fatty acids (g)	18.12	0.13	17.93	0.16	17.76	0.29	18.52	0.42	20.56	0.64	<0.0001
Cholesterol (mg)	302.77	3.00	318.93	3.90	294.08	7.22	261.37	8.25	213.00	10.28	<0.0001
Micronutrient											
Vitamin A (retinol equivalents)	690.09	12.63	644.95	15.61	748.55	31.70	787.65	40.37	888.13	49.15	0.0000
Vitamin C (mg)	92.12	1.43	88.09	1.66	97.00	3.76	98.00	4.40	116.21	9.24	0.0021
Vitamin E (mg α-tocopherol)	7.94	0.09	7.58	0.09	8.21	0.19	9.18	0.48	9.21	0.39	<0.0001
Vitamin B-6 (mg)	1.93	0.01	1.81	0.02	2.12	0.04	2.20	0.06	2.27	0.10	<0.0001
Vitamin B-12 (μg)	5.34	0.11	5.25	0.15	5.62	0.25	5.85	0.32	4.68	0.28	0.9783
Folate (μg dietary folate equivalents)	411.15	3.07	380.72	3.05	467.18	9.11	482.54	12.47	490.82	18.80	<0.0001
Calcium (mg)	908.90	7.72	863.31	8.88	974.95	17.11	1045.61	34.89	1015.89	34.63	<0.0001
Magnesium (mg)	291.94	1.64	271.28	1.71	305.90	3.47	343.59	7.11	401.82	8.67	<0.0001
Potassium (mg)	2,779.40	14.09	2,733.68	17.55	2,835.11	35.04	2,881.73	43.68	2,982.19	73.68	<0.0001
Phosphorus (mg)	1,408.31	6.01	1,365.03	7.28	1,464.26	14.45	1,505.59	21.87	1,591.16	29.61	<0.0001
Iron (mg)	16.10	0.11	14.81	0.11	17.61	0.27	19.77	0.53	20.40	0.72	<0.0001
Sodium (mg)	3,702.82	19.01	3,680.43	23.73	3,800.92	51.49	3,718.55	59.11	3,687.14	83.84	0.4054

[a]Covariates used were energy, sex, ethnicity, and age.
[b]LSM = least square mean.
[c]LSSE = least square standard error.
[d]For energy only, covariates used were sex, ethnicity, and age.

Whole grains and diet quality

British Journal of Nutrition (2015), 113, 1595–1602

Whole grain intake and its association with intakes of other foods, nutrients and markers of health in the National Diet and Nutrition Survey rolling programme 2008–11

Kay D. Mann[1,2], Mark S. Pearce[1], Brigid McKevith[3], Frank Thielecke[4,5] and Chris J. Seal[2]*

Table 2. Mean nutrient intakes of non-consumers and by tertiles (T) of whole grain intake

	Child/teenage mean					Adult mean				
	Whole grain intake/d					Whole grain intake/d				
Nutrient	0 g/d	T1	T2	T3	*P*†	0 g/d	T1	T2	T3	*P*†
Energy (kcal)	1549	1528	1582	1683*	<0·001	1862	1743	1784	1987*	<0·001
Energy (MJ)	6·5	6·4	6·7	7·1*	<0·001	7·8	7·3	7·5	8·4*	<0·001
% energy from protein	14·8	14·6	14·5	15·1	<0·05	15·8	16·2	16·9*	16·7*	<0·01
% energy from carbohydrate	50·3	50·7	51·5*	51·8*	<0·01	44·9	44·5	45·5	46·6*	<0·001
% energy from total sugar	21·8	22·7	23·6*	23·0*	<0·01	19·5	19·1	19·8	19·9	≥0·05
% energy from NME sugars	14·3	14·6	14·8	13·8	<0·01	13·6	12*	11·2*	10·6*	<0·001
% energy from fat	34·7	34·4	33·8*	33·0*	<0·001	33·7	34·0	32·9	32·8	<0·05
% energy from saturated fat	13·0	13·4	13·3	13·1	≥0·05	12·4	12·7	12·2	12·2	≥0·05
% energy from alcohol	0·2	0·2	0·1	0·1	≥0·05	5·6	5·3	4·7	3·9*	<0·05
Fibre (g/10 MJ)	14·8	15·1*	16·8*	19·3*	<0·001	14·4	16·2*	19·2*	21·6*	<0·001
Na (mg/10 MJ)	3051	2978	2885*	2910*	≥0·05	3090	3027	2989	2934*	≥0·05
Fe (mg/10 MJ)	11·7	12·3*	13·3*	15·0*	<0·001	12·3	13·6*	14·7*	15·2*	<0·001
Ca (mg/10 MJ)	1147	1169	1234*	1276*	<0·001	984	1044	1114*	1149*	<0·001
Vitamin E (mg/10 MJ)	11·1	10·5*	10·7	10·5	≥0·05	11·0	11·2	11·8	12·1*	<0·001
K (mg/10 MJ)	3233	3255	3322	3422*	<0·001	3303	3549*	3884*	3916*	<0·001
P (mg/10 MJ)	1489	1520	1563*	1665*	<0·001	1502	1556	1674*	1752*	<0·001
Mg (mg/10 MJ)	264·7	276·1*	294·3*	326*	<0·001	286	306*	344*	376*	<0·001
Thiamin (mg/10 MJ)	1·8	1·9*	2·0*	2·1*	<0·001	1·8	1·8	2·0*	2·0*	<0·001
Riboflavin (mg/10 MJ)	2·0	2·1	2·3*	2·4*	<0·001	1·8	2·0	2·2*	2·3*	<0·001
Niacin (mg/10 MJ)	41·7	41·7	41·4	44·2*	<0·01	47·9	46·7	48·5	49·1	≥0·05
Vitamin B6 (mg/10 MJ)	2·8	2·8	2·8	2·9	≥0·05	3·1	2·9	3·0	3·0	≥0·05
Vitamin B12 (μg/10 MJ)	6·0	5·8	6·1	6·4	≥0·05	6·7	6·9	7·6	7·7*	<0·05
Vitamin D (μg/10 MJ)	3·3	2·9	3·1	3·1	≥0·05	3·7	3·5	4·0	4·1*	<0·01
n (unweighted)	227	415	418	442		277	431	426	437	

NME, non-milk extrinsic.
* Values are significantly different from non-consumers ($P<0·05$; *t* test, adjusted for sex).
† Association across intakes of whole grain and nutrient intakes (linear regression, adjusted for sex).

Ultra-processed foods and diet quality

American Journal of
Preventive Medicine
RESEARCH ARTICLE

Consumption of Ultraprocessed Foods and Diet Quality Among U.S. Children and Adults

Junxiu Liu, PhD,[1,2] Euridice Martinez Steele, PhD,[3,4] Yan Li, PhD,[1,5] Dimitra Karageorgou, PhD,[2] Renata Micha, PhD,[2] Carlos A. Monteiro, PhD,[3,4] Dariush Mozaffarian, MD, DrPH[2]

Liu et al / Am J Prev Med 2022;62(2):252–264

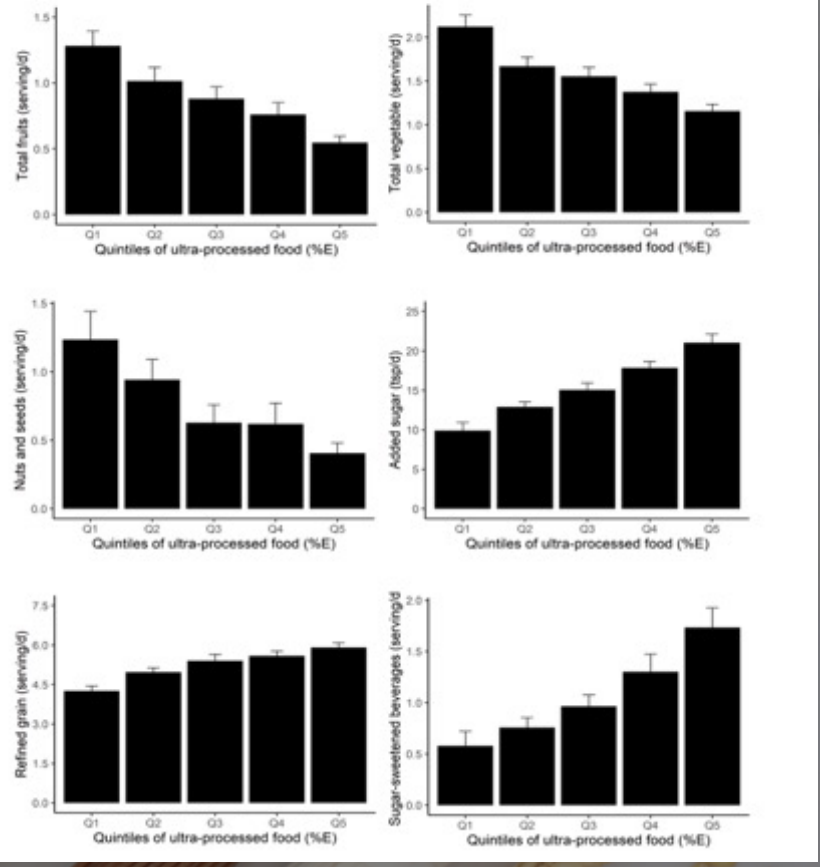
Largest differences between UPF quintiles and AHA dietary scores observed for:

- Fruits and vegetables
- SSB
- Nuts/seeds/legumes
- Refined grains
- Added sugars

Lesser difference found between UPF quintiles and AHA dietary scores for whole grains

98% of Americans do NOT meet daily intake requirement for whole grains

Appendix Figure 4b Adults Predicted marginal means of total fruits (servings/d), total vegetables (serving/d), nuts and seeds (serving/d), added sugar (tsp/d), refined grain (serving/d) and sugar-sweetened beverages (serving/d) across quintiles of ultra-processed food consumption (%E) among U.S. adults (aged >20 years), NHANES 2015–2018. *Notes*: Data were adjusted for NHANES survey weights to be nationally representative. Error bars indicate 95% CIs. NHANES, National Health and Nutrition Examination Survey.



The balancing act for whole grains

Poor whole-grain intake at the population level

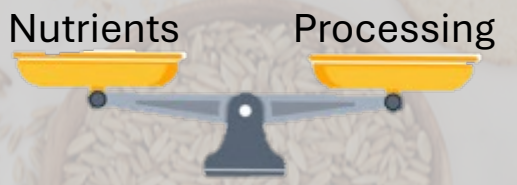
Better diet quality with higher whole-grain intake

Processing of whole grains is unavoidable and improves nutrient bioavailability

Whole grains including "ultra-processed" types have health protective effects

Perhaps could prioritise less processed whole grains but not at the expense of more highly processed types

Why?



Ultra-processed foods, diet quality, and vulnerable groups

American Journal of
Preventive Medicine

RESEARCH ARTICLE

Consumption of Ultraprocessed Foods and Diet Quality Among U.S. Children and Adults

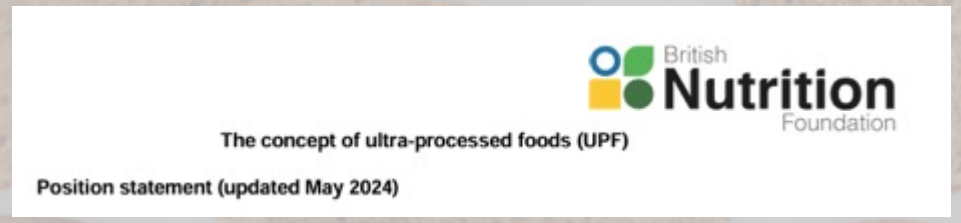
Junxiu Liu, PhD,[1,2] Euridice Martinez Steele, PhD,[3,4] Yan Li, PhD,[1,5] Dimitra Karageorgou, PhD,[2] Renata Micha, PhD,[2] Carlos A. Monteiro, PhD,[3,4] Dariush Mozaffarian, MD, DrPH[2]

Liu et al / Am J Prev Med 2022;62(2):252–264

Largest differences in associations across quintiles of UPF intake and poor diet quality were evident for:

- Minorities (non-Hispanic Black and Hispanic)
- Lower educated (less than high school graduate)
- Lower household income levels (PIR <1.30)
- Higher BMI
    - Underweight with greatest difference

Ultra-processed foods, diet quality, and vulnerable groups



- Poor access to cooking equipment
- Limited cooking skills
- Those unable to afford energy and food
- Busy lifestyles

- Women of childbearing age
- Aboriginal and Torres Strait Islander peoples

- Thiamine and folate intake theoretically halved
- ↓ iron intake (15.0mg to 9.2mg)
- ↓ iodine intake (17.7µg to12.1µg)

Processing impacts on accessibility

Improves access to nutrient dense, low-cost foods

International Journal of Environmental Research and Public Health

MDPI

Article

Diet and Economic Modelling to Improve the Quality and Affordability of the Australian Diet for Low and Medium Socioeconomic Households

Michelle Blumfield [1,†], Carlene Starck [2,3,†], Tim Keighley [1], Peter Petocz [1], Anna Roesler [1], Kylie Abbott [4], Tim Cassettari [2], Skye Marshall [1,5] and Flavia Fayet-Moore [4,*]

Citation: Blumfield, M.; Starck, C.; Keighley, T.; Petocz, P.; Roesler, A.; Abbott, K.; Cassettari, T.; Marshall, S.; Fayet-Moore, F. Diet and Economic Modelling to Improve the Quality and Affordability of the Australian Diet for Low and Medium Socioeconomic Households. *Int. J. Environ. Res. Public Health* **2021**, *18*, 5771. https://doi.org/10.3390/ijerph18115771

33% of top quartile of nutrient dense, low-cost foods were “ultra-processed” fortified wholegrain bread and breakfast cereals (<20 g sugars/100 g)

Processing impacts on accessibility

Supports food security for many population groups

npj | Science of Food www.nature.com/npjscifood

PERSPECTIVE OPEN

The science of food security

Martin Barry Cole[1], Mary Ann Augustin[1], Michael John Robertson[1] and John Michael Manners[1]

npj Science of Food (2018)2:14 ; doi:10.1038/s41538-018-0021-9

Extends the shelf life of products improving sustainability and reducing food waste

Processing impacts on accessibility

Food safety → kill harmful microorganisms, food spoilage

Nutrient bioavailability → digestibility of nutrients

Convenience → cooking abilities, busy lifestyles etc.

Sensory properties → acceptability of whole-grain foods

Summary

Promotion of all whole-grain foods prioritising lesser processed types

Especially considering vulnerable groups, cost, food security, and cooking abilities

RCT data on UPF subgroup intake and associations with health

Understand exact associations and potential mechanisms

Consistent and accurate messaging to reflect evidence

Promotion of whole grains in dietary messaging models (dietary guidelines and Nova)

Acknowledge evidence caveats or nuances for UPF – consumer education

Co-ordinated efforts to develop, evaluate, and implement healthy dietary patterns that consider nutrient composition, processing, sustainability etc.

Thank you

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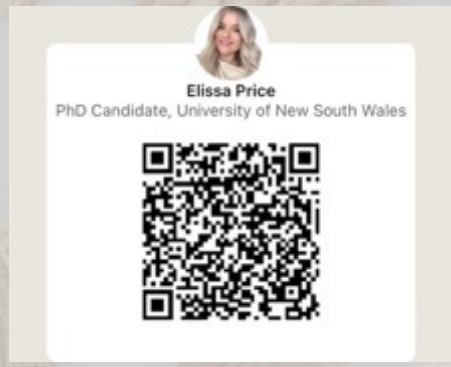

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Interactive Assessment

POLL: Which of these foods would be considered Ultra-Processed in the Nova Classification System?

A. Sliced 100% whole wheat sandwich bread
B. Refined, all-purpose flour
C. Dried pasta made from 100% whole grain flour
D. Seed oils
E. Beer

POLL: Which of these statements is FALSE

A. People who eat more ultra-processed foods tend to be more likely to develop conditions like hypertension and diabetes.

B. Whole grain foods are considered less “processed” than refined grain foods in the Nova Classification System.

C. A diet consisting of mostly ultra-processed foods can contain adequate amounts of most nutrients and have a high diet quality score.

POLL: Which of these statements is FALSE?

A. Processing can make certain nutrients more bioavailable.

B. Processing can lower the glycemic impact of a food.

C. Processing can improve shelf life.

D. The Nova Food Classification System focuses on nutrients that are removed during processing, not ingredients that are added.