

Supplementary information

Association of unsweetened and sweetened cereals consumption with all-cause and cause-specific mortality: a large prospective population-based cohort study

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Supplemental Table 1. Classification of cereal consumers by sweeteners.

Categories of cereal consumers	n	%
Non-consumers	54228	26.6%
Sole consumers		
Unsweetened	104432	51.3%
Sugar-sweetened	24859	12.2%
Artificially sweetened	4488	2.2%
Overlapped consumers of sweeteners		
Unsweetened & Sugar-sweetened	12775	6.3%
Unsweetened & Artificially sweetened	1381	0.7%
Sugar-sweetened & Artificially sweetened	1085	0.5%
Unsweetened & Sugar-sweetened & Artificially sweetened	248	0.1%
Total	203496	100%

Note: As shown in the workflow, a total of 210,947 individuals completed at least one 24-hour dietary recall questionnaire. We excluded participants who were lost during follow-up (n = 569), participants whose diets were not credible (n = 3,160), and participants in the top 1% of the cereal intake distribution (n = 3,722), leaving 203,496 participants with reliable cereal intake. We then further classified consumers based on whether additional sugar or artificially sweeteners were added to the cereal. In detail, the type and number of cross-consuming sweeteners are shown here.

Supplemental Table 2. Baseline characteristics between participants included and excluded in the UKB cohort before imputation.

Characteristic	Included	Excluded (with 24-hour dietary recall)	Excluded (without 24-hour dietary recall)	p-values
Participants, n (%)	186419 (37.1)	24528 (4.9)	291422 (58.0)	-
Median follow-up, years (IQR)	13.6 (13.0-14.4)	13.5 (13.0-14.3)	14.3 (13.5-14.8)	<0.001
Mean age (SD), y	56.0 (8.0)	56.4 (7.9)	56.9 (8.2)	<0.001
Male, n (%)	83765 (44.9)	10980 (44.8)	134323 (46.1)	<0.001
BMI (kg/m ²), n (%)				<0.001
< 25	69130 (37.2)	9361 (38.4)	86487 (29.9)	
≥ 25 & < 30	77301 (41.6)	10024 (41.2)	124737 (43.2)	
≥ 30	39565 (21.3)	4971 (20.4)	77686 (26.9)	
Mean Basal metabolic rate (SD), KJ	6605.9 (1353.6)	6615.2 (1357.7)	6622.9 (1371.7)	<0.001
Ethnicity, n (%)				<0.001
White	177944 (95.7)	23284 (96.0)	271345 (93.8)	
Other	7972 (4.3)	975 (4.0)	18071 (6.2)	
Mean Townsend deprivation index (SD)	-1.6 (2.9)	-1.6 (2.9)	-1.1 (3.2)	<0.001
Household income, n (%), £				<0.001
< 18,000	25864 (15.4)	3672 (17.3)	67640 (28.6)	
18,000-30,999	40603 (24.2)	5384 (25.4)	62156 (26.3)	
31,000-51,999	47715 (28.4)	6098 (28.7)	56933 (24.1)	
52,000-100,000	41279 (24.6)	4721 (22.3)	40243 (17.0)	
> 100,000	12270 (7.3)	1336 (6.3)	9317 (3.9)	
Education				<0.001
Degree	79443 (42.8)	10281 (42.6)	71380 (25.3)	
No degree	106307 (57.2)	13872 (57.4)	210954 (74.7)	
Smoking status, n (%)				<0.001
Never	105092 (56.5)	13889 (57.3)	154468 (53.4)	
Former	66063 (35.5)	8791 (36.2)	98155 (34.0)	
Current	14969 (8.0)	1577 (6.5)	36415 (12.6)	
Mean pack-years of smoking for current or former smokers (SD)	20.9 (17.3)	20.1 (16.9)	25.1 (19.6)	<0.001
Physical activity level, n (%)				<0.001
Low	29427 (18.5)	3501 (17.4)	43262 (19.4)	
Moderate	67269 (42.4)	8336 (41.5)	88382 (39.5)	
High	61944 (39.0)	8261 (41.1)	91891 (41.1)	
Vitamin use, n (%)	60569 (32.6)	8237 (34.0)	89061 (31.3)	<0.001
Minerals and other dietary supplements use, n (%)	81184 (43.6)	11454 (47.1)	121103 (42.4)	<0.001
NSAIDs use, n (%)	68226 (36.9)	9028 (37.5)	121661 (43.1)	<0.001
Healthy sleep pattern, n (%)	94405 (60.2)	12108 (62.0)	132100 (56.4)	<0.001
Family history of CVD, n (%)	105259 (57.2)	13622 (57.9)	164021 (57.7)	0.003
Family history of cancer, n (%)	65339 (35.5)	8345 (35.4)	102007 (35.9)	0.022
Number of long-term conditions, n (%)				<0.001
None	53765 (28.8)	6877 (28.1)	72278 (24.9)	
One	59768 (32.1)	7801 (31.9)	87322 (30.0)	
Two	39724 (21.3)	5242 (21.4)	64668 (22.2)	
Three	19968 (10.7)	2735 (11.2)	36684 (12.6)	
Four	8414 (4.5)	1137 (4.6)	17567 (6.0)	
Five and more	4780 (2.6)	676 (2.8)	12227 (4.2)	
Mean intake (SD)				
Energy, kcal/d	2077.0 (589.1)	2395.4 (975.0)	-	<0.001
Total sugar, g/d	118.1 (47.9)	144.1 (75.4)	-	<0.001
Coffee, drinks/d	2.0 (1.8)	2.2 (1.8)	-	<0.001
Starchy food, servings/d	0.1 (0.3)	0.1 (0.4)	-	<0.001
Refined grains, servings/d	0.9 (1.1)	1.3 (1.3)	-	<0.001
Snacks, servings/d	0.6 (1.0)	0.8 (1.2)	-	<0.001
Pizza, servings/d	0.1 (0.6)	0.2 (0.7)	-	<0.001
Cereal on average in past year, bowls /d	0.6 (0.4)	0.8 (0.3)	0.6 (0.4)	<0.001
Cereal, bowls /d	0.7 (0.6)	1.7 (0.9)	-	<0.001
Containing dried fruit	0.4 (0.6)	1.0 (1.1)	-	<0.001
No dried fruit	0.4 (0.6)	0.7 (1.0)	-	<0.001
Type of sweetener added to cereal, teaspoons/bowl				
Sugar	0.1 (0.4)	0.7 (0.7)	-	<0.001
Artificial sweetener	0.0 (0.2)	0.1 (0.4)	-	<0.001
Mean Alternative healthy eating index (AHEI, SD) *	33.3 (11.8)	35.8 (11.2)	-	<0.001

Mean completed 24-h dietary recalls (SD), n	2.1 (1.1)	3.0 (1.1)	0.0 (0.0)	<0.001
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Note: Nonparametric tests were used for continuous variables and chi-square tests were used for categorical variables. The statistical tests were performed for each variable between the three groups. * AHEI: The modified Alternative Healthy Eating Index is a combination of eight dietary indicators, including vegetables, fruit, sugar-sweetened beverages and fruit juice, nuts and legumes, red or processed meat, Long-chain (n-3) fats (EPA + DHA), PUFA, % of energy, and alcohol (Supplemental Table 3-4). The scores were summed producing an overall score ranging from 0 to 80.

Abbreviations: IQR, interquartile range; BMI: body mass index; SD: standard deviation; NSAIDs, Nonsteroidal anti-inflammatory drugs; CVD: cardiovascular disease; AHEI, Alternative Healthy Eating Index.

Supplemental Table 3. Scoring for the modified Alternative Healthy Eating Index.

Diet component	UKB variable	label	Coding (standard servings per day)	Scoring	
				Criteria for minimum score (0)	Criteria for maximum score (10)
Vegetable	103990	Vegetable consumers	0/1, N/Y		
	104060	Mixed vegetable	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104070	Vegetable pieces	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104080	Coleslaw	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104090	Side salad	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104120	Green bean	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104130	Beetroot	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104140	Broccoli	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104150	Butternut squash	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104160	Cabbage/kale	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104170	Carrot	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104180	Cauliflower	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104190	Celery	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104200	Courgette	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104210	Cucumber	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104220	Garlic	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104230	Leek	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104240	Lettuce	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104250	Mushroom	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104260	Onion	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104270	Parsnip	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104280	Pea	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104290	Sweet pepper	444/555/1/2/300, ¼ / ½ /1/2/3+		
104300	Spinach	444/555/1/2/300, ¼ / ½ /1/2/3+			
104310	Sprouts	444/555/1/2/300, ¼ / ½ /1/2/3+			
104320	Sweetcorn	444/555/1/2/300, ¼ / ½ /1/2/3+			

	104330	Sweet potato	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104340	Fresh tomato	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104350	Tinned tomato	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104360	Turnip/swede	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104370	Watercress	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104380	Other vegetables	444/555/1/2/300, ¼ / ½ /1/2/3+		
	102520	Soup consumers	0/1, N/Y		
	102540	Canned soup intake (bowls/d)	555/1/2/3/400, ½ /1/2/3/4+		
	102620	Homemade soup intake	555/1/2/3/400, ½ /1/2/3/4+		
	20108	Ingredients in canned soup	5, vegetables		
	20109	Ingredients in homemade soup	5, vegetables		
	103310	Spreads/sauces consumers	0/1, N/Y		
	20088	Types of spreads/sauces consumed			
		Tomato sauce	346 (max 1 serving)		
		*1 veg soup= 0.25 veg serving			
	Since 20108, and 20109 are not exclusive, we derived a “servings of vegetable soup” variable weighted by response. Since 20088 is not exclusive, we derived a “servings of vegetable sauce” variable weighted by response (assumed max 1 serving). Used mean intake across diet records for each item then summed item means for daily servings.			0 serving/day	≥5 serving/day
Fruit (not juice)	104400	Fruit consumers	0/1, N/Y		
	104410	Stewed fruit	555/1/2/3/400, ½ /1/2/3/4+		
	104420	Prune	555/1/2/3/400, ½ /1/2/3/4+		
	104430	Dried fruit	555/1/2/3/400, ½ /1/2/3/4+		
	104440	Mixed fruit	555/1/2/3/400, ½ /1/2/3/4+		
	104450	Apple	555/1/2/3/400, ½ /1/2/3/4+		
	104460	Banana	555/1/2/3/400, ½ /1/2/3/4+		
	104470	Berry	555/1/2/3/400, ½ /1/2/3/4+		
	104480	Cherry	555/1/2/3/400, ½ /1/2/3/4+		
	104490	Grapefruit	555/1/2/3/400, ½ /1/2/3/4+		

	104500	Grape	555/1/2/3/400, ½ /1/2/3/4+		
	104510	Mango	555/1/2/3/400, ½ /1/2/3/4+		
	104520	Melon intake	555/1/2/3/400, ½ /1/2/3/4+		
	104530	Orange intake	555/1/2/3/400, ½ /1/2/3/4+		
	104540	Satsuma intake	555/1/2/3/400, ½ /1/2/3/4+		
	104550	Peach/nectarine intake	555/1/2/3/400, ½ /1/2/3/4+		
	104560	Pear intake	555/1/2/3/400, ½ /1/2/3/4+		
	104570	Pineapple intake	555/1/2/3/400, ½ /1/2/3/4+		
	104580	Plum intake	555/1/2/3/400, ½ /1/2/3/4+		
	104590	Other fruit intake	555/1/2/3/400, ½ /1/2/3/4+		
	103990	Vegetable consumers	0/1, N/Y		
	104100	Avocado intake (servings/d)	444/555/1/2/300, ¼ / ½ /1/2/3+		
	Used mean intake across diet records for each item then summed item means for daily servings.			0 serving/day	≥4 serving/day
Sugar sweetened beverages + fruit juice	100170	Fizzy drink	555/1/2/3/4/5/600, ½ /1/2/3/4/5/6+		
	100180	Squash	555/1/2/3/4/5/600, ½ /1/2/3/4/5/6+		
	100190	Orange juice	555/1/2/3/4/5/600, ½ /1/2/3/4/5/6+		
	100200	Grapefruit juice	555/1/2/3/4/5/600, ½ /1/2/3/4/5/6+		
	100210	Pure fruit/vegetable juice (1 serving=1/2 fruit juice serving)	555/1/2/3/4/5/600, ½ /1/2/3/4/5/6+		
	100220	Fruit smoothie	555/1/2/3/4/5/600, ½ /1/2/3/4/5/6+		
	100510	Other non-alcoholic drinks	0/1, N/Y		
	100530	Flavoured milk	555/1/2/3/4/5/600, ½ /1/2/3/4/5/6+		
	100550	Hot chocolate	555/1/2/3/4/5/600, ½ /1/2/3/4/5/6+		
	Used mean intake across diet records for each item then summed item means for daily intake.			≥1 serving/day	0 serving/day
Nut& Legumes	103990	Vegetable consumers	0/1, N/Y		
	104000	Baked bean	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104010	Pulses	444/555/1/2/300, ¼ / ½ /1/2/3+		
	104110	Broad bean	444/555/1/2/300, ¼ / ½ /1/2/3+		

	102520	Soup consumer	0/1, N/Y		
	102540	Canned	555/1/2/3/400, ½ /1/2/3/4+		
	102620	Homemade	555/1/2/3/400, ½ /1/2/3/4+		
	20108	Ingredients in canned soup	4, pulses		
	20109	Ingredients in homemade soup *1 bean soup= 0.25 bean serving	4, pulses		
	103310	Spreads/sauces consumers	0/1, N/Y		
	20088	Types of spreads/sauces consumed	Peanut butter/Hummus, 334/336		
	102400	Savoury snack consumers	0/1, N/Y		
	102410	Salted peanuts	555/1/2/300, ½ /1/2/3+		
	102420	Unsalted peanuts	555/1/2/300, ½ /1/2/3+		
	102430	Salted nuts	555/1/2/300, ½ /1/2/3+		
	102440	Unsalted nuts	555/1/2/300, ½ /1/2/3+		
	102450	Seeds	555/1/2/300, ½ /1/2/3+		
	103250	Vegetarian alternatives	0/1, N/Y		
	103260	Vegetarian sausages/burgers	555/1/2/3/400, ½ /1/2/3/4+		
	103270	Tofu	555/1/2/3/400, ½ /1/2/3/4+		
	103280	Quorn	555/1/2/3/400, ½ /1/2/3/4+		
	103290	Other vegetarian alternative	555/1/2/3/400, ½ /1/2/3/4+		
	Since 20108, and 20109 are not exclusive, we derived a “servings of legume soup” variable weighted by response. Since 20088 is not exclusive, we derived a “servings of legume sauce” variable weighted by response (assumed max 1 serving). Used mean intake across diet records for each item then summed item means for daily servings.			0 serving/day	≥1 serving/day
Red meat & products	103000	Meat consumers	0/1, N/Y		
	103010	Sausage	555/1/2/3/4/500, ½ /1/2/3/4/5+		
	103020	Beef	555/1/2/3/4/500, ½ /1/2/3/4/5+		
	103030	Pork	555/1/2/3/4/500, ½ /1/2/3/4/5+		

	103040	Lamb	555/1/2/3/4/500, ½ /1/2/3/4/5+		
	103070	Bacon	555/1/2/3/4/500, ½ /1/2/3/4/5+		
	103080	Ham	555/1/2/3/4/500, ½ /1/2/3/4/5+		
	Used mean intake across diet records for each item then summed item means for daily servings.			≥1.5 serving/day	0 serving/day
Long chain (n-3) fats (EPA +DHA), mg/d	103140	Fish consumer	0/1, N/Y		
	103160	Oily fish (servings/d)	555/1/2/3/400, ½ /1/2/3/4+		
	The cutoff for optimal intake (250 mg/d) is ~2 4-oz servings of fish /wk, which is consistent with current guidelines (1 oz = 28.35 g). We applied the cutoff for optimal intake as 2 servings per week.			0 serving/day	≥2 serving/week
PUFA, % energy	100007	Polyunsaturated fat	g/day		
	100002	Energy	KJ/day		
	Converted g to calories (1 g ≈9 cal) and derived % of total energy (cal=kj*0.2388458966275). Used mean intake across diet records.			≤2 %	≥10 %
Alcohol, g/d	100580	Alcohol consumed	0/1, N/Y		
	100022	Alcohol	g/d		
	Used mean intake across diet records.			≥2.5 g/day (Female) ≥3.5 g/day (Male)	0.5-1.5 g/day (Female) 0.5-2.0 g/day (Male)

Note: N: no; Y: yes.

Supplemental Table 4. The eight items included in the modified Alternative Healthy Eating Index (AHEI).

Characteristic	Total	Non-consumers	Cereal Consumers			P value
			Unsweetened	Sugar-Sweetened	Artificially Sweetened	
Participants, n (%)	186419 (100)	53681 (28.8)	103746 (55.7)	24575 (13.2)	4417 (2.4)	-
Mean Alternative healthy eating index (AHEI, SD) *	33.3 (11.8)	31.6 (11.9)	34.4 (11.7)	32.5 (11.7)	33.8 (11.5)	<0.001
Mean intake (SD)						
Vegetables, servings/d	4.4 (3.6)	3.9 (3.6)	4.7 (3.6)	4.1 (3.4)	4.5 (3.8)	<0.001
Fruit, servings/d	3.4 (2.7)	2.7 (2.6)	3.8 (2.7)	3.1 (2.5)	3.6 (2.9)	<0.001
Sugar-sweetened beverages and fruit juice, drinks/d	1.1 (1.2)	1.0 (1.2)	1.1 (1.2)	1.1 (1.2)	0.9 (1.2)	<0.001
Nuts and legumes, servings/d	0.6 (1.0)	0.6 (0.9)	0.7 (1.0)	0.6 (0.9)	0.5 (0.9)	<0.001
Red or processed meat, servings/d	1.5 (1.7)	1.5 (1.7)	1.5 (1.6)	1.4 (1.6)	1.5 (1.7)	0.001
Long-chain (n-3) fats (EPA + DHA), servings/d	0.2 (0.4)	0.2 (0.4)	0.2 (0.4)	0.2 (0.4)	0.2 (0.4)	<0.001
PUFA, % of energy/d	0.1 (0.0)	0.1 (0.0)	0.1 (0.0)	0.1 (0.0)	0.1 (0.0)	<0.001
Alcohol, g/d	16.4 (21.5)	20.6 (25.8)	14.9 (19.1)	14.7 (19.8)	11.8 (19.1)	<0.001

Note: Nonparametric tests were used for continuous variables and chi-square tests were used for categorical variables. The statistical tests were performed for each variable between the four cereal categories. *The scores were summed producing an overall score ranging from 0 to 80.

Supplemental Table 5. Information about all variables involved in this study.

Variables	Field ID
Exposure	
Unsweetened cereal intake	Field ID 100760/100770/100800/100810/
Sugar-sweetened cereal intake	100820/100830/100840/100850/100860/
Artificially sweetened cereal intake	100880/100900/100910
Inclusion and exclusion criteria	
24-hour dietary recall	Field ID 105010/105030/20077
Date lost to follow-up	Field ID 191
Daily dietary data not credible	Field ID 100026
Covariates	
Age	Field ID 21003
SEX	Field ID 21003
BMI	Field ID 21001
Basal metabolic rate	Field ID 23105
Ethnicity	Field ID 21000
Townsend deprivation index	Field ID 189
Household income	Field ID 738
Education level	Field ID 6138
Smoking status	Field ID 20116
Pack years of smoking	Field ID 20161
Physical activity	Field ID 22032
Cereal on average in past year	Field ID 1458
Vitamin and mineral supplements	Field ID 6155
Mineral and other dietary supplements	Field ID 6179
NSAIDs use	Field ID 6154
Healthy sleep pattern	Details are shown in Supplemental Table 6
Family history of CVD	Field ID 20107/20110/20111
Family history of cancer	Field ID 20107/20110/20111
Number of long-term chronic conditions	Details are shown in Supplemental Table 7
Typical diet yesterday	Field ID 100020
Energy	Field ID 100002
Total sugar	Field ID 100008
Coffee intake	Field ID 100250/100270/100290/ 100300/100310/100330
Starchy food (whole grains)	Field ID 102700/102720/102740/102780
Refined grains	Details are shown in Supplemental Table 8
Snacks	Field ID 103990/104020/104320/ 101300/101470
Pizza	Field ID 102000
AHEI-2010 score	Details are shown in Supplemental Table 3
Outcome	

All-cause death	National Death Registries
Cancer or CVD-specific death	National Death Registries

Note: BMI: body mass index; NSAIDs, Nonsteroidal anti-inflammatory drugs (Aspirin, Ibuprofen, and Paracetamol);
CVD: cardiovascular disease; AHEI, Alternative Healthy Eating Index.

Supplemental Table 6. Definitions of sleep behaviors.

Sleep phenotypes	Date field	UK Biobank Questionnaire	Response	Scoring	
				Criteria for 0 point	Criteria for 1 point
Sleep duration	1160	Self-reported: "About how many hours sleep do you get in every 24 hours? (please include naps)"	Integer -1 Do not know -3 Prefer not to answer	<7 or >=9 hours/d	7-8 hours/d
Chronotype	1180	Self-reported: "Do you consider yourself to be?"	1 Definitely a 'morning' person 2 More a 'morning' than 'evening' person 3 More an 'evening' than a 'morning' person 4 Definitely an 'evening' person -1 Do not know -3 Prefer not to answer	3 and 4	1 and 2
Insomnia	1200	Self-reported: "Do you have trouble falling asleep at night or do you wake up in the middle of the night?"	1 Never/rarely 2 Sometimes 3 Usually -3 Prefer not to answer	3	1 and 2
Snoring	1210	Self-reported: "Does your partner or a close relative or friend complain about your snoring?"	1 Yes 2 No -1 Do not know -3 Prefer not to answer	1	2
Daytime dozing	1220	Self-reported: "How likely are you to doze off or fall asleep during the daytime when you don't mean to? (e.g. when working, reading or driving)"	0 Never/rarely 1 Sometimes 2 Often 3 All of the time -1 Do not know -3 Prefer not to answer	2 and 3	0 and 1

Note: Five distinct sleep traits were used to construct a healthy sleep score on a scale of 0-5, with higher scores indicating healthier sleep patterns.

Supplemental Table 7. Definition and list of long-term conditions in UK Biobank.

	Morbidity grouping	Conditions included	UKB Data field
1	Cancer	Cancer	2453 (1), 20001 (1001-1088, except 1060-1062, 1072, 99999)
2	Hypertension	Hypertension	6150 (4), 6153 (2), 6177 (2), 20002 (1065)
		Essential hypertension	20002 (1072)
3	Diabetes	Diabetes	2443 (1), 6153 (3), 6177 (3), 20002 (1220)
		Type 1 diabetes	20002 (1222)
		Type 2 diabetes	20002 (1223)
		Diabetic nephropathy	20002 (1607)
		Diabetic neuropathy/ulcers	20002 (1468)
		Diabetic eye disease	6148 (1), 20002 (1276)
4	Coronary heart disease	Heart attack/MI	6150 (1), 20002 (1075)
		Angina	6150 (2), 20002 (1074)
5	Stroke/TIA	Stroke	6150 (3), 20002 (1081)
		TIA	20002 (1082)
		Subarachnoid haemorrhage	20002 (1086)
		Brain haemorrhage	20002 (1491)
		Ischaemic stroke	20002 (1583)
6	Atrial fibrillation	Atrial fibrillation	20002 (1471)
7	Heart failure	Heart failure/pulmonary oedema	20002 (1076)
		Cardiomyopathy	20002 (1079)
		Hypertrophic cardiomyopathy	20002 (1588)
8	Peripheral vascular disease	Peripheral vascular disease	20002 (1067)
		Leg claudication/intermittent claudication	20002 (1087)
9	COPD	COPD/Chronic obstructive pulmonary disease	20002 (1112)
		Emphysema/Chronic bronchitis	6152 (6), 20002 (1113)
		Emphysema	20002 (1472)
10	Asthma	Asthma	6152 (8), 20002 (1111)
11	Bronchiectasis	Bronchiectasis	20002 (1114)
12	Dyspepsia	Gastro-oesophageal reflux (GORD)	20002 (1138)
		Oesophagitis/Barrett's oesophagus	20002 (1139)
		Gastric stomach ulcers	20002 (1142)
		Gastric erosions/gastritis	20002 (1143)
		Duodenal ulcer	20002 (1457)
		Dyspepsia/indigestion	20002 (1510)
		Hiatus hernia	20002 (1474)
		Helicobacter pylori	20002 (1442)
13	Diverticular disease	Diverticular disease/diverticulitis	20002 (1458)

14	Irritable bowel syndrome	Irritable bowel syndrome	20002 (1154)
15	Chronic liver disease	Oesophageal varices	20002 (1141)
		Non infective hepatitis	20002 (1157)
		Liver failure/cirrhosis	20002 (1158)
		Primary biliary cirrhosis	20002 (1506)
16	Inflammatory bowel disease	Inflammatory bowel disease	20002 (1461)
		Crohn's disease	20002 (1462)
		Ulcerative colitis	20002 (1463)
17	Constipation	Constipation	20002 (1599)
18	Viral hepatitis	Hepatitis B	20002 (1579)
		Hepatitis C	20002 (1580)
		Hepatitis D	20002 (1581)
19	Depression	Depression	20002 (1286)
		Postnatal depression	20002 (1531)
20	Anxiety	Anxiety/panic attacks	20002 (1287)
		Nervous breakdown	20002 (1288)
		Post-traumatic stress disorder	20002 (1469)
		Obsessive compulsive disorder	20002 (1615)
		Stress	20002 (1614)
		Insomnia	1200 (3), 20002 (1616)
		Psychological/psychiatric problem	20002 (1243)
21	Schizophrenia/Bipolar affective disorder	Schizophrenia	20002 (1289)
		Mania	20002 (1291)
		Bipolar disorder	20002 (1291)
		Manic depression	20002 (1291)
22	Connective tissue diseases	Myositis/myopathy	20002 (1322)
		Systemic lupus erythematosus/SLE	20002 (1381)
		Connective tissue disorder	20002 (1373)
		Sjogren's syndrome.sicca syndrome	20002 (1382)
		Dermatopolymyositis	20002 (1383)
		Scleroderma/systemic sclerosis	20002 (1384)
		Rheumatoid arthritis	20002 (1464)
		Psoriatic arthropathy	20002 (1477)
		Dermatomyositis	20002 (1480)
		Polymyositis	20002 (1481)
		Polymyalgia rheumatica	20002 (1377)
23	Painful conditions	Back pain	20002 (1534)
		Joint pain	20002 (1537)
		Headaches (not migraine)	20002 (1436)
		Sciatica	20002 (1476)
		Plantar fasciitis	20002 (1540)
		Carpal tunnel syndrome	20002 (1541)

		Fibromyalgia	20002 (1542)
		Arthritis	20002 (1538)
		Shingles	20002 (1573)
		Disc problem	20002 (1532)
		Prolapsed disc/slipped disc	20002 (1312)
		Spine arthritis/spondylitis	20002 (1311)
		Ankylosing spondylitis	20002 (1313)
		Back problem	20002 (1294)
		Osteoarthritis	20002 (1465)
		Gout	20002 (1466)
		Cervical spondylosis	20002 (1478)
		Trigeminal neuralgia	20002 (1523)
		Disc degeneration	20002 (1533)
		Trapped nerve/compressed nerve	20002 (1257)
24	Osteoporosis	Osteoporosis	20002 (1309)
25	Thyroid disorders	Thyroid problem (not cancer)	20002 (1224)
		Hyperthyroidism/thyrotoxicosis	20002 (1225)
		Hypothyroidism/myxoedema	20002 (1226)
		Grave's disease	20002 (1522)
		Thyroid goitre	20002 (1610)
		Thyroiditis	20002 (1428)
26	Alcohol problems	Alcohol dependency	20002 (1408)
		Alcoholic liver disease/alcoholic cirrhosis	20002 (1604)
27	Chronic kidney disease	Polycystic kidney	20002 (1427)
		Diabetic nephropathy	20002 (1607)
		Renal/kidney failure	20002 (1192)
		Renal failure requiring dialysis	20002 (1193)
		Renal failure not requiring dialysis	20002 (1194)
		Kidney nephropathy	20002 (1519)
		Immunoglobulin A (IgA) nephropathy	20002 (1520)
28	Prostate disorders	Prostate problem (not cancer)	20002 (1207)
		Enlarged prostate	20002 (1396)
		Benign prostatic hypertrophy	20002 (1516)
29	Glaucoma	Glaucoma	6148 (2), 20002 (1277)
30	Epilepsy	Epilepsy	20002 (1264)
31	Dementia	Dementia/Alzheimer/cognitive impairment	20002 (1263)
32	Psoriasis or eczema	Eczema/dermatitis	20002 (1452)
		Psoriasis	20002 (1453)
33	Migraine	Migraine	20002 (1265)
34	Chronic sinusitis	Chronic sinusitis	20002 (1416)

35	Anorexia or bulimia	Anorexia, bulimia/other eating disorder	20002 (1470)
36	Parkinson's disease	Parkinson's disease	20002 (1262)
37	Multiple sclerosis	Multiple sclerosis	20002 (1261)
38	Chronic fatigue syndrome	Chronic fatigue syndrome	20002 (1482)
39	Endometriosis	Endometriosis	20002 (1402)
40	Meniere disease	Meniere disease	20002 (1421)
41	Pernicious anaemia	Pernicious anaemia	20002 (1331)
42	Polycystic ovaries	Polycystic ovaries	20002 (1350)

Supplemental Table 8. Definition of refined grains.

Diet component	UKB variable	label	Coding (standard servings per day)
Refined grains	100940	Bread consumed	0/1, N/Y
	100950	Sliced bread intake	555/1/2/3/4/5/600, ½ /1/2/3/4/5/6+
	20091	Type of sliced bread eaten	1/2/3/4/5, white/mixed/wholemeal/seeded/other
	101230	Naan bread intake	555/1/2/3/4/5/600, ½ /1/2/3/4/5/6+
	101240	Garlic bread intake	555/1/2/3/4/5/600, ½ /1/2/3/4/5/6+
	102700	Starchy food consumers	0/1, N/Y
	102710	White pasta intake	555/1/200, ½ /1/2+
	102730	White rice intake	555/1/200, ½ /1/2+
	102760	Snackpot intake	555/1/200, ½ /1/2+
	102010	Pancake intake	555/1/2/3/400, ½ /1/2/3/4+
	102020	Scotch pancake intake	555/1/2/3/400, ½ /1/2/3/4+
	102050	Croissant intake	555/1/2/3/400, ½ /1/2/3/4+
	102070	Scone intake	555/1/2/3/400, ½ /1/2/3/4+
	102400	Savoury snack consumers	0/1, N/Y
	102470	Savoury biscuits intake	555/1/2/300, ½ /1/2/3+
	102480	Cheesy biscuits intake	555/1/2/300, ½ /1/2/3+
	102500	Other savoury snack intake	555/1/2/300, ½ /1/2/3+

Since 20091 is not exclusive, we derived a “servings of whole-white bread” variable weighted by response. Used mean intake across diet records for each item then summed item means for daily servings.

Note: N: no; Y: yes.

Supplemental Table 9. Detailed information on missing covariates.

Covariates	N*	Missing rate (%)
Townsend deprivation index	219	0.1
Ethnicity	503	0.3
BMI	423	0.2
Basal metabolic rate	2702	1.4
Household income	18688	10.0
Education	669	0.4
Family history of cancer	2510	1.3
Family history of CVD	2510	1.3
Self-reported CVD	11	0.0
Self-reported cancer	301	0.2
NSAIDs user	1287	0.7
IPAQ	27779	14.9
Smoking status	295	0.2
Pack-years of smoking for current or former smokers	27724	14.9
Vitamin use	365	0.2
Minerals and other dietary supplements use	129	0.1
Cereal on average in past year	191	0.1
Healthy sleep pattern	29633	15.9

Note: *N represents the number of missing responses.

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CVD, cardiovascular disease; IPAQ, International Physical Activity Questionnaire.

Supplemental Table 10. Mean (SD) consumption of sugar and artificially sweetener added to cereal across multiple 24-hour dietary recalls.

The number of times participants completed 24-hour dietary recalls	Number of participants (%)		Mean consumption (SD)	
	Sugar-sweetened consumers	Artificially sweetened consumers	Sugar added to cereal (teaspoons/bowl)	Artificially sweetener added to cereal (teaspoons/bowl)
1 time	11528 (46.9%)	2196 (49.7%)	1.1 ± 0.6	1.2 ± 0.7
2 times	5602 (22.8%)	992 (22.5%)	1.1 ± 0.6	1.2 ± 0.7
3 times	4310 (17.5%)	725 (16.4%)	1.1 ± 0.6	1.3 ± 0.7
4 times	2695 (11.0%)	449 (10.2%)	1.1 ± 0.6	1.4 ± 0.7
5 times	440 (1.8%)	55 (1.2%)	1.2 ± 0.6	1.4 ± 0.7
Total	24575 (100.0%)	4417 (100.0%)	1.1 ± 0.6	1.2 ± 0.7

Supplemental Table 11. Associations of cereal consumption with all-cause and cause-specific mortality after excluding participants with missing covariates.

Outcome	Events/Model	Non-consumers	Cereal consumers		
			0-0.5 bowls/d	0.5-1.5 bowls/d	>1.5 bowls/d
Unsweetened cereal					
All-cause mortality (n = 85137)	Events, n (%)	1723 (6.0)	709 (4.6)	1763 (5.3)	381 (5.1)
	Multivariable model*	1 (Reference)	0.84 (0.77-0.92)	0.88 (0.82-0.95)	0.88 (0.79-0.99)
Cancer mortality (n = 78679)	Events, n (%)	725 (2.7)	332 (2.3)	789 (2.6)	185 (2.7)
	Multivariable model*	1 (Reference)	0.92 (0.80-1.05)	0.96 (0.87-1.07)	1.04 (0.88-1.23)
CVD mortality (n = 81135)	Events, n (%)	254 (0.9)	85 (0.6)	240 (0.8)	45 (0.6)
	Multivariable model*	1 (Reference)	0.70 (0.54-0.90)	0.85 (0.70-1.02)	0.72 (0.52-1.00)
Sugar-sweetened cereal					
All-cause mortality (n = 41847)	Events, n (%)	1723 (6.0)	75 (7.0)	687 (6.6)	120 (7.8)
	Multivariable model*	1 (Reference)	0.91 (0.72-1.15)	0.92 (0.84-1.00)	0.98 (0.81-1.18)
Cancer mortality (n = 38625)	Events, n (%)	725 (2.7)	37 (3.7)	302 (3.2)	52 (3.6)
	Multivariable model*	1 (Reference)	1.16 (0.83-1.62)	1.02 (0.89-1.17)	1.09 (0.82-1.46)
CVD mortality (n = 39633)	Events, n (%)	254 (0.9)	10 (1.0)	86 (0.9)	20 (1.4)
	Multivariable model*	1 (Reference)	0.78 (0.41-1.47)	0.78 (0.60-1.00)	1.02 (0.64-1.63)
Artificially sweetened cereal					
All-cause mortality (n = 31073)	Events, n (%)	1723 (6.0)	15 (7.4)	139 (7.8)	28 (8.4)
	Multivariable model*	1 (Reference)	0.87 (0.52-1.45)	0.97 (0.81-1.15)	1.09 (0.75-1.59)
Cancer mortality (n = 28738)	Events, n (%)	725 (2.7)	4 (2.2)	58 (3.6)	16 (5.2)
	Multivariable model*	1 (Reference)	0.68 (0.25-1.82)	1.09 (0.83-1.43)	1.54 (0.93-2.55)
CVD mortality (n = 29487)	Events, n (%)	354 (0.9)	2 (1.1)	17 (1.0)	2 (0.7)
	Multivariable model*	1 (Reference)	0.83 (0.21-3.36)	0.89 (0.54-1.46)	0.52 (0.13-2.10)

Note: CVD: cardiovascular disease.

*Estimates are hazard ratios (95% confidence intervals), obtained from fully adjusted Cox regression models.

Supplemental Table 12. Associations of cereal consumption with all-cause and cause-specific mortality after excluding participants who had an outcome event during the first two years of follow-up.

Outcome	Events/Model	Non-consumers	Cereal consumers		
			0-0.5 bowls/d	0.5-1.5 bowls/d	>1.5 bowls/d
Unsweetened cereal					
All-cause mortality (n = 157178)	Events, n (%)	3336 (6.2)	1447 (5.1)	3475 (5.6)	731 (5.5)
	Multivariable model*	1 (Reference)	0.90 (0.84-0.95)	0.91 (0.86-0.95)	0.91 (0.84-0.99)
Cancer mortality (n = 144654)	Events, n (%)	1412 (2.9)	633 (2.4)	1501 (2.6)	330 (2.7)
	Multivariable model*	1 (Reference)	0.90 (0.81-0.99)	0.93 (0.86-1.01)	0.99 (0.87-1.12)
CVD mortality (n = 149061)	Events, n (%)	474 (0.9)	188 (0.7)	458 (0.8)	97 (0.8)
	Multivariable model*	1 (Reference)	0.84 (0.71-1.00)	0.87 (0.76-0.99)	0.85 (0.68-1.07)
Sugar-sweetened cereal					
All-cause mortality (n = 78083)	Events, n (%)	3336 (6.2)	154 (7.1)	1321 (6.8)	230 (8.1)
	Multivariable model*	1 (Reference)	0.95 (0.81-1.12)	0.94 (0.88-1.00)	0.99 (0.86-1.13)
Cancer mortality (n = 71813)	Events, n (%)	1412 (2.9)	66 (3.3)	577 (3.2)	97 (3.7)
	Multivariable model*	1 (Reference)	0.99 (0.77-1.27)	1.00 (0.91-1.11)	1.05 (0.85-1.29)
CVD mortality (n = 73633)	Events, n (%)	474 (0.9)	18 (0.9)	178 (1.0)	40 (1.5)
	Multivariable model*	1 (Reference)	0.77 (0.48-1.24)	0.91 (0.76-1.09)	1.15 (0.83-1.60)
Artificially sweetened cereal					
All-cause mortality (n = 57971)	Events, n (%)	3336 (6.2)	39 (9.2)	264 (7.8)	47 (7.5)
	Multivariable model*	1 (Reference)	1.08 (0.79-1.49)	0.96 (0.85-1.09)	0.93 (0.69-1.24)
Cancer mortality (n = 53387)	Events, n (%)	1412 (2.9)	14 (3.7)	99 (3.2)	25 (4.3)
	Multivariable model*	1 (Reference)	1.05 (0.62-1.79)	0.93 (0.76-1.14)	1.20 (0.80-1.78)
CVD mortality (n = 54704)	Events, n (%)	474 (0.9)	5 (1.3)	39 (1.3)	3 (0.5)
	Multivariable model*	1 (Reference)	1.02 (0.42-2.47)	1.11 (0.80-1.55)	0.43 (0.14-1.33)

Note: CVD: cardiovascular disease.

*Estimates are hazard ratios (95% confidence intervals), obtained from fully adjusted Cox regression models.

Supplemental Table 13. Associations of cereal consumption with all-cause and cause-specific mortality after excluding participants who were not on a typical diet yesterday.

Outcome	Events/Model	Non-consumers	Cereal consumers		
			0-0.5 bowls/d	0.5-1.5 bowls/d	>1.5 bowls/d
Unsweetened cereal					
All-cause mortality (n = 107141)	Events, n (%)	2570 (7.0)	1124 (5.8)	2656 (6.1)	471 (5.8)
	Multivariable model*	1 (Reference)	0.92 (0.86-0.99)	0.90 (0.85-0.95)	0.87 (0.78-0.96)
Cancer mortality (n = 98480)	Events, n (%)	1061 (3.2)	466 (2.6)	1114 (2.8)	208 (2.8)
	Multivariable model*	1 (Reference)	0.90 (0.80-1.01)	0.92 (0.84-1.01)	0.94 (0.81-1.09)
CVD mortality (n = 101144)	Events, n (%)	369 (1.1)	149 (0.8)	354 (0.9)	64 (0.8)
	Multivariable model*	1 (Reference)	0.87 (0.71-1.06)	0.86 (0.74-1.00)	0.82 (0.63-1.08)
Sugar-sweetened cereal					
All-cause mortality (n = 54523)	Events, n (%)	2570 (7.0)	124 (7.8)	1071 (7.4)	163 (8.4)
	Multivariable model*	1 (Reference)	0.95 (0.79-1.14)	0.93 (0.86-1.00)	0.92 (0.78-1.08)
Cancer mortality (n = 50058)	Events, n (%)	1061 (3.2)	54 (3.8)	443 (3.3)	61 (3.5)
	Multivariable model*	1 (Reference)	1.04 (0.79-1.37)	0.95 (0.85-1.07)	0.90 (0.69-1.18)
CVD mortality (n = 51156)	Events, n (%)	369 (1.1)	15 (1.0)	149 (1.1)	30 (1.7)
	Multivariable model*	1 (Reference)	0.80 (0.47-1.34)	0.93 (0.76-1.13)	1.15 (0.79-1.69)
Artificially sweetened cereal					
All-cause mortality (n = 39781)	Events, n (%)	2570 (7.0)	32 (9.9)	209 (8.3)	38 (8.6)
	Multivariable model*	1 (Reference)	1.04 (0.74-1.48)	0.90 (0.78-1.04)	0.97 (0.71-1.34)
Cancer mortality (n = 36587)	Events, n (%)	1061 (3.2)	14 (4.8)	78 (3.4)	20 (4.8)
	Multivariable model*	1 (Reference)	1.29 (0.76-2.20)	0.90 (0.71-1.13)	1.25 (0.80-1.95)
CVD mortality (n = 37318)	Events, n (%)	369 (1.1)	2 (0.7)	28 (1.2)	1 (0.2)
	Multivariable model*	1 (Reference)	0.45 (0.11-1.80)	0.92 (0.62-1.36)	0.18 (0.02-1.26)

Note: CVD: cardiovascular disease.

*Estimates are hazard ratios (95% confidence intervals), obtained from fully adjusted Cox regression models.

Supplemental Table 14. Associations of cereal consumption with all-cause and cause-specific mortality after removing sugar added to cereal from total sugar and total energy.

Outcome	Events/Model	Non-consumers	Cereal consumers		
			0-0.5 bowls/d	0.5-1.5 bowls/d	>1.5 bowls/d
Unsweetened cereal					
All-cause mortality (n = 157427)	Events, n (%)	3457 (6.4)	1490 (5.3)	3556 (5.7)	735 (5.5)
	Multivariable model*	1 (Reference)	0.89 (0.84-0.95)	0.90 (0.86-0.94)	0.89 (0.82-0.97)
Cancer mortality (n = 144815)	Events, n (%)	1441 (2.9)	644 (2.5)	1528 (2.7)	332 (2.7)
	Multivariable model*	1 (Reference)	0.90 (0.81-0.99)	0.93 (0.86-1.00)	0.98 (0.86-1.11)
CVD mortality (n = 149266)	Events, n (%)	492 (1.0)	191 (0.8)	468 (0.8)	97 (0.8)
	Multivariable model*	1 (Reference)	0.82 (0.69-0.98)	0.86 (0.75-0.98)	0.83 (0.66-1.04)
Sugar-sweetened cereal					
All-cause mortality (n = 78256)	Events, n (%)	3457 (6.4)	159 (7.3)	1362 (7.0)	236 (8.2)
	Multivariable model*	1 (Reference)	0.96 (0.81-1.12)	0.94 (0.88-1.01)	0.99 (0.87-1.13)
Cancer mortality (n = 71917)	Events, n (%)	1441 (2.9)	68 (3.4)	594 (3.3)	100 (3.8)
	Multivariable model*	1 (Reference)	1.00 (0.78-1.28)	1.02 (0.92-1.12)	1.06 (0.87-1.31)
CVD mortality (n = 73775)	Events, n (%)	492 (1.0)	18 (0.9)	182 (1.0)	40 (1.5)
	Multivariable model*	1 (Reference)	0.74 (0.46-1.19)	0.90 (0.75-1.07)	1.11 (0.80-1.54)
Artificially sweetened cereal					
All-cause mortality (n = 58098)	Events, n (%)	3457 (6.4)	39 (9.2)	268 (8.0)	49 (7.8)
	Multivariable model*	1 (Reference)	1.04 (0.76-1.43)	0.94 (0.83-1.07)	0.94 (0.71-1.25)
Cancer mortality (n = 53466)	Events, n (%)	1441 (2.9)	14 (3.7)	99 (3.2)	26 (4.4)
	Multivariable model*	1 (Reference)	1.03 (0.61-1.75)	0.91 (0.74-1.12)	1.22 (0.83-1.81)
CVD mortality (n = 54806)	Events, n (%)	492 (1.0)	5 (1.3)	39 (1.3)	3 (0.5)
	Multivariable model*	1 (Reference)	0.98 (0.40-2.37)	1.07 (0.76-1.48)	0.41 (0.13-1.28)

Note: CVD: cardiovascular disease.

*Estimates are hazard ratios (95% confidence intervals), obtained from fully adjusted Cox regression models.

Supplemental Table 15. Associations of cereal consumption with all-cause and cause-specific mortality after excluding participants who ate cereal last year but not the day before.

Outcome	Events/Model	Non-consumers	Cereal consumers		
			0-0.5 bowls/d	0.5-1.5 bowls/d	>1.5 bowls/d
Unsweetened cereal					
All-cause mortality (n = 152854)	Events, n (%) Multivariable model*	3457 (6.4) 1 (Reference)	1415 (5.3) 0.90 (0.84-0.96)	3418 (5.7) 0.90 (0.86-0.95)	714 (5.5) 0.89 (0.82-0.97)
Cancer mortality (n = 140596)	Events, n (%) Multivariable model*	1441 (2.9) 1 (Reference)	609 (2.5) 0.89 (0.81-0.98)	1464 (2.7) 0.93 (0.86-1.00)	321 (2.7) 0.97 (0.85-1.10)
CVD mortality (n = 144914)	Events, n (%) Multivariable model*	492 (1.0) 1 (Reference)	182 (0.7) 0.83 (0.70-0.99)	450 (0.8) 0.86 (0.75-0.98)	95 (0.8) 0.83 (0.67-1.05)
Sugar-sweetened cereal					
All-cause mortality (n = 76779)	Events, n (%) Multivariable model*	3457 (6.4) 1 (Reference)	140 (7.0) 0.91 (0.77-1.08)	1273 (7.0) 0.93 (0.87-0.99)	225 (8.2) 0.97 (0.85-1.12)
Cancer mortality (n = 70558)	Events, n (%) Multivariable model*	1441 (2.9) 1 (Reference)	59 (3.2) 0.94 (0.72-1.22)	543 (3.2) 0.98 (0.88-1.09)	94 (3.7) 1.03 (0.83-1.28)
CVD mortality (n = 72392)	Events, n (%) Multivariable model*	492 (1.0) 1 (Reference)	15 (0.8) 0.67 (0.40-1.13)	172 (1.0) 0.90 (0.75-1.07)	36 (1.4) 1.04 (0.73-1.47)
Artificially sweetened cereal					
All-cause mortality (n = 57864)	Events, n (%) Multivariable model*	3457 (6.4) 1 (Reference)	37 (9.6) 1.09 (0.79-1.51)	257 (8.0) 0.96 (0.85-1.09)	47 (7.8) 0.94 (0.71-1.26)
Cancer mortality (n = 53252)	Events, n (%) Multivariable model*	1441 (2.9) 1 (Reference)	14 (4.0) 1.15 (0.67-1.94)	96 (3.3) 0.94 (0.76-1.16)	26 (4.6) 1.27 (0.86-1.88)
CVD mortality (n = 54593)	Events, n (%) Multivariable model*	492 (1.0) 1 (Reference)	5 (1.4) 1.09 (0.45-2.65)	37 (1.3) 1.07 (0.76-1.50)	3 (0.6) 0.42 (0.14-1.32)

Note: CVD: cardiovascular disease.

*Estimates are hazard ratios (95% confidence intervals), obtained from fully adjusted Cox regression models.

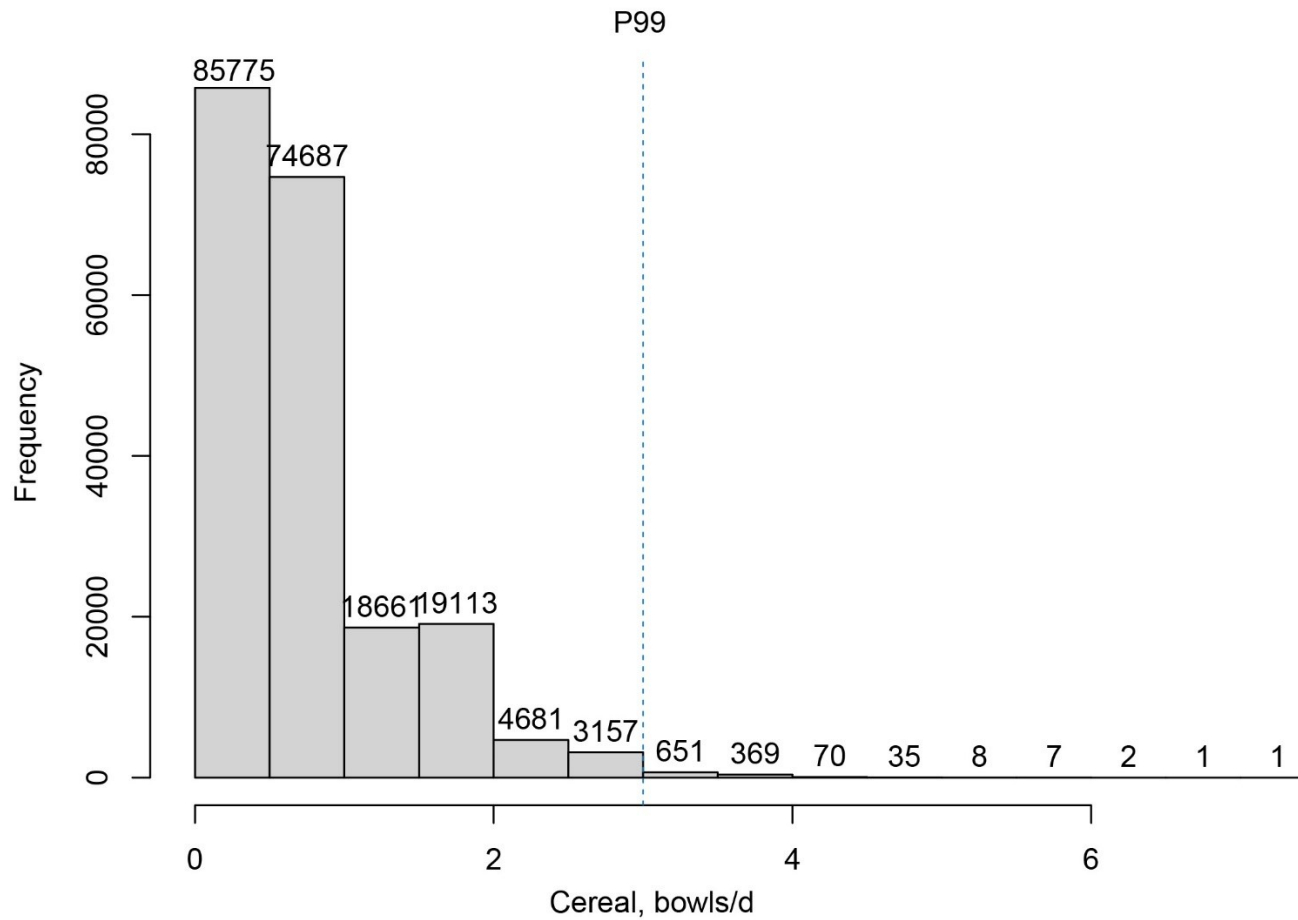
Supplemental Table 16. Associations of breakfast cereal consumption with all-cause and specific-cause mortality.

Characteristic	Non-consumers	Breakfast cereal consumers		
		0-0.5 bowls/d	0.5-1.5 bowls/d	>1.5 bowls/d
All-cause mortality (n = 2001905)				
Events, n (%)	3457 (6.4)	1707 (5.5)	5644 (6.1)	1432 (5.9)
Basic model†	1 (Reference)	0.74 (0.70-0.79)	0.80 (0.77-0.84)	0.78 (0.73-0.83)
Multivariable model*	1 (Reference)	0.89 (0.84-0.95)	0.91 (0.87-0.95)	0.90 (0.84-0.96)
Cancer mortality (n = 185513)				
Events, n (%)	1441 (2.9)	737 (2.6)	2437 (2.9)	647 (2.9)
Basic model†	1 (Reference)	0.77 (0.71-0.85)	0.84 (0.79-0.90)	0.86 (0.78-0.94)
Multivariable model*	1 (Reference)	0.91 (0.83-0.99)	0.96 (0.90-1.03)	1.00 (0.91-1.10)
CVD mortality (n = 190894)				
Events, n (%)	492 (1.0)	216 (0.7)	760 (0.9)	196 (0.9)
Basic model†	1 (Reference)	0.65 (0.56-0.77)	0.75 (0.67-0.84)	0.73 (0.62-0.86)
Multivariable model*	1 (Reference)	0.80 (0.68-0.95)	0.88 (0.78-0.99)	0.86 (0.72-1.02)

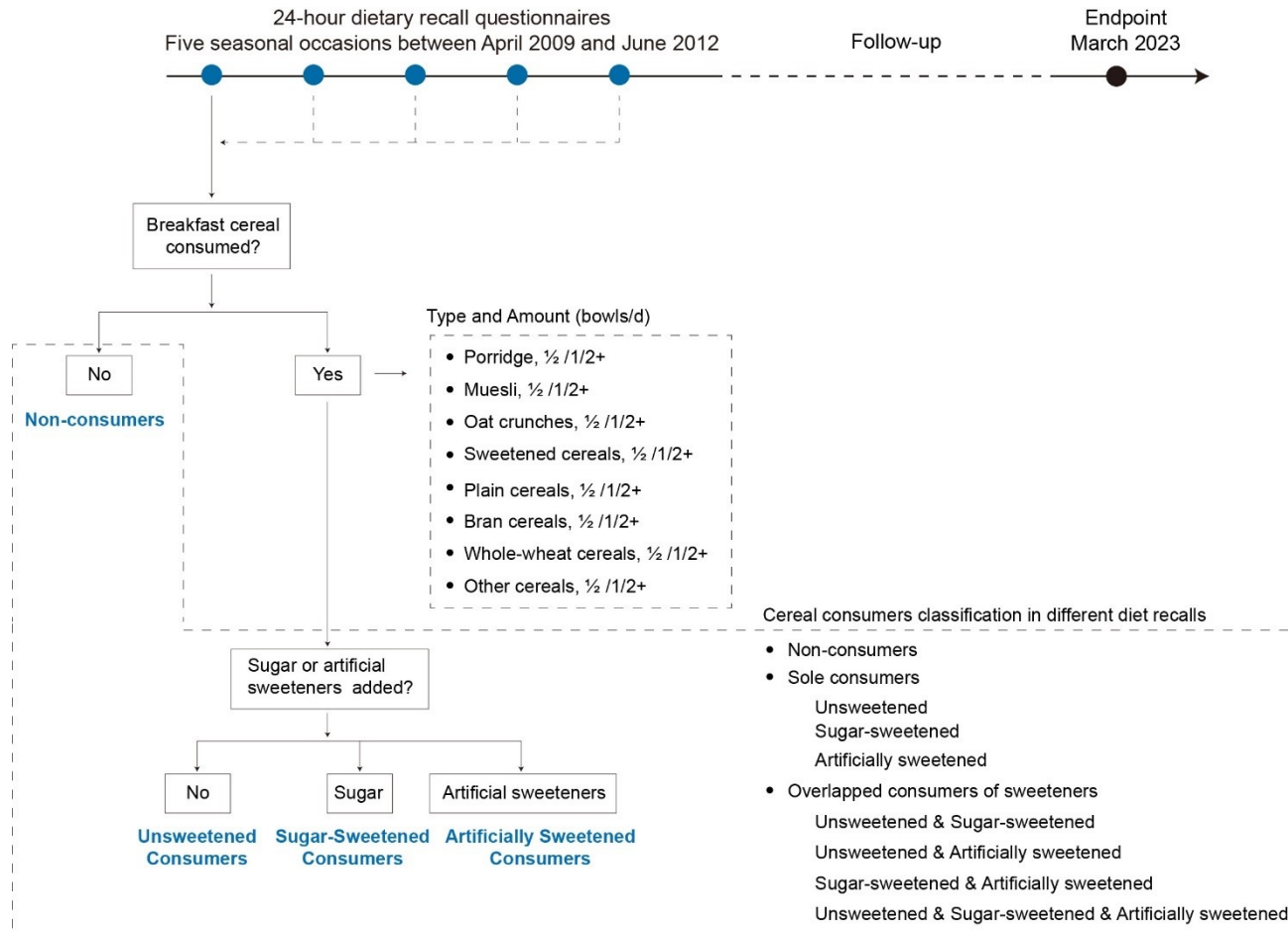
Note: CVD: cardiovascular disease.

Note: † Estimates are hazard ratios (95% CIs) from Cox regression models adjusted for age (continuous) and sex (male or female). * Estimates are hazard ratios (95% CIs) from multivariable Cox regression models additionally adjusted for BMI (≥ 30 , ≥ 25 & < 30 , or < 25 km/m²), basal metabolic rate (continuous), ethnicity (White or other), Townsend deprivation index (continuous), household income (> 100000 , 52000 - 100000 , 31000 - 51999 , 18000 - 30999 , or $< 18,000$ £), education (degree or no degree), smoking status (never, former, or current), pack-years of smoking (continuous), physical activity level (low, moderate, or high), vitamin use (yes or no), mineral and other dietary supplements use (yes or no), NSAIDs use (yes or no), healthy sleep pattern (yes or no), family history of CVD (yes or no), family history of cancer (yes or no), number of long-term conditions (none, one, two, three, four or five and more), and intake of total energy, total sugar, coffee, starchy food, refined grains, snacks, pizza, and a modified AHEI score. HR, hazard ratio; CI, confidence interval; BMI, body mass index; CVD, cardiovascular disease; NSAIDs, Nonsteroidal anti-inflammatory drugs; AHEI, Alternative Healthy Eating Index.

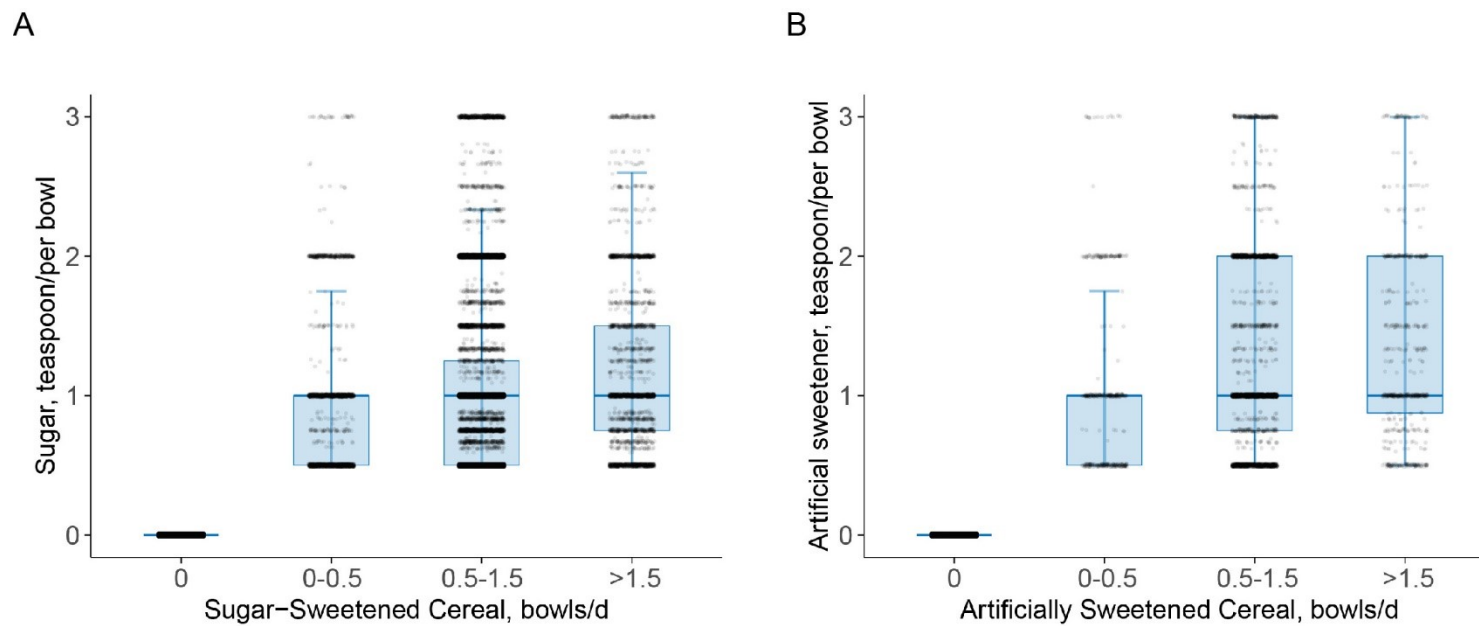
Histogram of Breakfast Cereal



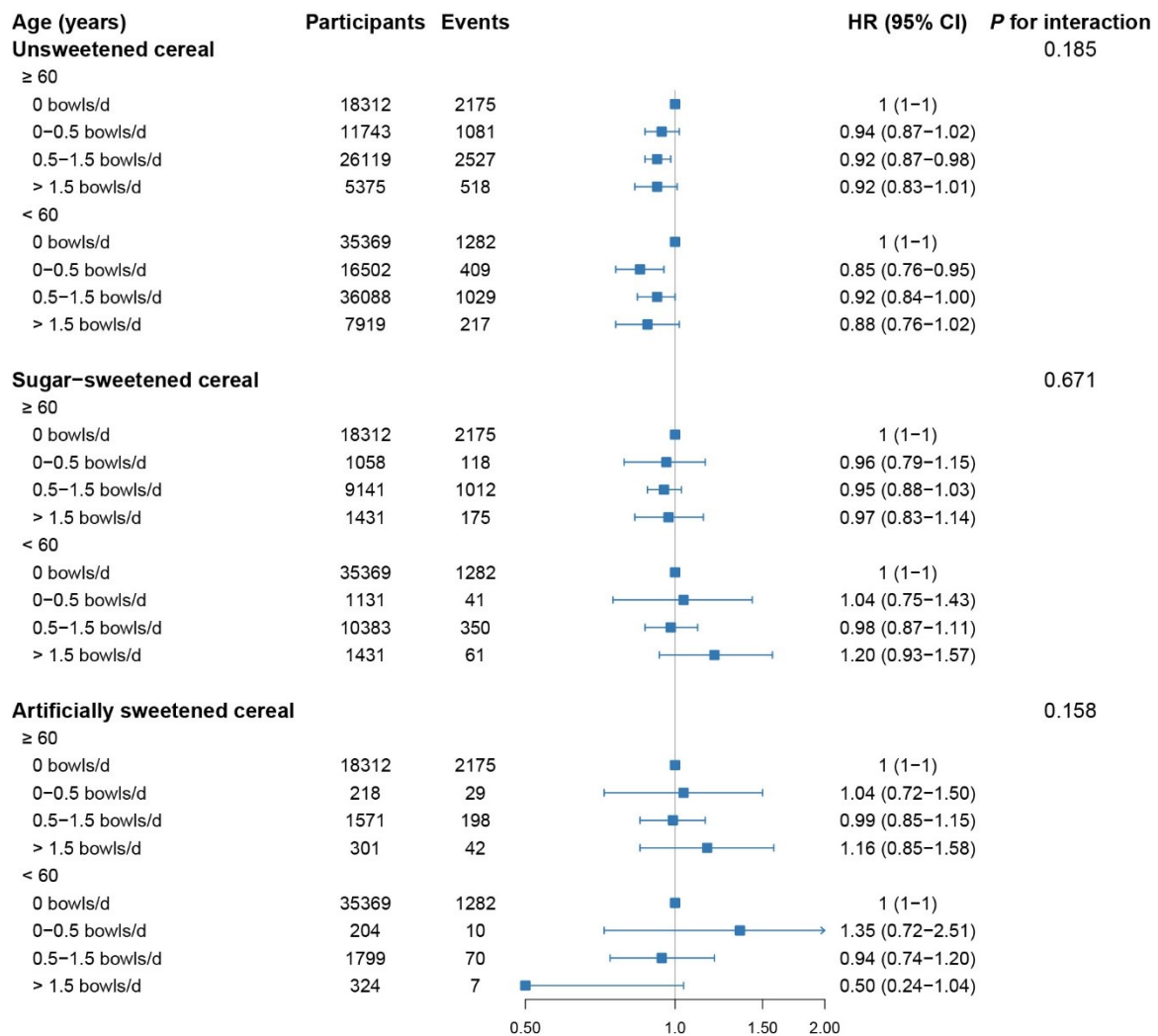
Supplemental Figure 1. Histogram of total cereal intake. The dashed blue line is the 99th percentile of cereal intake.



Supplemental Figure 2. Flowchart of four cereal consumer classifications.

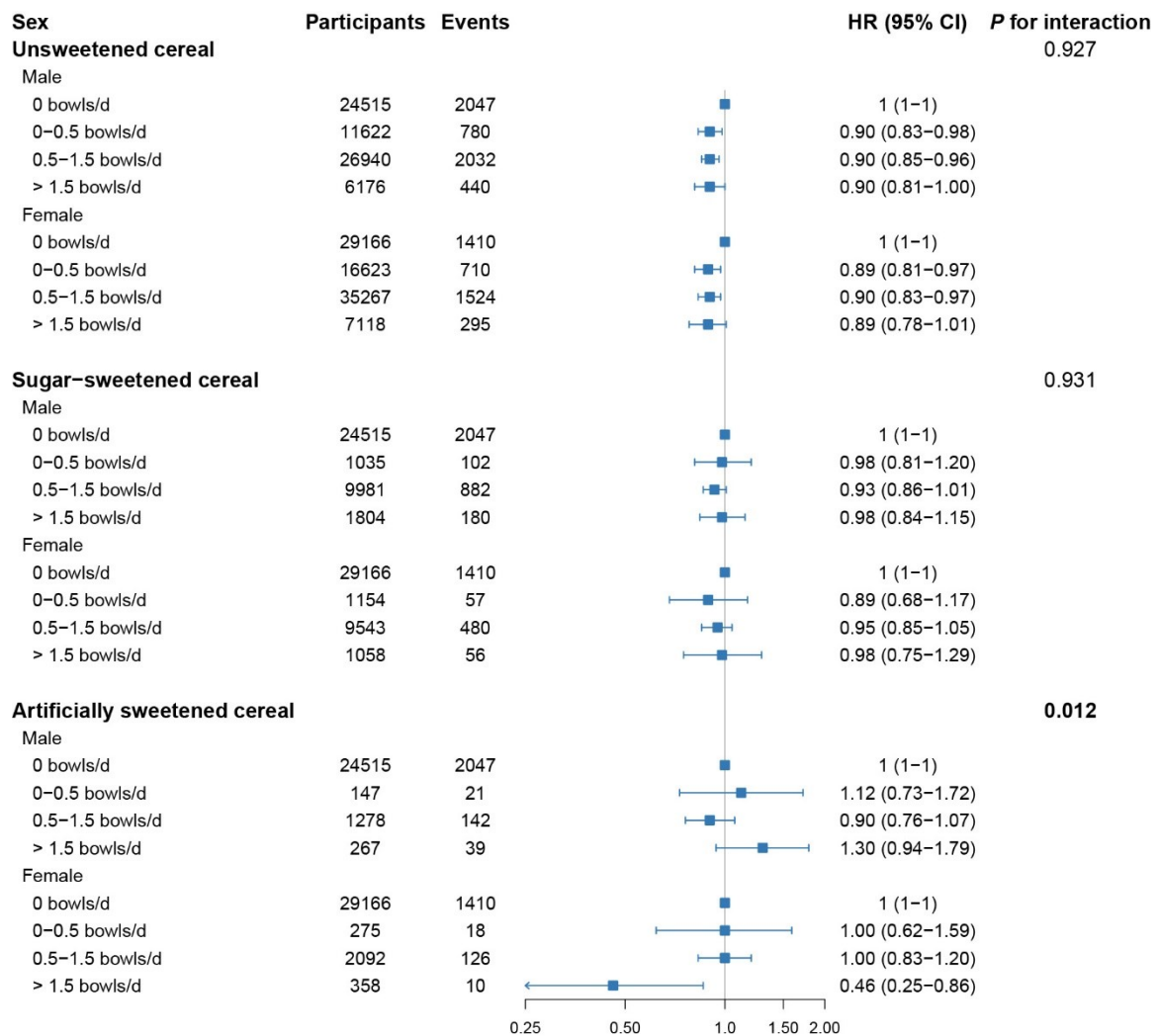


Supplemental Figure 3. The amount of added sugar or artificial sweetener per bowl of cereal for sugar-sweetened consumers (A) and artificially sweetened consumers (B).



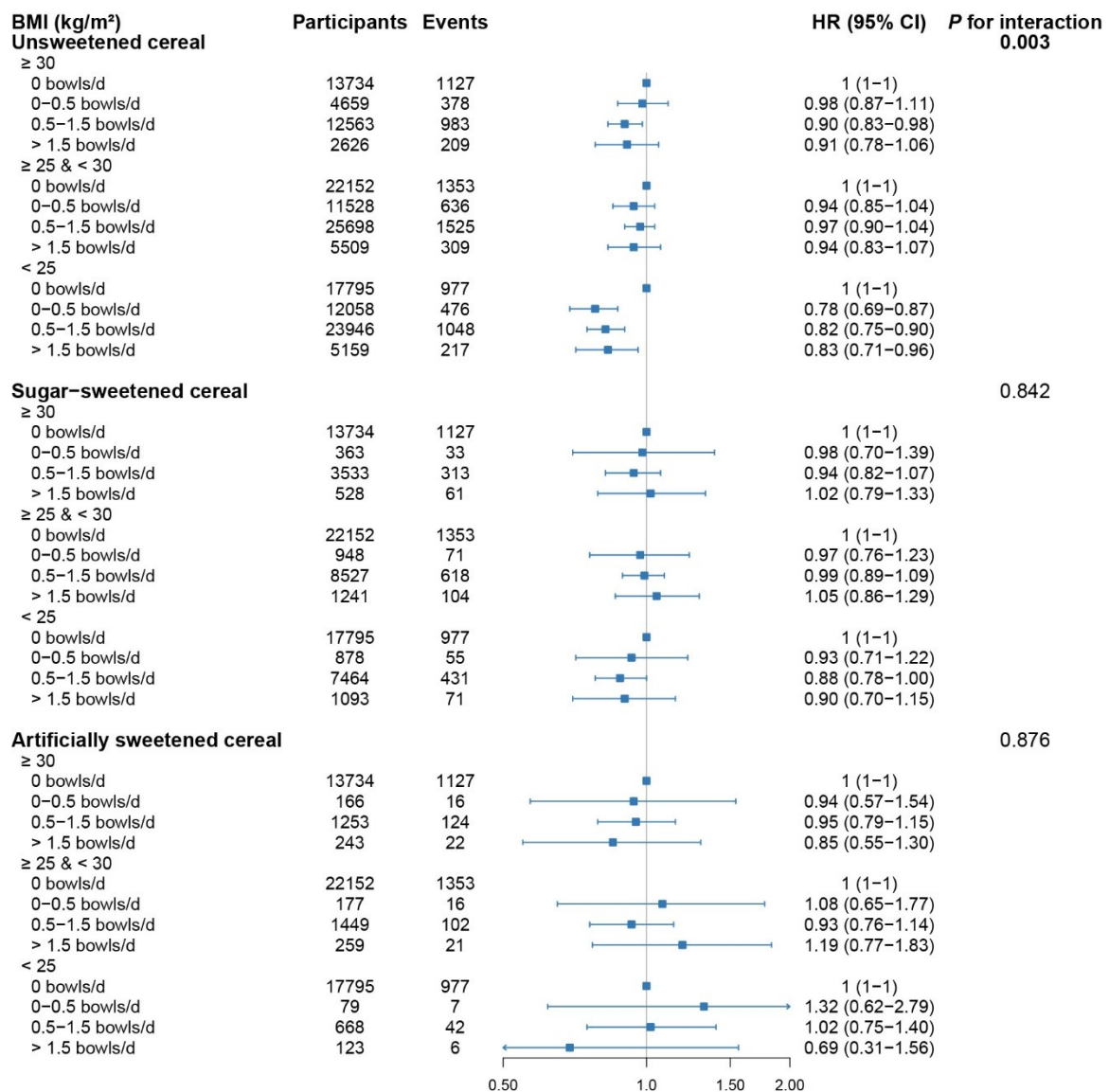
Supplemental Figure 4. Age-stratified analysis of the association between cereal consumption and all-cause mortality in the multivariable model.

Note: The multivariable model was adjusted for sex (male or female), BMI (≥ 30 , ≥ 25 & < 30 , or < 25 kg/m^2), basal metabolic rate (continuous), ethnicity (White or other), Townsend deprivation index (continuous), household income (> 100000 , 52000 - 100000 , 31000 - 51999 , 18000 - 30999 , or $< 18,000$ £), education (degree or no degree), smoking status (never, former, or current), pack-years of smoking (continuous), physical activity level (low, moderate, or high), vitamin use (yes or no), mineral and other dietary supplements use (yes or no), NSAIDs use (yes or no), healthy sleep pattern (yes or no), family history of CVD (yes or no), family history of cancer (yes or no), number of long-term conditions (none, one, two, three, four or five and more), and intake of total energy, total sugar, coffee, starchy food, refined grains, snacks, pizza, and a modified AHEI score. HR, hazard ratio; CI, confidence interval; BMI, body mass index; CVD, cardiovascular disease; NSAIDs, Nonsteroidal anti-inflammatory drugs; AHEI, Alternative Healthy Eating Index.



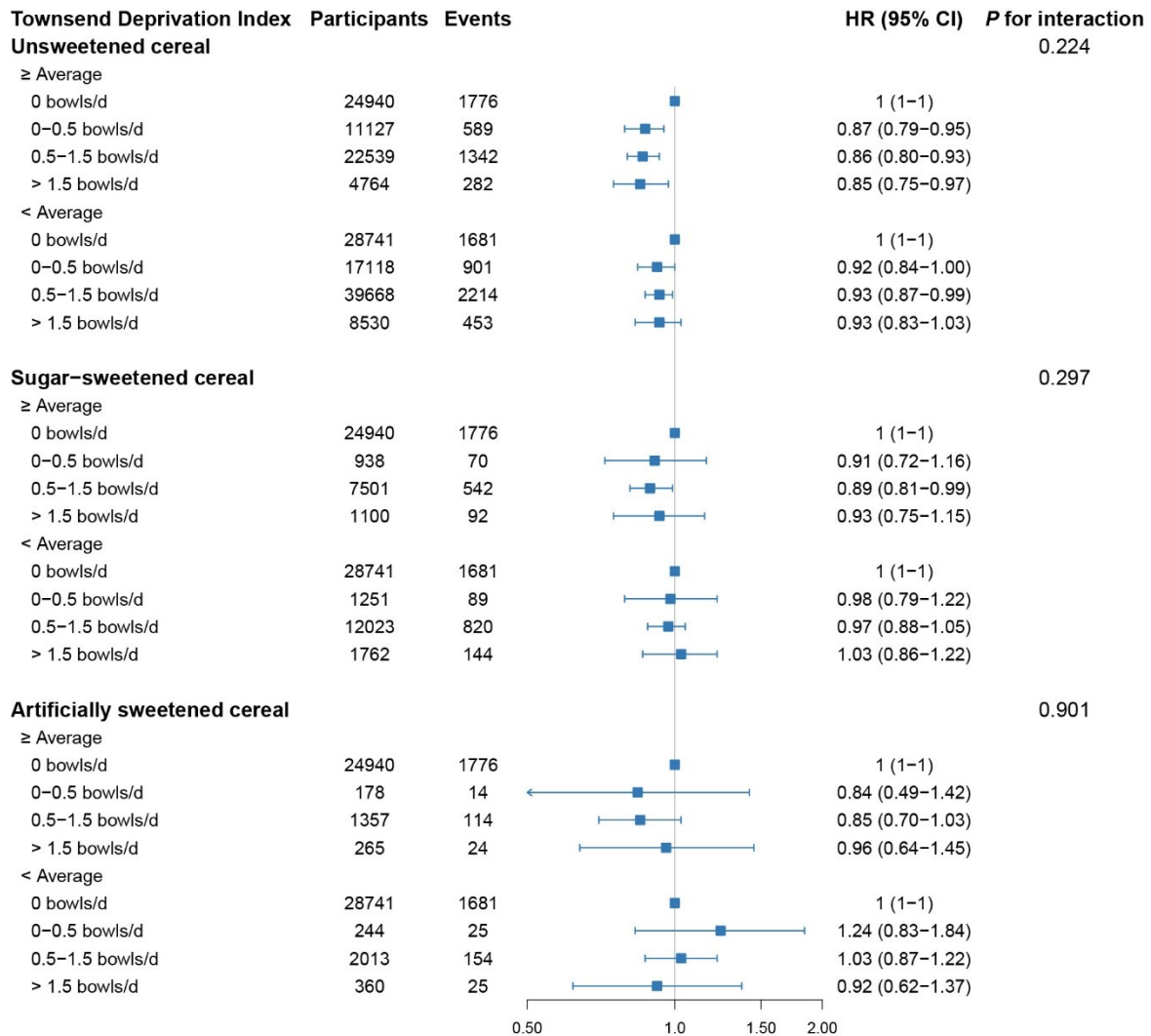
Supplemental Figure 5. Sex-stratified analysis of the association between cereal consumption and all-cause mortality in the multivariable model.

Note: The multivariable model was adjusted for age (continuous), BMI (≥ 30 , ≥ 25 & < 30 , or < 25 kg/m^2), basal metabolic rate (continuous), ethnicity (White or other), Townsend deprivation index (continuous), household income (> 100000 , 52000 - 100000 , 31000 - 51999 , 18000 - 30999 , or $< 18,000$ £), education (degree or no degree), smoking status (never, former, or current), pack-years of smoking (continuous), physical activity level (low, moderate, or high), vitamin use (yes or no), mineral and other dietary supplements use (yes or no), NSAIDs use (yes or no), healthy sleep pattern (yes or no), family history of CVD (yes or no), family history of cancer (yes or no), number of long-term conditions (none, one, two, three, four or five and more), and intake of total energy, total sugar, coffee, starchy food, refined grains, snacks, pizza, and a modified AHEI score. HR, hazard ratio; CI, confidence interval; BMI, body mass index; CVD, cardiovascular disease; NSAIDs, Nonsteroidal anti-inflammatory drugs; AHEI, Alternative Healthy Eating Index.



Supplemental Figure 6. BMI-stratified analysis of the association between cereal consumption and all-cause mortality in the multivariable model.

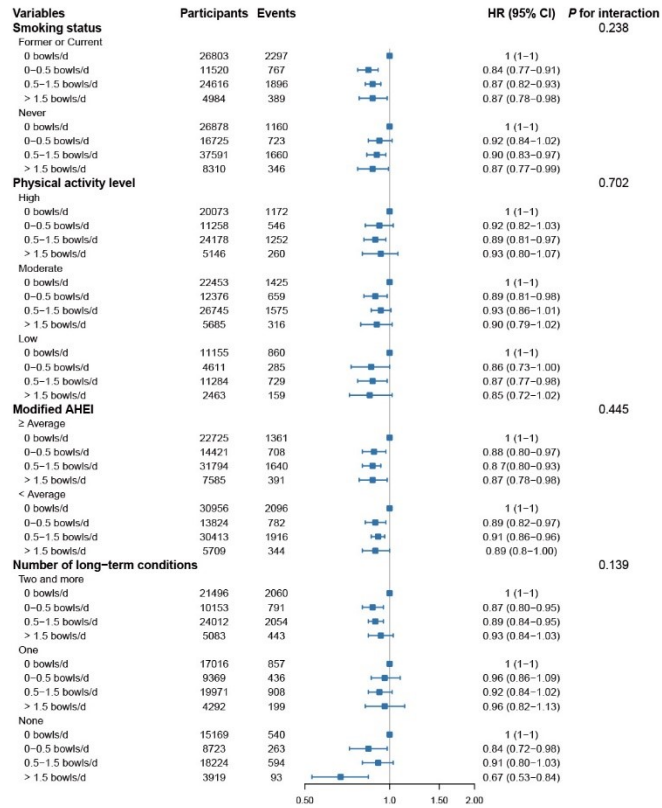
Note: The multivariable model was adjusted for age (continuous), sex (male or female), basal metabolic rate (continuous), ethnicity (White or other), Townsend deprivation index (continuous), household income (> 100000, 52000-100000, 31000-51999, 18000-30999, or < 18,000 £), education (degree or no degree), smoking status (never, former, or current), pack-years of smoking (continuous), physical activity level (low, moderate, or high), vitamin use (yes or no), mineral and other dietary supplements use (yes or no), NSAIDs use (yes or no), healthy sleep pattern (yes or no), family history of CVD (yes or no), family history of cancer (yes or no), number of long-term conditions (none, one, two, three, four or five and more), and intake of total energy, total sugar, coffee, starchy food, refined grains, snacks, pizza, and a modified AHEI score. HR, hazard ratio; CI, confidence interval; BMI, body mass index; CVD, cardiovascular disease; NSAIDs, Nonsteroidal anti-inflammatory drugs; AHEI, Alternative Healthy Eating Index.



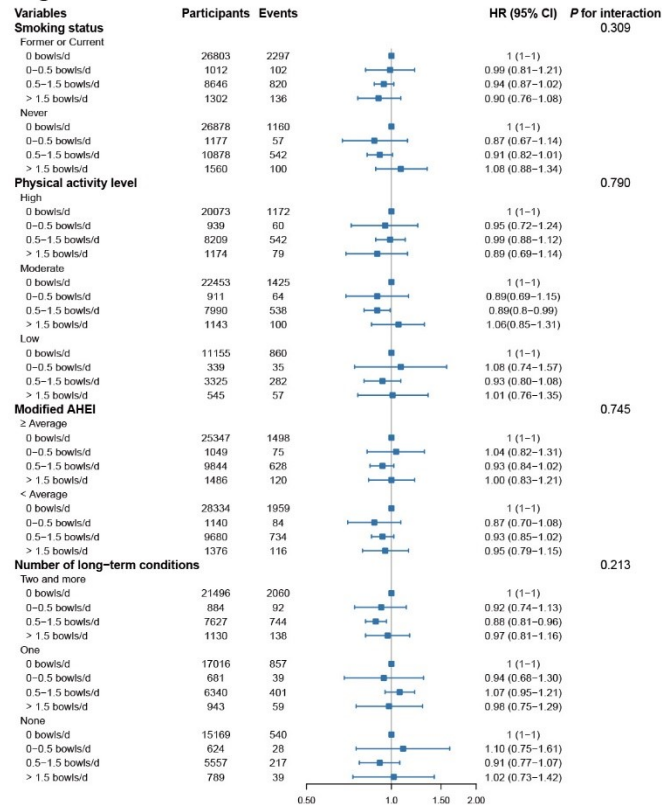
Supplemental Figure 7. TDI-stratified analysis of the association between cereal consumption and all-cause mortality in the multivariable model.

Note: The multivariable model was adjusted for age (continuous), sex (male or female), BMI (≥ 30 , ≥ 25 & < 30 , or < 25 kg/m^2), basal metabolic rate (continuous), ethnicity (White or other), household income (> 100000 , 52000 - 100000 , 31000 - 51999 , 18000 - 30999 , or $< 18,000$ £), education (degree or no degree), smoking status (never, former, or current), pack-years of smoking (continuous), physical activity level (low, moderate, or high), vitamin use (yes or no), mineral and other dietary supplements use (yes or no), NSAIDs use (yes or no), healthy sleep pattern (yes or no), family history of CVD (yes or no), family history of cancer (yes or no), number of long-term conditions (none, one, two, three, four or five and more), and intake of total energy, total sugar, coffee, starchy food, refined grains, snacks, pizza, and a modified AHEI score. HR, hazard ratio; CI, confidence interval; BMI, body mass index; CVD, cardiovascular disease; NSAIDs, Nonsteroidal anti-inflammatory drugs; AHEI, Alternative Healthy Eating Index.

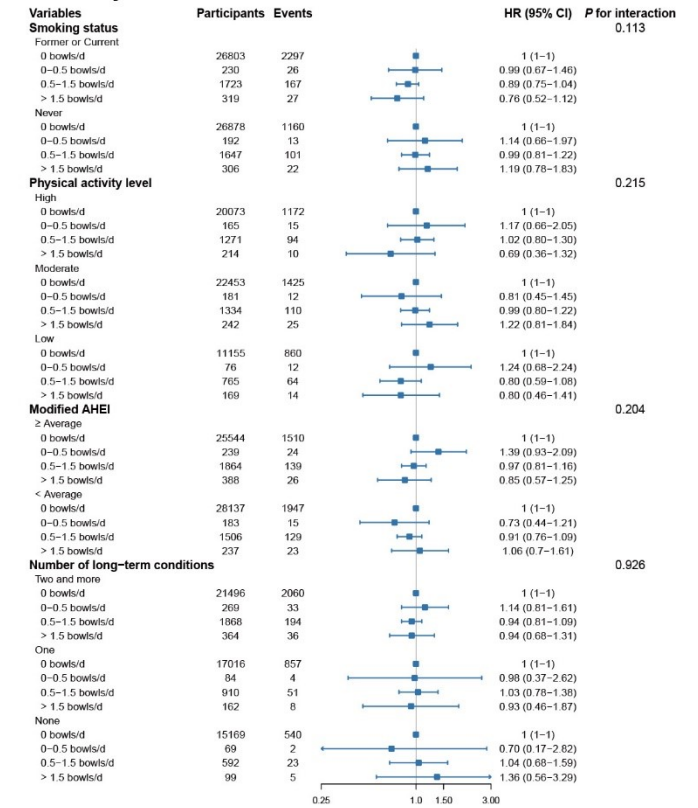
Unsweetened cereal



Sugar-sweetened cereal

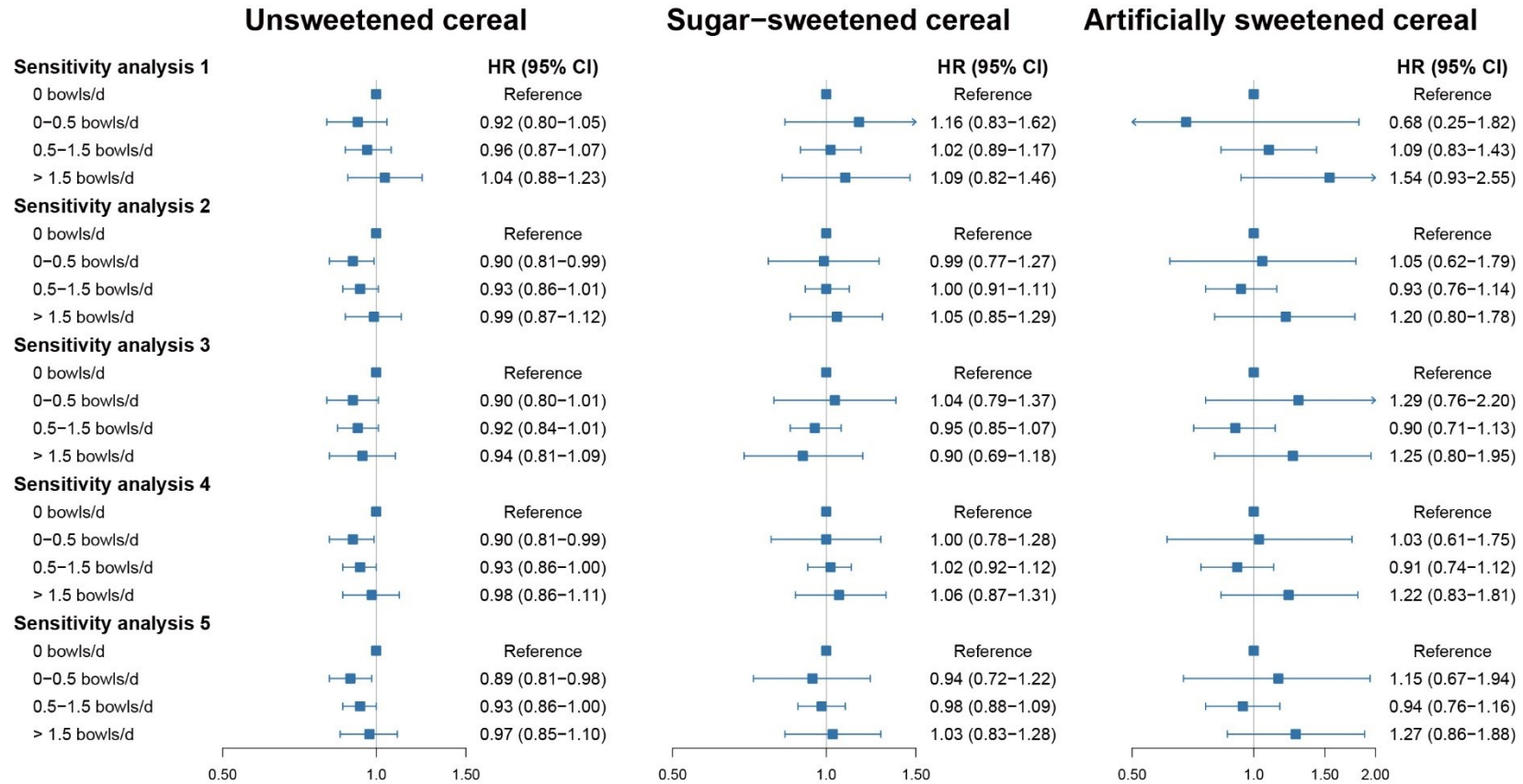


Artificially sweetened cereal



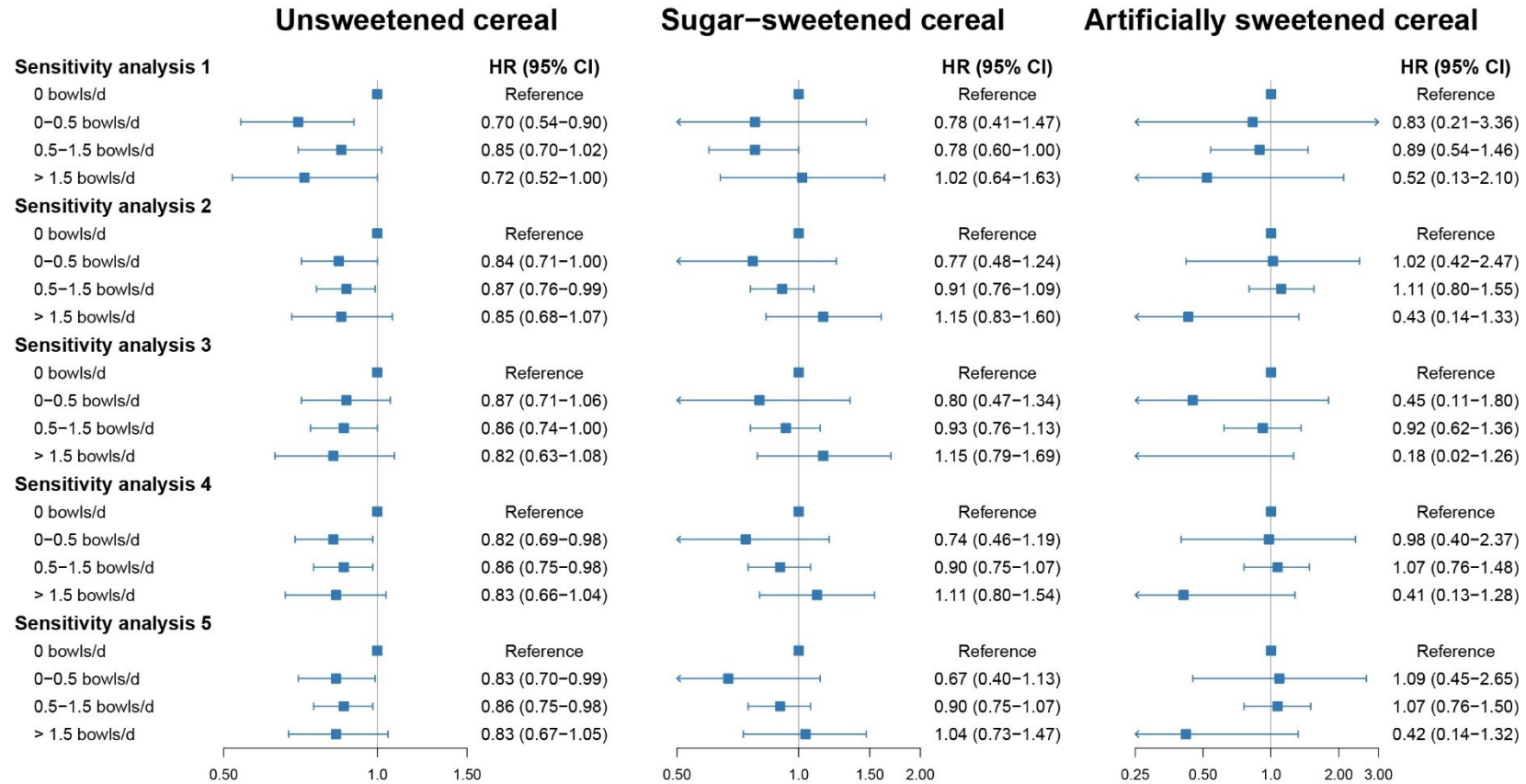
Supplemental Figure 8. Associations of cereal consumption with all-cause mortality by subgroups.

Note: The estimated effects are based on fully adjusted models except for the corresponding subgroup covariates. HR, hazard ratio; CI, confidence interval; AHEI, Alternative Healthy Eating Index.



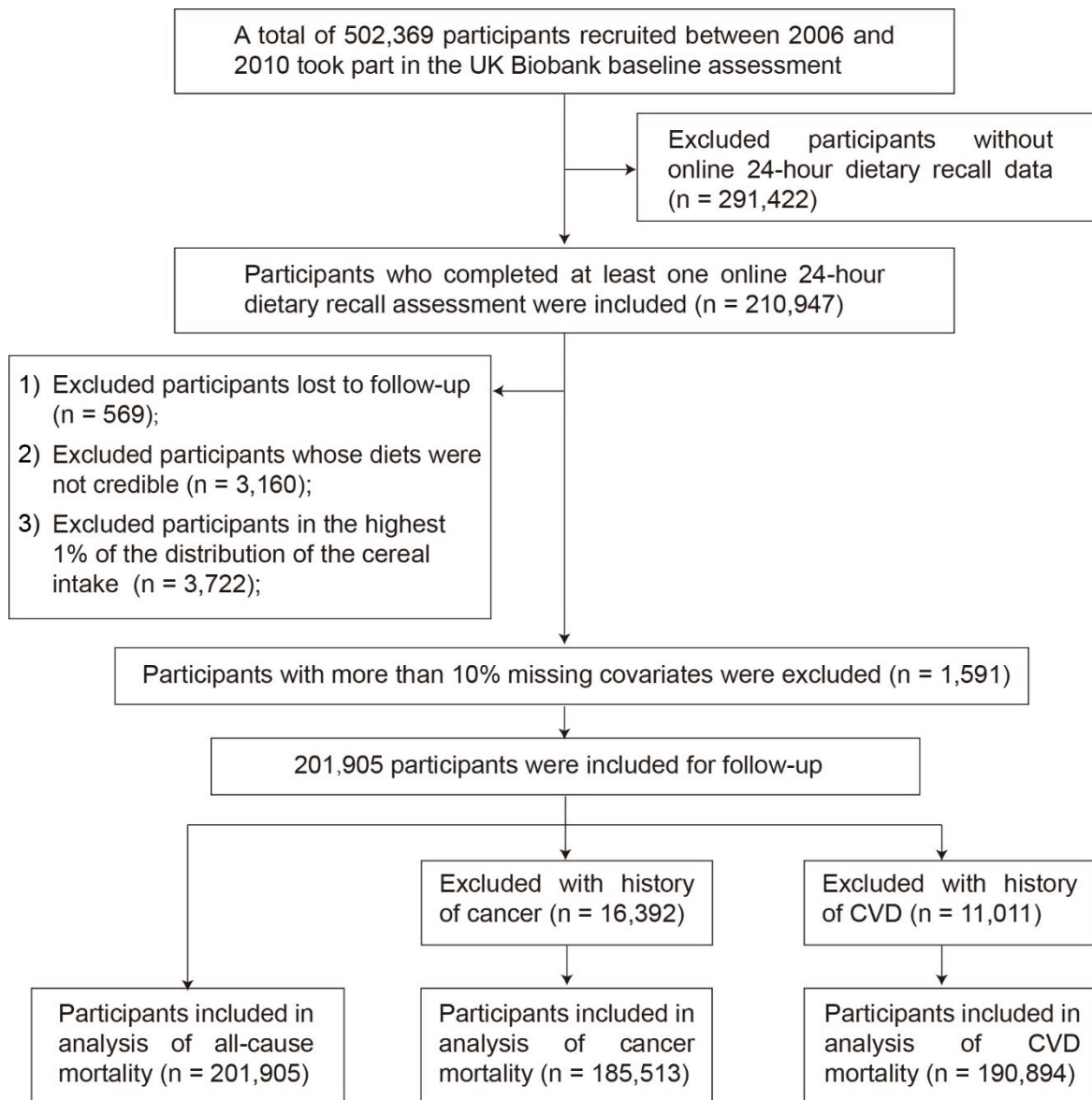
Supplemental Figure 9. Sensitivity analysis of the association of cereal consumption with cancer-specific mortality.

Note: Sensitivity analysis 1 excluded participants with missing values in covariates; sensitivity analysis 2 excluded participants who had an outcome event within the first 2 years of follow-up; sensitivity analysis 3 excluded participants who reported having an unusual cereal consumption day; sensitivity analysis 4 remove the sugar added to the cereal from the total sugar, and the energy produced is also removed from the total energy; sensitivity analysis 5 excluded participants who reported cereal consumption in the baseline questionnaire but were classified as non-consumers by the 24-hour dietary recall. All models were fully adjusted. HR: hazard ratio; CI: confidence interval.



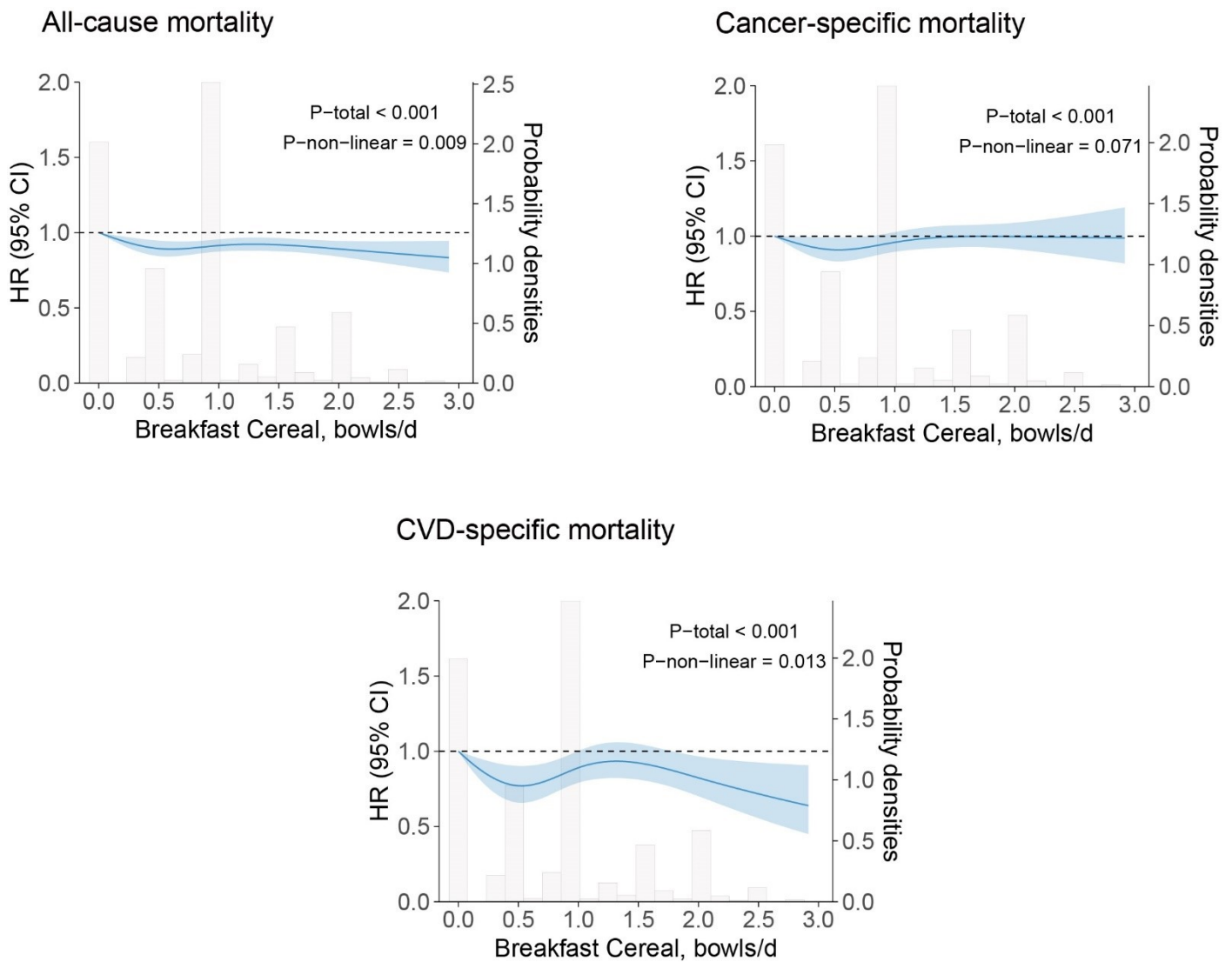
Supplemental Figure 10. Sensitivity analysis of the association of cereal consumption with CVD-specific mortality.

Note: Sensitivity analysis 1 excluded participants with missing values in covariates; sensitivity analysis 2 excluded participants who had an outcome event within the first 2 years of follow-up; sensitivity analysis 3 excluded participants who reported having an unusual cereal consumption day; sensitivity analysis 4 remove the sugar added to the cereal from the total sugar, and the energy produced is also removed from the total energy; sensitivity analysis 5 excluded participants who reported cereal consumption in the baseline questionnaire but were classified as non-consumers by the 24-hour dietary recall. All models were fully adjusted. HR: hazard ratio; CI: confidence interval; CVD: cardiovascular disease.



Supplemental Figure 11. Flowchart of breakfast cereal consumption and all-cause, special-cause deaths.

CVD: cardiovascular disease.



Supplemental Figure 12. Dose–response associations of Breakfast cereal consumption with all-cause, cancer, and CVD mortality.

Note: The multivariable model was adjusted for age (continuous), sex (male or female), BMI (≥ 30 , ≥ 25 & < 30 , or < 25 kg/m^2), basal metabolic rate (continuous), ethnicity (White or other), Townsend deprivation index (continuous), household income (> 100000 , 52000-100000, 31000–51999, 18000-30999, or $< 18,000$ £), education (degree or no degree), smoking status (never, former, or current), pack-years of smoking (continuous), physical activity level (low, moderate, or high), vitamin use (yes or no), mineral and other dietary supplements use (yes or no), NSAIDs use (yes or no), healthy sleep pattern (yes or no), family history of CVD (yes or no), family history of cancer (yes or no), number of long-term conditions (none, one, two, three, four or five and more), and intake of total energy, total sugar, coffee, starchy food, refined grains, snacks, pizza, and a modified AHEI-2010 score.

HR, hazard ratio; CI, confidence interval; BMI, body mass index; CVD, cardiovascular disease; NSAIDs, Nonsteroidal anti-inflammatory drugs; AHEI, Alternative Healthy Eating Index.