

Supplementary method

Covariates

We considered other covariates including age, sex (male and female), ethnicity (White, others), smoking (Never, Previous, Current smoking), alcohol consumption (Never, Special occasions only, One to three times a month, Once or twice a week, Three or four times a week, Daily or almost daily), Townsend deprivation index (TDI), income (<31000, ≥31000), education level (College or University degree, Others), and physical activity. In the sensitivity analysis, body mass index ($BMI < 18.5$, $18.5 \leq BMI < 25$, $25 \leq BMI < 30$, $BMI \geq 30$), the number of multimorbidity (none, 1, or ≥ 2), depression symptoms, and anxiety symptoms are further adjusted. Physical activity was assessed at baseline using the self-reported short-form international physical activity questionnaire (IPAQ). The IPAQ questions participants on three types of activity (walking, moderate, and vigorous-intensity activities). From these questions, the total physical activity volume can be computed in metabolic equivalent minutes per week (MET-min/week)¹. According to the postal code of each participant, the Townsend deprivation index (TDI), was described through households without a car, overcrowded households, households not owner-occupied, and persons unemployed². A number of morbidities, based on 43 commonly long-term conditions³, were categorized into none, one, and two or more. We further considered adjusting the analyses for depressive and anxiety symptoms. PHQ-2 was used to assess depressive symptoms at baseline. The questionnaire asked respondents about the frequency of “depression mood” (UK Biobank code: 2050) and “unenthusiasm/disinterest” (UK Biobank code: 2060) in the past two weeks. The response options included “not at all” (assigned a score of 0), “several days” (1), “more than half the days” (2), and “nearly every day” (3). Therefore, the score range of the questionnaire can be from 0 to 6, where 3 scores and above indicated that depression may occur⁴. GAD-7 is a classification scale focusing on seven anxious symptoms and signs, with a total score (0–21). (detailed Field ID in UK Biobank: Feeling nervous, anxious or on edge 20506, Not being able to stop or control worrying 20509, Worrying too much about different things 20520, Trouble relaxing 20515, Being so restless that it is hard to sit still 20516, Becoming easily annoyed or irritable 20505, Feeling afraid as if something awful might happen 20512). The selection criteria are as follows: anxiety GAD scores ≤ 5 ⁵. More detailed information about these covariates could be discovered in the UK Biobank Showcase (<http://biobank.ndph.ox.ac.uk/showcase>

Multiple imputation procedure

We used multiple imputation by two procedure steps “PROC MI” and “PROC MIANALYZE” in SAS to handle missing data on all covariates. In detail, we imputed missing data using multiple imputations by chained equations⁶. Due to the computational burden of using UK Biobank data, we imputed 5 complete datasets, and the maximum iteration was set to 20, though we generally realized that more imputation sets would be preferable. We used predictive mean matching to impute continuous variables and logistic regression for binary variables. All covariates were included in the multiple imputation model regardless of whether they were

missing or not ⁷. We performed all analyses with each of the 5 imputed datasets one by one using the same analytic methods. Then the 5 results sets were pooled using Rubin's rule into a single set that accounts for the uncertainty caused by missing values and multiple imputations

Supplementary Table 1. UPF items in the UK Biobank

Data field	Food item	Portion size	Energy	energy for one serving
		g/serving	KJ/100 g	KJ/serving
100160	Low calorie drink intake	330	43	141.90
100170	Fizzy drink intake carbonated (fizzy) drinks	330	174	574.20
100180	Squash intake	250	159	397.50
100250	Instant coffee intake	190	8	15.20
100380	Intake of artificial sweetener added to coffee ^c	6	200	12.00
100500	Intake of artificial sweetener added to tea ^d	6	200	12.00
100530	Flavoured milk intake	250	270	675.00
100720	Fortified wine intake	50	481	240.50
100730	Spirits intake	23	919	211.37
100770	Porridge intake	203.5	195	396.83
100800	muesli intake	100	1540	1540.00
100810	Oat crunch intake	100	1639	1639.00
100820	Sweetened cereal intake	38	1632	620.16
100830	Plain cereal intake	30	1601	480.30
100840	Bran cereal intake	50	1406	703.00
100850	Whole-wheat cereal intake	44	1474	648.56
100860	Other cereal intake	44	1566	689.04
101090	Bap intake	90	1065	958.50
101160	Bread roll intake	60	1084	650.40
101230	Naan bread intake	160	1206	1929.60
101250	Crispbread intake	10	1591	159.10
101260	Oatcakes intake	13	1737	225.81
101270	Other bread intake	45	1661	747.45
101310	Number of bread slices with butter/margarine			306.10/367.32/459.15
101350	Number of baguettes with butter/margarine			306.10/367.32/459.15
101390	Number of baps with butter/margarine			306.10/367.32/459.15
101430	Number of bread rolls with butter/margarine	Thin 10 medium 12 thick 15	3061	306.10/367.32/459.15
101470	Number of crackers/crispbreads with butter/margarine			306.10/367.32/459.15
101510	Number of oatcakes with butter/margarine			306.10/367.32/459.15
101550	Number of other bread types with butter/margarine			306.10/367.32/459.15
101970	Double crust pastry intake	60	1060	636.00
101980	Single crust pastry intake	30	1310	393.00
101990	Crumble intake	70	924	646.80
102000	Pizza intake	150	1036	1554.00
102010	Pancake intake	110	1065	1171.50
102020	Scotch pancake intake	41	1138	466.58
102030	Yorkshire pudding intake	25	881	220.25
102040	Indian snacks intake	40	975	390.00
102050	Croissant intake	60	1563	937.80
102060	Danish pastry intake	110	1441	1585.10
102070	Scone intake	48	1378	661.44
102120	Ice-cream intake	120	1229	1474.80
102140	Milk-based pudding intake	200	494	988.00
102150	Other milk-based pudding intake	60	518	310.80
102170	Soya dessert intake	125	309	386.25
102180	Fruitcake intake	70	1478	1034.60
102190	Cake intake	60	1617	970.20
102200	Doughnut intake	60	1414	848.40
102210	Sponge pudding intake	120	1116	1339.20
102220	Cheesecake intake	110	1231	1354.10
102230	Other dessert intake	60	696	417.60
102260	Chocolate bar intake	50	2081	1040.50
102270	White chocolate intake	50	2212	1106.00
102280	Milk chocolate intake	50	2177	1088.50
102290	Dark chocolate intake	50	2273	1136.50
102300	Chocolate-covered raisin intake	25	1159	289.75
102310	Chocolate sweet intake	36	1922	691.92
102320	Diet sweets intake	18	975	175.50
102330	Sweets intake	36	1793	645.48
102340	Chocolate-covered biscuits intake	17	2076	352.92
102350	Chocolate biscuits intake	24	2071	497.04
102360	Sweet biscuits intake	17	1842	313.14
102370	Cereal bar intake	28	1525	427.00
102380	Other sweets intake sweet snacks	40	1793	717.20

102460	Crisp intake	40	2186	874.40
102470	Savoury biscuits intake	40	2168	867.20
102480	Cheesy biscuits intake	40	1366	546.40
102500	Other savoury snack intake	40	2099	839.60
102530	Powdered/instant soup intake	200	270	540.00
102760	Snackpot intake (snack pot, noodles/rice	280	1541	4314.80
102770	Couscous intake	150	1440	2160.00
102850	Low fat cheese spread intake	40	733	293.20
102860	Cheese spread intake	15	1106	165.90
103010	Sausage intake	30	1218	365.40
103050	Crumbed or deep-fried poultry intake (chicken or turkey in breadcrumbs or deep fried	100	1111	1111.00
103070	Bacon intake	46	891	409.86
103080	Ham intake	23	891	204.93
103260	Vegetarian sausages/burgers intake	90	748	673.20
103280	Quorn intake	90	389	350.10
103290	Other vegetarian alternative intake	90	1386	1247.40
104000	Baked bean intake	135	335	452.25
104020	Fried potatoes intake	180	796	1432.80
104050	Mashed potato intake	60	438	262.8

Supplementary Table 2. Baseline characteristics by UPF consumption(servings).

Characteristics	UPF consumption(servings)			
	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Age (mean (SD))	55.9(7.8)	56.2(7.9)	56.4(8.0)	56.3(8.1)
Sex (%)				
Female	31649 (64.6)	25230 (59.0)	24177 (51.8)	17865 (39.7)
Male	17325 (35.4)	17558 (41.0)	22481 (48.2)	27189 (60.3)
Ethnicity (%)				
White	45249 (92.4)	41042 (95.9)	45219 (96.9)	43927 (97.5)
Others	3725 (7.6)	1746 (4.1)	1439 (3.1)	1127 (2.5)
Education (%)				
>=College	24258 (49.5)	19616 (45.8)	19203 (41.2)	15739 (34.9)
<College	24716 (50.5)	23172 (54.2)	27455 (58.8)	29315 (65.1)
Income (%)				
<31000	17176 (35.1)	16074 (37.6)	18979 (40.7)	20408 (45.3)
>=31000	31798 (64.9)	26714 (62.4)	27679 (59.3)	24646 (54.7)
Townsend deprivation index	-1.4(3.0)	-1.7(2.8)	-1.8(2.7)	-1.7(2.8)
Smoking (%)				
Never	28949 (59.1)	25372 (59.3)	26775 (57.4)	23797 (52.8)
Previous	16877 (34.5)	14668 (34.3)	16491 (35.3)	16838 (37.4)
Current	3148 (6.4)	2748 (6.4)	3392 (7.3)	4419 (9.8)
Drinking (%)				
Daily or almost daily	12392 (25.3)	10352 (24.2)	10460 (22.4)	9165 (20.3)
Three or four times a week	12818 (26.2)	11293 (26.4)	12057 (25.8)	10646 (23.6)
Once or twice a week	11557 (23.6)	10539 (24.6)	12074 (25.9)	11945 (26.5)
One to three times a month	4657 (9.5)	4498 (10.5)	5218 (11.2)	5539 (12.3)
Special occasions only	4482 (9.2)	3833 (9.0)	4300 (9.2)	4916 (10.9)
Never	3068 (6.3)	2273 (5.3)	2549 (5.5)	2843 (6.3)
Physical activity (mean (SD))	2499.5(2369.8)	2460.8(2388.0)	2505.6(2439.3)	2603.2(2612.3)

Abbreviations: SD, standard deviation.

Supplementary Table 3. Baseline characteristics by UPF consumption (energy ratio).

Characteristics	UPF consumption (energy ratio)			
	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Age (mean (SD))	56.5(7.8)	56.6(7.8)	56.3(8.0)	55.4(8.3)
Sex (%)				
Female	27356 (59.6)	25537 (55.7)	23853 (52.0)	22175 (48.3)
Male	18513 (40.4)	20331 (44.3)	22016 (48.0)	23693 (51.7)
Ethnicity (%)				
White	42939 (93.6)	44109 (96.2)	44317 (96.6)	44072 (96.1)
Others	2930 (6.4)	1759 (3.8)	1552 (3.4)	1796 (3.9)
Education (%)				
\geq College	21742 (47.4)	21356 (46.6)	19663 (42.9)	16055 (35.0)
<College	24127 (52.6)	24512 (53.4)	26206 (57.1)	29813 (65.0)
Income (%)				
<31000	16633 (36.3)	17307 (37.7)	18346 (40.0)	20351 (44.4)
\geq 31000	29236 (63.7)	28561 (62.3)	27523 (60.0)	25517 (55.6)
Townsend deprivation index	-1.4(3.0)	-1.7(2.8)	-1.8(2.7)	-1.6(2.9)
Smoking (%)				
Never	24471 (53.3)	26084 (56.9)	27097 (59.1)	27241 (59.4)
Previous	17743 (38.7)	16730 (36.5)	15695 (34.2)	14706 (32.1)
Current	3655 (8.0)	3054 (6.7)	3077 (6.7)	3921 (8.5)
Drinking (%)				
Daily or almost daily	14315 (31.2)	12179 (26.6)	9643 (21.0)	6232 (13.6)
Three or four times a week	12393 (27.0)	12788 (27.9)	12059 (26.3)	9574 (20.9)
Once or twice a week	9702 (21.2)	11010 (24.0)	12259 (26.7)	13144 (28.7)
One to three times a month	3718 (8.1)	4222 (9.2)	5132 (11.2)	6840 (14.9)
Special occasions only	3522 (7.7)	3553 (7.7)	4278 (9.3)	6178 (13.5)
Never	2219 (4.8)	2116 (4.6)	2498 (5.4)	3900 (8.5)
Physical activity (mean (SD))	2605.2(2470.4)	2523.9(2409.5)	2476.3(2412.6)	2464.5(2518.1)

Abbreviations: SD, standard deviation.

Supplementary Table 4. Baseline characteristics by UPF consumption (weight ratio).

Characteristics	UPF consumption (weight ratio)			
	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Age (mean (SD))	56.3(7.8)	56.5(7.9)	56.5(8.0)	55.5(8.2)
Sex (%)				
Female	27069 (59.0)	25317 (55.2)	23873 (52.0)	22662 (49.4)
Male	18800 (41.0)	20551 (44.8)	21996 (48.0)	23206 (50.6)
Ethnicity (%)				
White	43299 (94.4)	43816 (95.5)	44076 (96.1)	44246 (96.5)
Others	2570 (5.6)	2052 (4.5)	1793 (3.9)	1622 (3.5)
Education (%)				
\geq College	23995 (52.3)	21106 (46.0)	18322 (39.9)	15393 (33.6)
<College	21874 (47.7)	24762 (54.0)	27547 (60.1)	30475 (66.4)
Income (%)				
<31000	15866 (34.6)	17720 (38.6)	18967 (41.4)	20084 (43.8)
\geq 31000	30003 (65.4)	28148 (61.4)	26902 (58.6)	25784 (56.2)
Townsend deprivation index	-1.3(3.0)	-1.7(2.8)	-1.8(2.8)	-1.7(2.8)
Smoking (%)				
Never	25747 (56.1)	26960 (58.8)	26722 (58.3)	25464 (55.5)
Previous	17037 (37.1)	16129 (35.2)	15909 (34.7)	15799 (34.4)
Current	3085 (6.7)	2779 (6.1)	3238 (7.1)	4605 (10.0)
Drinking (%)				
Daily or almost daily	13406 (29.2)	11107 (24.2)	9909 (21.6)	7947 (17.3)
Three or four times a week	12524 (27.3)	12210 (26.6)	11928 (26.0)	10152 (22.1)
Once or twice a week	9869 (21.5)	11347 (24.7)	12203 (26.6)	12696 (27.7)
One to three times a month	3924 (8.6)	4689 (10.2)	5023 (11.0)	6276 (13.7)
Special occasions only	3643 (7.9)	4038 (8.8)	4294 (9.4)	5556 (12.1)
Never	2503 (5.5)	2477 (5.4)	2512 (5.5)	3241 (7.1)
Physical activity (mean (SD))	2566.5(2425.1)	2518.8(2406.4)	2520.0(2467.2)	2464.8(2513.4)

Abbreviations: SD, standard deviation.

Supplementary Table 5. Associations of UPF servings with depression and anxiety stratified by potential modifiers.

Subgroups	Depression		Anxiety	
	HR 95%CI	P for interaction	HR 95%CI	P for interaction
Age				
<60 years	1.36 (1.24 - 1.50)	4.58E-05	1.22 (1.12 - 1.33)	1.38E-02
≥60 years	1.03 (0.91 - 1.16)		1.02 (0.91 - 1.14)	
Sex				
Male	1.13 (1.00 - 1.29)	0.781867	1.16 (1.02 - 1.31)	0.40105017
Female	1.27 (1.16 - 1.40)		1.12 (1.03 - 1.22)	
Education level				
<College	1.15 (1.05 - 1.26)	0.409999	1.06 (0.97 - 1.16)	0.10751392
≥College	1.33 (1.17 - 1.51)		1.28 (1.13 - 1.43)	
PA (MET-minute/week)				
<500	1.36 (1.15 - 1.62)	0.186931	1.20 (1.01 - 1.42)	0.569099379
≥500	1.17 (1.08 - 1.28)		1.12 (1.03 - 1.20)	
Income				
<31000	1.10 (0.99 - 1.22)	0.028905	0.99 (0.89 - 1.09)	0.001623155
≥31000	1.34 (1.20 - 1.50)		1.28 (1.17 - 1.42)	
Deprivation index				
Low	1.17 (1.07 - 1.28)	0.096789	1.18 (1.08 - 1.28)	0.515933996
High	1.30 (1.14 - 1.48)		1.02 (0.90 - 1.16)	
Smoking status				
None-smokers	1.19 (1.07 - 1.33)	0.729775	1.16 (1.05 - 1.28)	0.471673639
Current or ever smokers	1.26 (1.13 - 1.39)		1.11 (1.01 - 1.23)	
Alcohol intake				
<3 times/week	1.13 (1.02 - 1.24)	0.182186	1.07 (0.98 - 1.17)	0.489478059
≥3 times/week	1.38 (1.22 - 1.55)		1.23 (1.10 - 1.37)	

Abbreviations: UPF, ultra-processed food; CI, confidence interval; HR, hazard ratio; PA, physical activity.

HR was calculated by Cox model adjusted for age, sex, ethnicity, smoking, drinking, Townsend deprivation index, income, education, and physical activity.

Supplementary Table 6. Associations of UPF energy ratio with depression and anxiety stratified by potential modifiers.

Subgroups	Depression		Anxiety	
	HR 95%CI	P for interaction	HR 95%CI	P for interaction
Age				
<60 years	1.21 (1.10 - 1.33)	1.18E-02	1.13 (1.03 - 1.23)	3.38E-01
≥60 years	1.03 (0.91 - 1.17)		1.11 (0.99 - 1.24)	
Sex				
Male	1.08 (0.95 - 1.23)	0.608508028	1.13 (1.00 - 1.27)	0.435113663
Female	1.17 (1.06 - 1.28)		1.10 (1.01 - 1.19)	
Education level				
<College	1.10 (1.00 - 1.20)	0.196683461	1.04 (0.96 - 1.14)	0.107370178
≥College	1.18 (1.04 - 1.35)		1.26 (1.12 - 1.41)	
PA (MET-minute/week)				
<500	1.09 (0.92 - 1.29)	0.694399303	1.09 (0.93 - 1.29)	0.843099503
≥500	1.13 (1.04 - 1.23)		1.11 (1.03 - 1.20)	
Income				
<31000	1.05 (0.94 - 1.16)	0.186234556	1.07 (0.97 - 1.18)	0.747450115
≥31000	1.23 (1.10 - 1.37)		1.15 (1.04 - 1.26)	
Deprivation index				
Low	1.08 (0.98 - 1.18)	0.008782147	1.11 (1.02 - 1.20)	0.970961873
High	1.23 (1.08 - 1.40)		1.10 (0.97 - 1.25)	
Smoking status				
None-smokers	1.04 (0.93 - 1.16)	0.032411211	1.12 (1.02 - 1.23)	0.547752999
Current or ever smokers	1.23 (1.11 - 1.37)		1.12 (1.01 - 1.24)	
Alcohol intake				
<3 times/week	1.03 (0.94 - 1.14)	0.018829135	1.04 (0.95 - 1.14)	0.142004453
≥3 times/week	1.33 (1.18 - 1.50)		1.22 (1.10 - 1.36)	

Abbreviations: UPF, ultra-processed food; CI, confidence interval; HR, hazard ratio; PA, physical activity.

HR was calculated by Cox model adjusted for age, sex, ethnicity, smoking, drinking, Townsend deprivation index, income, education, and physical activity.

Supplementary Table 7. Associations of UPF weight ratio with depression and anxiety stratified by potential modifiers.

Subgroups	Depression		Anxiety	
	HR 95%CI	P for interaction	HR 95%CI	P for interaction
Age				
<60 years	1.48 (1.34 - 1.63)	8.51E-08	1.15 (1.05 - 1.26)	3.62E-01
≥60 years	0.98 (0.87 - 1.11)		1.11 (1.00 - 1.24)	
Sex				
Male	1.25 (1.10 - 1.43)	0.608508028	1.14 (1.01 - 1.28)	0.56826735
Female	1.26 (1.15 - 1.39)		1.12 (1.03 - 1.21)	
Education level				
<College	1.13 (1.03 - 1.24)	0.003131387	1.08 (0.99 - 1.18)	0.355779526
≥College	1.49 (1.31 - 1.70)		1.20 (1.07 - 1.35)	
PA (MET-minute/week)				
<500	1.13 (0.95 - 1.35)	0.550858682	1.04 (0.88 - 1.23)	0.586815405
≥500	1.28 (1.17 - 1.39)		1.14 (1.06 - 1.23)	
Income				
<31000	1.23 (1.10 - 1.37)	0.603824369	1.05 (0.95 - 1.16)	0.170180486
≥31000	1.29 (1.16 - 1.44)		1.20 (1.09 - 1.32)	
Deprivation index				
Low	1.18 (1.08 - 1.30)	0.061232719	1.14 (1.05 - 1.24)	0.972199595
High	1.39 (1.22 - 1.59)		1.08 (0.95 - 1.22)	
Smoking status				
None-smokers	1.22 (1.10 - 1.36)	0.154006328	1.17 (1.06 - 1.28)	0.476550304
Current or ever smokers	1.32 (1.19 - 1.47)		1.09 (0.99 - 1.21)	
Alcohol intake				
<3 times/week	1.19 (1.08 - 1.32)	0.255453338	1.10 (1.01 - 1.21)	0.838861982
≥3 times/week	1.35 (1.20 - 1.52)		1.16 (1.04 - 1.30)	

Abbreviations: UPF, ultra-processed food; CI, confidence interval; HR, hazard ratio; PA, physical activity.

HR was calculated by the Cox model adjusted for age, sex, ethnicity, smoking, drinking, Townsend deprivation index, income, education, and physical activity.

Supplementary Table 8. Associations between UPF consumption and transitions from baseline to depression or anxiety, and then to death when using age as time-scale.

		Depression			Anxiety			
		Case	HR (95% CI)	P-value	Case	HR (95% CI)	P-value	
Servings								
	Baseline→Depression	5453	1.2325(1.1434,1.3285)	4.73e-08	Baseline→Anxiety	6763	1.1374(1.0615,1.2188)	0.000261
	Depression→Death	609	0.8597(0.6923,1.0678)	0.171659	Anxiety→Death	583	0.9662(0.7660,1.2186)	0.771326
	Baseline→Death	8608	1.0970(1.0328,1.1651)	0.002615	Baseline→Death	8634	1.0929(1.0293,1.1605)	0.003683
Energy proportion								
	Baseline→Depression	5453	1.1612(1.0767,1.2524)	0.000105	Baseline→Anxiety	6763	1.1388(1.0632,1.2197)	0.000207
	Depression→Death	609	0.9737(0.7811,1.2138)	0.812918	Anxiety→Death	583	0.8061(0.6423,1.0117)	0.062963
	Baseline→Death	8608	1.0192(0.9587,1.0835)	0.542677	Baseline→Death	8634	1.0325(0.9713,1.0975)	0.304942
Weight proportion								
	Baseline→Depression	5453	1.2888(1.1940,1.3911)	7.54e-11	Baseline→Anxiety	6763	1.1240(1.0491,1.2042)	0.000890
	Depression→Death	609	0.8478(0.6767,1.0621)	0.150991	Anxiety→Death	583	1.0123(0.8032,1.2758)	0.917622
	Baseline→Death	8608	1.0965(1.0314,1.1656)	0.003165	Baseline→Death	8634	1.0918(1.0272,1.1606)	0.004798

Abbreviations: UPF, ultra-processed food; CI, confidence interval; HR, hazard ratio.

HR was calculated by the Cox model adjusted for sex, ethnicity, smoking, drinking, Townsend deprivation index, income, education, and physical activity.

Supplementary Table 9. Sensitivity analyses for the association between UPF intake and risk of depression or anxiety when only included participants with at least two completed 24h recall questionnaires.

	Depression				Anxiety		
	case/person years	HR 95%CI	P		case/person years	HR 95%CI	P
Serving							
Q1	662/367768	Ref		869/366174	Ref		
Q2	635/356554	1.01 (0.91 - 1.13)	0.856420433	951/354534	1.15 (1.05 - 1.26)	0.002635622	
Q3	750/364227	1.18 (1.06 - 1.31)	0.002742818	973/362719	1.17 (1.07 - 1.28)	0.000941418	
Q4	844/352217	1.36 (1.22 - 1.51)	1.69E-08	933/351453	1.17 (1.07 - 1.29)	0.001038351	
P-trend			4.71E-10			0.001280362	
Energy%							
Q1	643/360523	Ref		852/359234	Ref		
Q2	685/361085	1.09 (0.97 - 1.21)	0.135836626	934/359094	1.12 (1.02 - 1.23)	0.016517626	
Q3	710/359936	1.12 (1.00 - 1.25)	0.041953648	919/358551	1.10 (1.00 - 1.21)	0.0492662	
Q4	853/359222	1.26 (1.13 - 1.40)	2.17E-05	1021/358002	1.17 (1.06 - 1.28)	0.001456484	
P-trend			2.43E-05			0.004111905	
Weight%							
Q1	616/360972	Ref		862/359255	Ref		
Q2	671/360755	1.11 (0.99 - 1.24)	0.068945841	920/359083	1.08 (0.98 - 1.18)	0.12537193	
Q3	689/360140	1.13 (1.02 - 1.27)	0.024929208	906/358626	1.06 (0.96 - 1.16)	0.244428215	
Q4	915/358899	1.41 (1.27 - 1.57)	1.92E-10	1038/357917	1.15 (1.05 - 1.27)	0.002857591	
P-trend			2.38E-10			0.006398676	

Abbreviations: UPF, ultra-processed food; CI, confidence interval; HR, hazard ratio.

HR was calculated by the Cox model adjusted for age, sex, ethnicity, smoking, drinking, Townsend deprivation index, income, education, and physical activity.

Supplementary Table 10. Sensitivity analyses for the association between UPF intake and risk of depression or anxiety when further excluded participants who developed depression or anxiety within the first 2 years of the follow-up.

	Depression				Anxiety		
	case/person years	HR 95%CI	P		case/person years	HR 95%CI	P
Serving							
Q1	1198/629890	Ref		1445/628265	Ref		
Q2	999/551944	0.97 (0.89 - 1.05)	0.434054558	1379/549872	1.11 (1.03 - 1.20)	0.004574942	
Q3	1184/599995	1.05 (0.97 - 1.14)	0.238558856	1488/598278	1.11 (1.03 - 1.20)	0.004122312	
Q4	1363/576043	1.23 (1.13 - 1.33)	7.50E-07	1465/575319	1.15 (1.06 - 1.23)	0.000394307	
P-trend			1.65E-07			0.000658176	
Energy%							
Q1	1147/589121	Ref		1396/587760	Ref		
Q2	1089/591355	0.97 (0.89 - 1.05)	0.459085206	1375/589440	1.01 (0.94 - 1.09)	0.823227343	
Q3	1136/589988	1.00 (0.92 - 1.09)	0.977665363	1398/588610	1.02 (0.95 - 1.10)	0.577266933	
Q4	1372/587408	1.12 (1.03 - 1.21)	0.008042127	1608/585924	1.12 (1.04 - 1.20)	0.003893341	
P-trend			0.005229675			0.004196821	
Weight%							
Q1	1051/590638	Ref		1311/589190	Ref		
Q2	1094/590669	1.05 (0.97 - 1.15)	0.238494794	1444/588457	1.11 (1.03 - 1.20)	0.00572893	
Q3	1167/589475	1.11 (1.02 - 1.20)	0.018938104	1438/588066	1.10 (1.02 - 1.18)	0.017493154	
Q4	1432/587091	1.26 (1.16 - 1.37)	3.23E-08	1584/586020	1.15 (1.07 - 1.24)	0.000314331	
P-trend			1.19052E-08			0.001105509	

Abbreviations: UPF, ultra-processed food; CI, confidence interval; HR, hazard ratio.

HR was calculated by the Cox model adjusted for age, sex, ethnicity, smoking, drinking, Townsend deprivation index, income, education, and physical activity.

Supplementary Table 11. Sensitivity analyses for the association between UPF intake and risk of depression or anxiety when further excluded participants with cardiovascular disease (CVD), cancer, or chronic obstructive pulmonary disease (COPD) at baseline.

	Depression				Anxiety		
	case/person years	HR 95%CI	P		case/person years	HR 95%CI	P
Serving							
Q1	777/405105	Ref		991/403054	Ref		
Q2	756/413134	0.97 (0.88 - 1.07)	0.581730736	1084/410785	1.10 (1.01 - 1.20)	0.030418527	
Q3	793/397561	1.06 (0.96 - 1.17)	0.244845283	1073/395671	1.15 (1.05 - 1.25)	0.002339047	
Q4	919/398101	1.22 (1.10 - 1.34)	8.83841E-05	1061/396936	1.15 (1.05 - 1.26)	0.002347232	
P-trend			1.85922E-05			0.001531053	
Energy%							
Q1	761/403516	Ref		977/401788	Ref		
Q2	758/404742	1.02 (0.92 - 1.13)	0.695137897	1043/402393	1.09 (1.00 - 1.19)	0.044334045	
Q3	781/403609	1.05 (0.95 - 1.16)	0.355026251	1023/401811	1.07 (0.98 - 1.17)	0.125515503	
Q4	945/402035	1.18 (1.07 - 1.31)	0.000801746	1166/400454	1.16 (1.06 - 1.26)	0.001047704	
P-trend			0.000707715			0.003057566	
Weight%							
Q1	712/404120	Ref		992/401742	Ref		
Q2	751/404301	1.07 (0.97 - 1.19)	0.172619499	1028/402240	1.05 (0.96 - 1.15)	0.272365533	
Q3	799/403469	1.13 (1.02 - 1.25)	0.022224596	1048/401799	1.06 (0.97 - 1.16)	0.182418174	
Q4	983/402012	1.29 (1.17 - 1.43)	4.01E-07	1141/400665	1.10 (1.01 - 1.20)	0.034633483	
P-trend			2.4079E-07			0.038297068	

Abbreviations: UPF, ultra-processed food; CI, confidence interval; HR, hazard ratio.

HR was calculated by the Cox model adjusted for age, sex, ethnicity, smoking, drinking, Townsend deprivation index, income, education, and physical activity.

Supplementary Table 12. Sensitivity analyses for the association between UPF intake and risk of depression or anxiety when further adjusted for BMI and multimorbidity.

	Depression				Anxiety		
	case/person years	HR 95%CI	P		case/person years	HR 95%CI	P
Serving							
Q1	1377/632999	Ref		1717/630209	Ref		
Q2	1145/554388	0.95 (0.88 - 1.03)	0.202203389	1587/551514	1.07 (1.00 - 1.15)	0.039086414	
Q3	1367/602917	1.03 (0.95 - 1.11)	0.51820301	1743/600314	1.09 (1.02 - 1.17)	0.013261606	
Q4	1564/578865	1.15 (1.06 - 1.24)	0.000332851	1716/577598	1.10 (1.03 - 1.18)	0.004961673	
P-trend			7.63451E-05			0.004843801	
Energy%							
Q1	1307/592205	Ref		1608/590158	Ref		
Q2	1253/594297	0.98 (0.91 - 1.06)	0.58774648	1621/591420	1.03 (0.96 - 1.11)	0.354297155	
Q3	1296/593098	0.99 (0.92 - 1.08)	0.894861621	1653/590580	1.05 (0.98 - 1.12)	0.206378062	
Q4	1597/589571	1.12 (1.04 - 1.21)	0.003728062	1881/587477	1.12 (1.04 - 1.20)	0.001450106	
P-trend			0.003090146			0.001704334	
Weight%							
Q1	1200/593680	Ref		1572/590814	Ref		
Q2	1262/593746	1.05 (0.97 - 1.14)	0.219435803	1656/591005	1.06 (0.99 - 1.13)	0.106660892	
Q3	1345/592408	1.09 (1.00 - 1.17)	0.040578929	1686/590173	1.07 (0.99 - 1.14)	0.071670084	
Q4	1646/589336	1.19 (1.10 - 1.29)	6.89E-06	1849/587644	1.09 (1.02 - 1.17)	0.011904723	
P-trend			4.58789E-06			0.015325368	

Abbreviations: UPF, ultra-processed food; CI, confidence interval; HR, hazard ratio.

HR was calculated by the Cox model adjusted for age, sex, ethnicity, smoking, drinking, Townsend deprivation index, income, education, physical activity, BMI, and multimorbidity.

Supplementary Table 13. Sensitivity analyses for the association between UPF intake and risk of depression or anxiety when further adjusted for depression and anxiety symptoms at baseline.

□	Depression			□	□	Anxiety			□
	case/person years	HR 95%CI	P			case/person years	HR 95%CI	P	
Serving									
Q1	1377/632999	Ref		1717/630209	Ref				
Q2	1145/554388	0.96 (0.89 - 1.04)	0.339554652	1587/551514	1.08 (1.01 - 1.15)	0.034325425			
Q3	1367/602917	1.05 (0.97 - 1.13)	0.216857053	1743/600314	1.09 (1.02 - 1.17)	0.00860548			
Q4	1564/578865	1.20 (1.11 - 1.29)	2.10E-06	1716/577598	1.12 (1.04 - 1.20)	0.001406545			
P-trend			3.13E-07			0.001345516			
Energy%									
Q1	1307/592205	Ref		1608/590158	Ref				
Q2	1253/594297	0.98 (0.90 - 1.05)	0.532086936	1621/591420	1.03 (0.96 - 1.10)	0.409957036			
Q3	1296/593098	0.99 (0.91 - 1.06)	0.704490456	1653/590580	1.04 (0.97 - 1.11)	0.321053132			
Q4	1597/589571	1.12 (1.04 - 1.21)	0.002727182	1881/587477	1.12 (1.04 - 1.20)	0.001721579			
P-trend			0.002618198			0.002343044			
Weight%									
Q1	1200/593680	Ref		1572/590814	Ref				
Q2	1262/593746	1.06 (0.98 - 1.14)	0.167642272	1656/591005	1.06 (0.99 - 1.13)	0.120482093			
Q3	1345/592408	1.10 (1.02 - 1.20)	0.013216215	1686/590173	1.06 (0.99 - 1.14)	0.086069875			
Q4	1646/589336	1.25 (1.16 - 1.35)	8.57E-09	1849/587644	1.11 (1.03 - 1.18)	0.004416605			
P-trend			3.69989E-09			0.00609701			

Abbreviations: UPF, ultra-processed food; CI, confidence interval; HR, hazard ratio.

HR was calculated by the Cox model adjusted for age, sex, ethnicity, smoking, drinking, Townsend deprivation index, income, education, physical activity, depression, and anxiety symptoms.

Supplementary Table 14. Associations between UPF consumption and transitions from baseline to depression or anxiety, and then to cancer mortality.

		Depression			Anxiety			
		Case	HR (95% CI)	P-value			P-value	
		Case	HR (95% CI)	P-value	Case	HR (95% CI)	P-value	
Servings								
	Baseline→Depression	5453	1.2179(1.1299,1.3128)	2.61e-07	Baseline→Anxiety	6763	1.1317(1.0561,1.2127)	0.000451
	Depression→Death	268	1.0600(0.7530,1.4922)	0.738429	Anxiety→Death	306	1.0025(0.7230,1.3900)	0.988086
	Baseline→Death	5070	1.1209(1.0354,1.2135)	0.004802	Baseline→Death	5032	1.1281(1.0418,1.2215)	0.002988
Energy proportion								
	Baseline→Depression	5453	1.1340(1.0513,1.2232)	0.001137	Baseline→Anxiety	6763	1.1232(1.0485,1.2032)	0.000942
	Depression→Death	268	1.0607(0.7583,1.4837)	0.730724	Anxiety→Death	306	0.8129(0.5902,1.1197)	0.204776
	Baseline→Death	5070	1.1370(1.0492,1.2321)	0.001733	Baseline→Death	5032	0.9618(0.8868,1.0430)	0.346164
Weight proportion								
	Baseline→Depression	5453	1.2604(1.1675,1.3606)	3.12e-09	Baseline→Anxiety	6763	1.1116(1.0375,1.1911)	0.002671
	Depression→Death	268	1.2381(0.8768,1.7483)	0.225102	Anxiety→Death	306	1.1233(0.8022,1.5730)	0.498574
	Baseline→Death	5070	1.1627(1.0728,1.2601)	0.000240	Baseline→Death	5032	1.1714(1.0808,1.2696)	0.000118

Abbreviations: UPF, ultra-processed food; CI, confidence interval; HR, hazard ratio.

HR was calculated by the Cox model adjusted for age, sex, ethnicity, smoking, drinking, Townsend deprivation index, income, education, and physical activity.

Supplementary Table 15. Associations between UPF consumption and transitions from baseline to depression or anxiety, and then to cardiovascular disease mortality.

		Depression			Anxiety			
		Case	HR (95% CI)	P-value			P-value	
		Case	HR (95% CI)	P-value	Case	HR (95% CI)	P-value	
Servings								
	Baseline→Depression	5453	1.2179(1.1299,1.3128)	2.61e-07	Baseline→Anxiety	6763	1.1317(1.05613,1.2127)	0.000451
	Depression→Death	99	0.8962(0.5258,1.5277)	0.68722	Anxiety→Death	70	1.2546(0.63791,2.4673)	0.511049
	Baseline→Death	1585	1.3404(1.1646,1.5427)	4.41e-05	Baseline→Death	1614	1.3111(1.14142,1.5060)	0.000128
Energy proportion								
	Baseline→Depression	5453	1.1340(1.0513,1.2232)	0.001137	Baseline→Anxiety	6763	1.1254(1.0506,1.2056)	0.000768
	Depression→Death	99	1.5741(0.9234,2.6834)	0.095485	Anxiety→Death	70	0.8923(0.4794,1.6606)	0.719090
	Baseline→Death	1585	1.0819(0.9376,1.2484)	0.281019	Baseline→Death	1614	1.1204(0.9724,1.2909)	0.115800
Weight proportion								
	Baseline→Depression	5453	1.2604(1.1675,1.3606)	3.12e-09	Baseline→Anxiety	6763	1.1116(1.03745,1.1911)	0.002671
	Depression→Death	99	1.0372(0.5863,1.8347)	0.900203	Anxiety→Death	70	1.6690(0.85547,3.2561)	0.133053
	Baseline→Death	1585	1.3364(1.1605,1.5390)	5.65e-05	Baseline→Death	1614	1.3044(1.13397,1.5005)	0.000200

Abbreviations: UPF, ultra-processed food; CI, confidence interval; HR, hazard ratio.

HR was calculated by the Cox model adjusted for age, sex, ethnicity, smoking, drinking, Townsend deprivation index, income, education, and physical activity.

Supplementary Table 16. The proportion of missing values

Variable	The proportion of missing values
Age	0.00%
Sex	0.00%
Ethnicity	0.32%
Smoking status	0.27%
Alcohol intake frequency	0.07%
Townsend deprivation index	0.12%
Income	10.32%
Education level	0.45%
Physical activity	15.06%

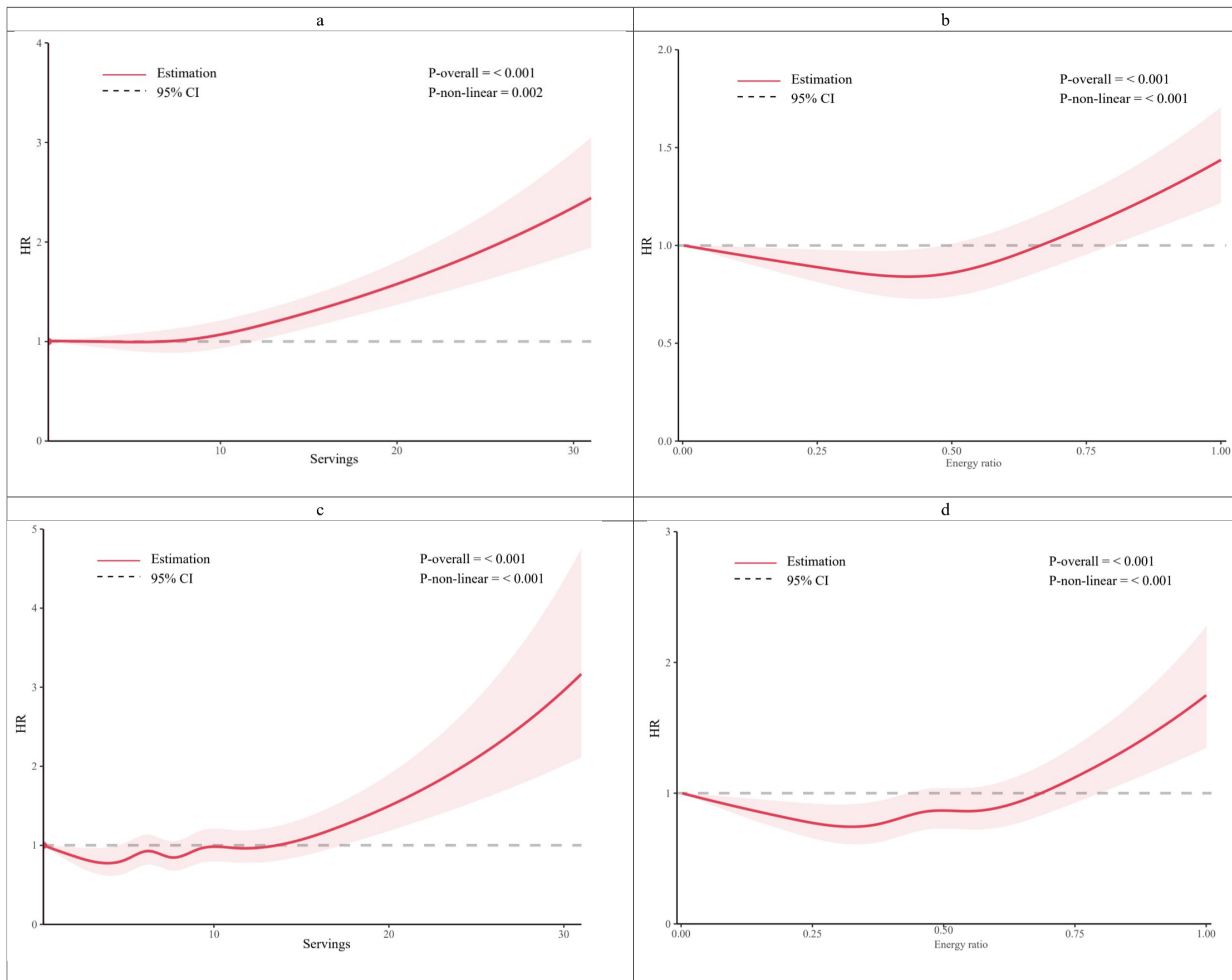


Figure S1. Restricted cubic spline analyses for the association of UPF consumption with depression(a-b), and anxiety(c-d).

Data are presented as hazard ratio (HR) and their 95% confidence interval (shaded areas).

(a)Associations of UPF servings with depression;

(b)Associations of UPF energy ratio with depression.

(c)Associations of UPF servings with anxiety;

(d)Associations of UPF energy ratio with anxiety;

Abbreviation: HR, hazard ratios; CI, confidence interval; UPF, ultra-processed food.

Models were adjusted for age, sex, ethnicity, physical activity, smoking status, alcohol intake frequency, before-tax household income, Townsend deprivation index, and education level.

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