

Supplementary materials

Supplementary Table 1. Association between refined grains intake and general and abdominal obesity different age subgroups.

	18-40 years old					41-65 years old				
	Q1	Q2	Q3	Q4	<i>P</i> for trend	Q1	Q2	Q3	Q4	<i>P</i> for trend
General obesity										
Model 1	1.00	1.31(0.88-1.97)	1.00(0.65-1.53)	1.28(0.86-1.93)	0.46	1.00	1.40(0.99-2.01)	1.08(0.74-1.56)	1.13(0.78-1.64)	0.91
Model 2	1.00	1.29(0.86-1.94)	0.98(0.63-1.51)	1.09(0.73-1.65)	0.96	1.00	1.41(0.99-2.01)	1.07(0.74-1.56)	1.18(0.81-1.70)	0.76
Model 3	1.00	1.54(0.98-2.45)	1.23(0.72-2.13)	1.40(0.73-2.74)	0.53	1.00	1.46(0.97-2.21)	1.09(0.68-1.78)	1.16(0.62-2.21)	0.98
Model 4	1.00	1.50(0.95-2.40)	1.21(0.71-2.11)	1.39(0.71-2.74)	0.55	1.00	1.48(0.98-2.25)	1.09(0.67-1.78)	1.14(0.60-2.19)	0.94
Abdominal obesity										
Model 1	1.00	0.98(0.78-1.22)	0.90(0.72-1.13)	1.12(0.90-1.39)	0.44	1.00	1.10(0.88-1.38)	1.06(0.85-1.33)	1.27(1.02-1.59)	0.06
Model 2	1.00	0.94(0.74-1.20)	0.86(0.68-1.10)	0.91(0.72-1.15)	0.32	1.00	1.10(0.88-1.39)	1.08(0.86-1.36)	1.12(0.89-1.41)	0.39
Model 3	1.00	1.29(0.98-1.69)	1.39(1.02-1.90)	1.81(1.23-2.68)	<0.01	1.00	1.36(1.04-1.77)	1.39(1.03-1.88)	1.60(1.07-2.40)	0.03
Model 4	1.00	1.27(0.96-1.68)	1.42(1.03-1.95)	1.87(1.26-2.80)	<0.01	1.00	1.40(1.07-1.83)	1.46(1.08-1.97)	1.69(1.12-2.56)	0.02

Note: Model 1 not adjusted any potential covariates; Model 2 adjusted for gender; Model 3 adjusted for gender, fat, protein, fiber, cholesterol and total energy intake; Model 4 adjusted for gender, fat, protein, fiber, cholesterol, energy intake, drinking alcohol, smoking status and physical activity, education and ethnicity; OR, Odds Ratio; CI, confidence intervals; **OR>1, increasing the likelihood of general obesity/ abdominal obesity; OR<1, decreasing the likelihood of general obesity/abdominal obesity.**

Supplementary Table 2. Association between refined grains intake and general and abdominal obesity different gender subgroups.

	Male					Female				
	Q1	Q2	Q3	Q4	<i>P</i> for trend	Q1	Q2	Q3	Q4	<i>P</i> for trend
General obesity										
Model 1	1.00	1.36(0.95-1.96)	1.02(0.69-1.50)	1.00(0.68-1.47)	0.61	1.00	1.14(0.78-1.66)	1.06(0.72-1.55)	1.00(0.68-1.47)	0.90
Model 2	1.00	1.36(0.95-1.96)	1.04(0.71-1.52)	1.01(0.69-1.48)	0.67	1.00	1.17(0.80-1.73)	1.14(0.77-1.69)	1.22(0.82-1.83)	0.37
Model 3	1.00	1.25(0.84-1.89)	0.85(0.53-1.38)	0.66(0.35-1.26)	0.12	1.00	1.39(0.88-2.19)	1.43(0.84-2.44)	1.71(0.86-3.42)	0.16
Model 4	1.00	1.25(0.84-1.89)	0.86(0.53-1.40)	0.68(0.36-1.30)	0.14	1.00	1.39(0.88-2.20)	1.39(0.82-2.39)	1.65(0.82-3.31)	0.21
Abdominal obesity										
Model 1	1.00	0.93(0.75-1.15)	0.78(0.63-0.97)	0.83(0.67-1.03)	0.04	1.00	1.07(0.85-1.35)	1.17(0.93-1.47)	0.97(0.77-1.23)	0.95
Model 2	1.00	0.94(0.75-1.17)	0.85(0.68-1.06)	0.88(0.70-1.10)	0.17	1.00	1.11(0.86-1.44)	1.30(1.01-1.67)	1.25(0.97-1.63)	0.04
Model 3	1.00	1.04(0.81-1.34)	0.97(0.72-1.30)	1.03(0.70-1.52)	0.96	1.00	1.44(1.07-1.93)	1.77(1.27-2.48)	1.88(1.21-2.93)	<0.01
Model 4	1.00	1.08(0.84-1.39)	1.03(0.77-1.39)	1.18(0.79-1.77)	0.54	1.00	1.41(1.05-1.90)	1.71(1.23-2.40)	1.81(1.16-2.82)	<0.01

Note: Model 1 not adjusted any potential covariates; Model 2 adjusted for age; Model 3 adjusted for age, fat, protein, fiber, cholesterol and total energy intake; Model 4 adjusted for age, fat, protein, fiber, cholesterol, total energy intake, drinking alcohol, smoking status and physical activity, education and ethnicity; OR, Odds Ratio; CI, confidence intervals; **OR>1, increasing the likelihood of general obesity/ abdominal obesity; OR<1, decreasing the likelihood of general obesity/abdominal obesity.**

Supplementary Table 3. Adjusted dose-response relationship of refined grains intake on general obesity and abdominal obesity in different subgroups.

	General obesity		Abdominal obesity	
	OR<1	OR>1	OR<1	OR>1
Gender				
Male	-	>308.58 g/d	-	-
Female	-	-	<223.40 g/d	223.40-388.09 g/d
Age				
18-40	-	-	<232.68 g/d	232.68-509.80 g/d
41-65	-	-	<181.12 g/d	-

Note: Different gender subgroups adjusted for age, gender, fat, protein, fiber, cholesterol, total energy intake, drinking alcohol, smoking status, physical activity, education and ethnicity; Different age subgroups adjusted for gender, fat, protein, fiber, cholesterol, total energy intake, drinking alcohol, smoking status, physical activity, education and ethnicity; OR, Odds Ratio; **OR>1, increasing the likelihood of general obesity/abdominal obesity; OR<1, decreasing the likelihood of general obesity/abdominal obesity.**

Supplementary Table 4. Factor loading for 3 food patterns for the participants in the study.

	Dairy pattern (Refined Grains- Dairy products)	High protein dietary pattern (Refined Grains- Livestock, Snacks and Fish)	High fat dietary pattern (Refined Grains- Eggs and Poultry)
Refined Grains	0.475	0.122	0.108
Whole grains		-0.174	0.127
Potatoes		-0.143	
Legumes	-0.175	0.135	
Vegetables			
Fungi		0.118	
Fruits			
Seeds and nuts	-0.113		0.359
Livestock		0.58	0.242
Poultry			-0.471
Dairy products	0.822		
Eggs			0.727
Fish	-0.135	0.502	
Beverages			
Snacks		-0.546	0.156
Sweet			
Condiments			

Note: Factor loading was obtained from the principal component analysis. Factor loadings > 0.10 are listed in the table.

Supplementary Table 5. OR (95% CI) of abdominal obesity on quintiles of energy-adjusted dietary pattern scores.

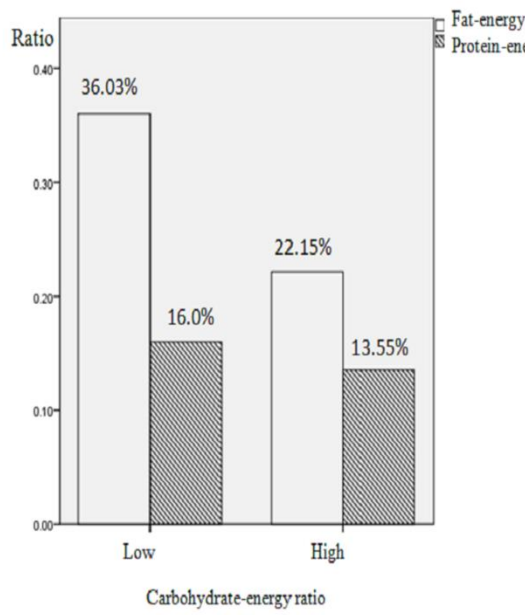
	Quintiles of energy-adjusted dietary pattern score					<i>P</i> for tend
	Q1	Q2	Q3	Q4	Q5	
Dairy pattern (Refined Grains- Dairy products), n	1383	1382	1383	1382	1383	<0.01
	1.00	0.95(0.80-1.14)	0.88(0.74-1.06)	0.74(0.62-0.89)	0.72(0.60-0.87)	
High protein dietary pattern (Refined Grains- Livestock,Snacks and Fish), n	1383	1382	1383	1382	1383	<0.01
	1.00	1.03(0.85-1.25)	1.05(0.86-1.28)	1.33(1.11-1.61)	1.24(1.03-1.50)	
High fat dietary pattern (Refined Grains- Eggs and Poultry), n	1383	1382	1383	1382	1383	0.036
	1.00	0.99(0.82-1.20)	0.98(0.81-1.19)	1.03(0.85-1.24)	1.23(1.02-1.47)	

Note: Model was adjusted for age, gender, education, smoking, alcohol consumption, total energy, physical activity and ethnicity.

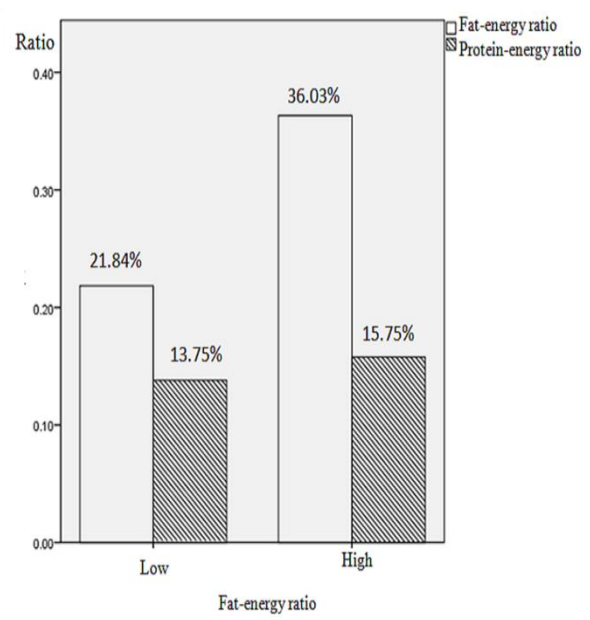
Supplementary Table 6. OR (95% CI) of obesity on quintiles of energy-adjusted dietary pattern scores.

	Quintiles of energy-adjusted dietary pattern score					<i>P</i> for tend
	Q1	Q2	Q3	Q4	Q5	
Dairy pattern (Refined Grains- Dairy products), n	1383	1382	1383	1382	1383	<0.01
	1.00	0.92(0.69-1.21)	0.73(0.55-0.98)	0.71(0.52-0.95)	0.67(0.49-0.90)	
High protein dietary pattern (Refined Grains- Livestock, Snacks and Fish), n	1383	1382	1383	1382	1383	0.23
	1.00	1.17(0.85-1.62)	1.24(0.90-1.70)	1.12(0.81-1.54)	1.26(0.94-1.71)	
High fat dietary pattern (Refined Grains- Eggs and Poultry), n	1383	1382	1383	1382	1383	0.56
	1.00	1.03(0.75- 1.41)	1.22(0.91-1.65)	0.92(0.67-1.26)	1.17(0.87-1.58)	

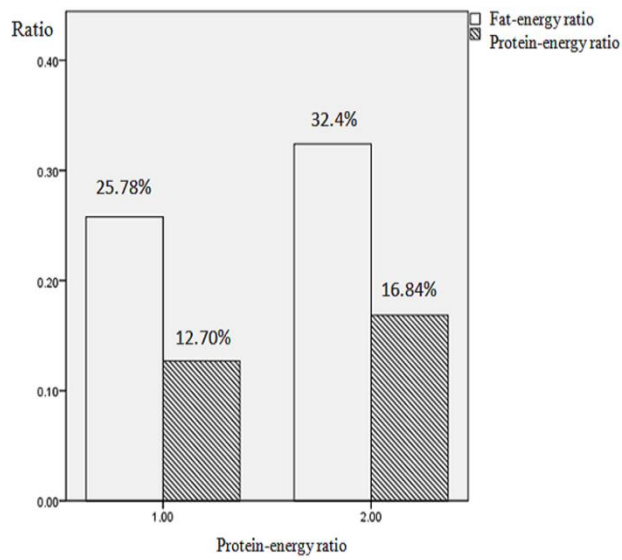
Note: Model was adjusted for age, gender, education, smoking, alcohol consumption, total energy, physical activity and ethnicity.



A



B



C

Supplementary Figure 1: The distrubution of fat-energy ratio and protein-energy ratio in different level of macronutrients subgroups.

Supplementary Table 7. The percentage of participants reaching the recommended nutrient intake (RNI) of micronutrients according to the quartiles of energy-adjusted refined grains intake.

	Q1	Q2	Q3	Q4	<i>P</i> Value
N	1728	1729	1728	1728	
Iron	92.4%	68.8%	72.1%	77.7%	<0.01
Calcium	73.4%	40.7%	32.1%	23.2%	<0.01
Phosphorus	98.4%	84.0%	85.2%	90.4%	<0.01
Magnesium	94.1%	67.0%	70.0%	72.2%	<0.01
Potassium	94.4%	65.2%	63.1%	54.8%	<0.01
Sodium	97.5%	88.7%	87.8%	84.8%	<0.01
Iodine	32.2%	31.6%	36.1%	40.4%	<0.01
Zinc	80.9%	53.9%	59.5%	63.0%	<0.01
Vitamin A	85.1%	61.8%	52.8%	42.2%	<0.01
Vitamin E	99.7%	96.9%	95.1%	91.9%	<0.01
Vitamin B1	60.5%	32.6%	35.2%	40.3%	<0.01
Vitamin B2	99.7%	96.9%	95.1%	91.9%	<0.01
Vitamin B3	92.4%	68.9%	74.9%	80.9%	<0.01
Vitamin C	89.3%	62.5%	55.3%	42.3%	<0.01

Note: *P* Values were determined using χ^2 test for categorical variables.

Supplementary Table 8. Association between refined grains intake and general obesity in total participants.

	Q1	Q2	Q3	Q4	P for trend
	OR(95% CI)				
Model 1	1.00	1.376(1.022,1.852)	1.199(0.866,1.659)	1.218(0.832,1.782)	0.207
Model 2	1.00	1.382(1.028,1.859)	1.192(0.862,1.648)	1.210(1.827,1.770)	0.188
Model 3	1.00	1.378(1.024,1.855)	1.205(0.870,1.670)	1.231(0.837,1.808)	0.206
Model 4	1.00	1.375(1.022,1.850)	1.196(0.864,1.655)	1.209(0.826,1.771)	0.205
Model 5	1.00	1.377(1.023,1.852)	1.194(0.863,1.652)	1.215(0.830,1.777)	0.202
Model 6	1.00	1.374(1.022,1.848)	1.198(0.867,1.657)	1.234(0.844,1.806)	0.210
Model 7	1.00	1.376(1.022,1.852)	1.199(0.866,1.659)	1.218(0.833,1.783)	0.207
Model 8	1.00	1.380(1.025,1.859)	1.224(0.884,1.696)	1.274(0.868,1.870)	0.211
Model 9	1.00	1.374(1.021,1.850)	1.197(0.865,1.657)	1.215(0.830,1.779)	0.209
Model 10	1.00	1.374(1.020,1.851)	1.187(0.857,1.644)	1.191(0.812,1.746)	0.200
Model 11	1.00	1.368(1.016,1.842)	1.194(0.863,1.652)	1.216(0.831,1.779)	0.223
Model 12	1.00	1.374(1.020,1.852)	1.197(0.863,1.661)	1.216(0.827,1.787)	0.210
Model 13	1.00	1.377(1.023,1.854)	1.198(0.865,1.658)	1.214(0.829,1.778)	0.203
Model 14	1.00	1.375(1.021,1.851)	1.203(0.869,1.666)	1.226(0.837,1.797)	0.212
Model 15	1.00	1.376(1.022,1.852)	1.201(0.868,1.662)	1.225(0.836,1.795)	0.208

Note: Model 1 adjusted for age, gender, total energy, fat, protein, fiber, cholesterol, drinking alcohol, smoking status and physical activity, education and ethnicity; Model 2 adjusted for Model 1+Fe; Model 3 adjusted for Model 1+Ca; Model 4 adjusted for Model 1+P; Model 5 adjusted for Model 1+Mg; Model 6 adjusted for Model 1+K; Model 7 adjusted for Model 1+Na; Model 8 adjusted for Model 1+I; Model 9 adjusted for Model 1+Zn; Model 10 adjusted for Model 1+ Vitamin A; Model 11 adjusted for Model 1+ Vitamin E; Model 12 adjusted for Model 1+ Vitamin B1; Model 13 adjusted for Model 1+ Vitamin B2; Model 14 adjusted for Model 1+ Vitamin B3; Model 15 adjusted for Model 1+ Vitamin C; OR, Odds Ratio; CI, confidence intervals; **OR>1, increasing the likelihood of general obesity; OR<1, decreasing the likelihood of general obesity.**

Supplementary Table 9. Association between refined grains intake and abdominal obesity in total participants.

	Q1	Q2	Q3	Q4	P for trend
	OR(95% CI)				
Model 1	1.00	1.202(0.997,1.449)	1.328(1.088,1.622)	1.393(1.103,1.760)	0.025
Model 2	1.00	1.202(0.997,1.450)	1.328(1.087,1.622)	1.393(1.103,1.759)	0.025
Model 3	1.00	1.238(1.021,1.502)	1.406(1.126,1.755)	1.548(1.154,2.077)	0.017
Model 4	1.00	1.202(0.997,1.449)	1.327(1.086,1.620)	1.388(1.099,1.754)	0.027
Model 5	1.00	1.202(0.997,1.449)	1.328(1.087,1.622)	1.393(1.103,1.759)	0.025
Model 6	1.00	1.202(0.996,1.450)	1.327(1.086,1.622)	1.368(1.082,1.729)	0.032
Model 7	1.00	1.202(0.997,1.449)	1.329(1.088,1.623)	1.394(1.104,1.761)	0.025
Model 8	1.00	1.203(0.997,1.450)	1.334(1.091,1.630)	1.404(1.110,1.776)	0.022
Model 9	1.00	1.200(0.995,1.447)	1.325(1.084,1.618)	1.387(1.098,1.752)	0.028
Model 10	1.00	1.244(1.025,1.509)	1.407(1.128,1.756)	1.546(1.155,2.069)	0.016
Model 11	1.00	1.206(1.000,1.455)	1.332(1.090,1.627)	1.394(1.104,1.761)	0.024
Model 12	1.00	1.212(1.004,1.463)	1.346(1.100,1.647)	1.419(1.121,1.797)	0.018
Model 13	1.00	1.207(1.000,1.456)	1.319(1.079,1.612)	1.371(1.085,1.732)	0.035
Model 14	1.00	1.201(0.996,1.449)	1.333(1.091,1.629)	1.403(1.110,1.773)	0.022
Model 15	1.00	1.200(0.995,1.448)	1.316(1.077,1.608)	1.350(1.068,1.707)	0.043

Note: Model 1 adjusted for age, gender, total energy, fat, protein, fiber, cholesterol, drinking alcohol, smoking status and physical activity, education and ethnicity; Model 2 adjusted for Model 1+Fe; Model 3 adjusted for Model 1+Ca; Model 4 adjusted for Model 1+P; Model 5 adjusted for Model 1+Mg; Model 6 adjusted for Model 1+K; Model 7 adjusted for Model 1+Na; Model 8 adjusted for Model 1+I; Model 9 adjusted for Model 1+Zn; Model 10 adjusted for Model 1+ Vitamin A; Model 11 adjusted for Model 1+ Vitamin E; Model 12 adjusted for Model 1+ Vitamin B₁; Model 13 adjusted for Model 1+ Vitamin B₂; Model 14 adjusted for Model 1+ Vitamin B₃; Model 15 adjusted for Model 1+ Vitamin C; OR, Odds Ratio; CI, confidence intervals; **OR>1, increasing the likelihood of abdominal obesity; OR<1, decreasing the likelihood of abdominal obesity.**