Web Material

Meat, dietary heme iron and risk of type 2 diabetes: The Singapore Chinese Health Study

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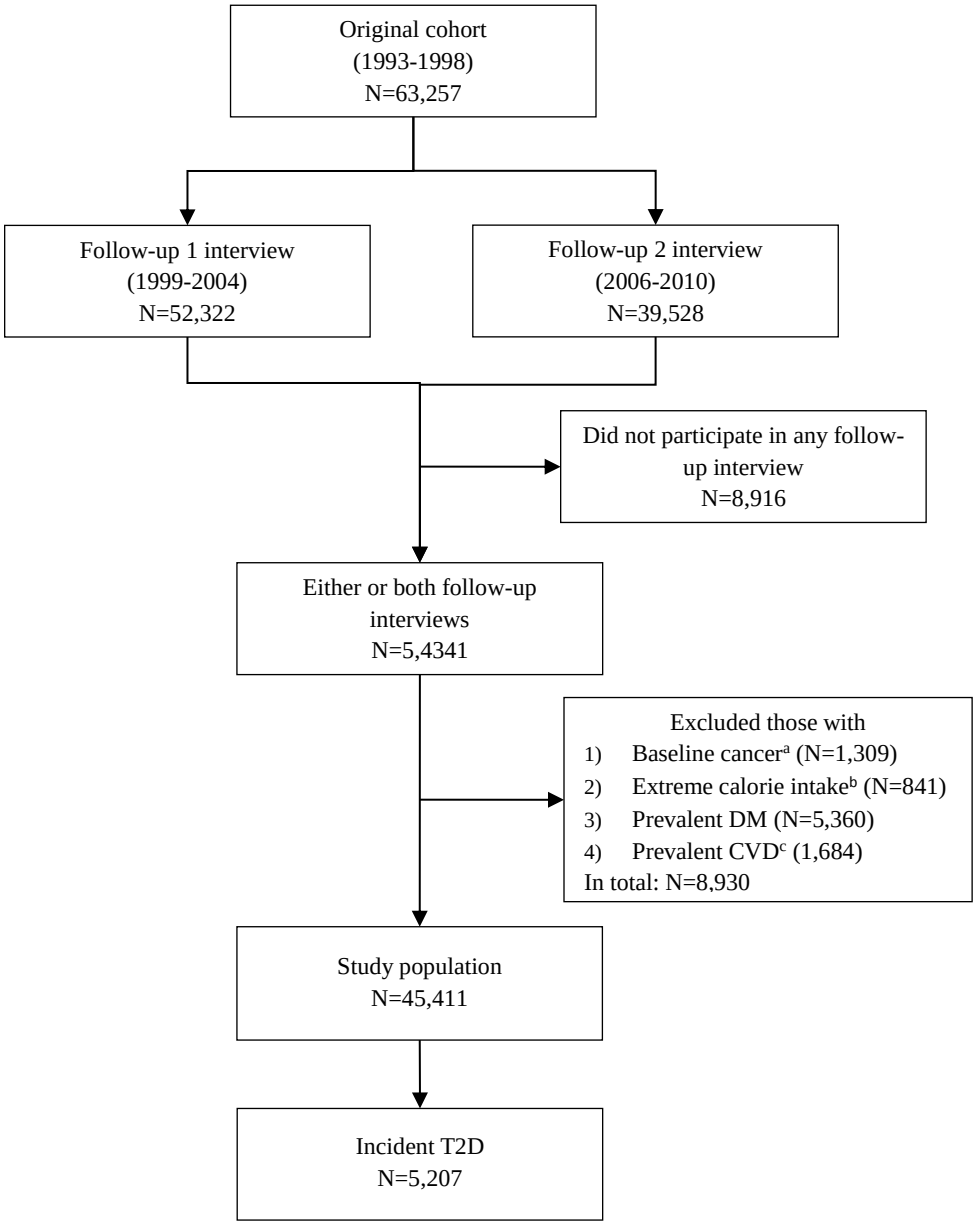
Web Appendix 1: FFQ items regarding different meat types

Participants were asked about their red meat intake through eight items comprising of "minced pork (or beef) patty and ball", "pork spareribs including bak kut teh", "pork satay", "other lean and fat pork slices, chops or cubes", "lean pork slices including char siew", "belly pork including siew yoke, pig trotters and pig skin", "pork liver", "mutton curry or mutton rendang", and "other pig organs such as intestines". Seven poultry items were listed as "deep fried chicken", "pan or stir fried chicken", "soy sauce chicken", "chicken satay", "boiled, stewed or roasted chicken", "chicken curry or chicken rendang", and "roasted or stewed duck or goose". The intakes of fresh fish and shellfish were asked through 6 items, "fish ball or cake", "deep fried fish", "pan or stir fried fish", "boiled or steamed fish", "shrimp or prawn", and "squid or cuttlefish". Intake of preserved or processed meat foods were also asked in 12 items comprising "Chinese sausage", "ham", "hot dog (pork or chicken)", "luncheon meat", "meat floss", "sweet barbeque meat", "salted fish", "anchovy", "dried fish", "other dried seafood", "canned tuna", and "canned sardine".

Web Figure 1: Participant flow



[a] Cancer history was identified either through self-report or via linkage with the nationwide Singapore Cancer Registry at baseline;

[b] <600 or >3000 kcal/d for women and <700 or >3700 kcal/d for men (>3 SDs higher or lower than the mean);

[c] Based on self-reported history of coronary heart disease or stroke at recruitment.

Web Table 1: Hazard Ratio (95% confidence interval) of Incident Type 2 Diabetes according to Intakes of Different Meat Types, the Singapore Chinese Health Study, 1993-2010

	Quartiles of meat intake				*P* for trend[a]
	Q1	**Q2**	**Q3**	**Q4**	
Red meat					
Median intake, g/d	12.3	24.2	33.4	48.8	
Cases/person-years	1,240/127,885	1,290/123,383	1,215/121,781	1,462/121,692	
Model 1[b]	1.00	1.07 (0.99, 1.16)	1.02 (0.94, 1.11)	1.24 (1.15, 1.34)	<0.001
Model 2[c]	1.00	1.07 (0.99, 1.16)	1.02 (0.94, 1.11)	1.23 (1.14, 1.33)	<0.001
Model 3[d]	1.00	1.02 (0.93, 1.12)	0.96 (0.87, 1.06)	1.13 (1.01, 1.25)	0.02
Poultry					
Median intake, g/d	5.8	14.7	21.9	35.9	
Cases/person-years	1,224/123,045	1,292/121,730	1,283/122,589	1,408/127,377	
Model 1[b]	1.00	1.06 (0.98, 1.15)	1.06 (0.98, 1.15)	1.14 (1.06, 1.23)	0.001
Model 2[c]	1.00	1.09 (1.00, 1.18)	1.08 (1.00, 1.18)	1.15 (1.06, 1.24)	0.001
Model 3[d]	1.00	1.04 (0.95, 1.13)	1.00 (0.91, 1.10)	1.01 (0.91, 1.12)	0.97
Fish/shellfish					
Median intake, g/d	27.9	45.3	60.2	82.7	
Cases/person-years	1,239/122,515	1,267/122,309	1,284/125,094	1,417/124,823	
Model 1[b]	1.00	1.02 (0.94, 1.10)	1.01 (0.93, 1.09)	1.12 (1.04, 1.21)	0.003
Model 2[c]	1.00	1.00 (0.93, 1.09)	0.96 (0.89, 1.04)	1.07 (0.99, 1.16)	0.12
Model 3[d]	1.00	0.97 (0.90, 1.05)	0.92 (0.85, 1.00)	1.00 (0.92, 1.09)	0.98

[a] Linear trend was tested by treating the median intake values of quartiles as a continuous variable using cox proportional hazards models;

[b] Multivariate model 1: adjusted for age, sex, dialect, year of interview, and educational level;

[c] Multivariate model 2: further adjusted for body mass index, physical activity, smoking status, alcohol use, baseline history of self-reported hypertension, vegetables–fruit–soy dietary pattern, and total energy intake;

[d] Multivariate model 3: further adjusted for heme iron intake.

Web Table 2: Hazard ratio (95% confidence interval) of incident type 2 diabetes according to intakes of fresh or preserved meat

	Quartiles of meat intake				P for trend[a]
	Q1	Q2	Q3	Q4	
Fresh red meat					
Median intake, g/d	10.5	20.7	29.0	43.5	
Cases/person-years	1,239/127,522	1,302/122,599	1,208/122,636	1,458/121,984	
Model 1[b]	1.00	1.09 (1.01, 1.18)	1.00 (0.93, 1.09)	1.22 (1.14, 1.32)	<0.001
Model 2[c]	1.00	1.09 (1.01, 1.19)	1.01 (0.93, 1.10)	1.22 (1.13, 1.31)	<0.001
Model 3[d]	1.00	1.04 (0.95, 1.14)	0.94 (0.85, 1.03)	1.11 (1.00, 1.23)	0.04
Red organ meat					
Median intake, g/d	0	0.5	0.96	2.40	
Cases/person-years	1302/129172	1322/125207	1298/120324	1285/120038	
Model 1[b]	1.00	1.04 (0.96, 1.12)	1.05 (0.97, 1.14)	1.06 (0.98, 1.14)	0.15
Model 2[c]	1.00	1.09 (1.00, 1.19)	1.11 (1.01, 1.22)	1.11 (1.02, 1.21)	0.02
Model 3[d]	1.00	1.06 (0.97, 1.15)	1.04 (0.94, 1.14)	1.02 (0.93, 1.12)	0.90
Preserved red meat					
Median intake, g/d	0	1.4	2.57	5.39	
Cases/person-years	1,318/128,168	1,286/125,362	1,290/121,244	1,313/119,967	
Model 1[b]	1.00	0.99 (0.92, 1.07)	1.02 (0.94, 1.10)	1.07 (0.99, 1.16)	0.05
Model 2[c]	1.00	0.99 (0.91, 1.08)	1.03 (0.94, 1.12)	1.09 (1.00, 1.18)	0.02
Model 3[d]	1.00	0.98 (0.90, 1.07)	1.00 (0.92, 1.10)	1.05 (0.97, 1.15)	0.15
Fresh fish/shellfish					
Median intake, g/d	25.4	42.3	57.2	79.4	
Cases/person-years	1,235/122,467	1,272/121,981	1,271/125,347	1,429/124,946	
Model 1[b]	1.00	1.03 (0.95, 1.11)	1.00 (0.93, 1.08)	1.14 (1.05, 1.23)	0.002
Model 2[c]	1.00	1.02 (0.94, 1.10)	0.95 (0.88, 1.03)	1.09 (1.01, 1.17)	0.07
Model 3[d]	1.00	0.99 (0.91, 1.07)	0.91 (0.84, 0.99)	1.02 (0.93, 1.10)	0.89
Preserved fish/shellfish					
Median intake, g/d	0.23	1.70	2.96	5.78	
Cases/person-years	1,304/125,801	1,254/123,735	1,314/121,103	1,335/124,102	
Model 1[b]	1.00	0.97 (0.89, 1.14)	1.03 (0.95, 1.11)	1.03 (0.95, 1.11)	0.22
Model 2[c]	1.00	1.00 (0.92, 1.08)	1.07 (0.98, 1.16)	1.06 (0.98, 1.14)	0.07
Model 3[d]	1.00	0.98 (0.90, 1.06)	1.04 (0.95, 1.13)	1.03 (0.95, 1.12)	0.28

[a] Linear trend was tested by treating the median intake values of quartiles as a continuous variable;

[b] Multivariate model 1: adjusted for age, sex, dialect, year of interview, and educational level;

[c] Multivariate model 2: further adjusted for body mass index, physical activity, smoking status, alcohol use, baseline history of self-reported hypertension, meat–dim sum dietary pattern, vegetables–fruit–soy dietary pattern, and total energy intake;

[d] Multivariate model 3: further adjusted for heme iron intake.

Web Table 3: Hazard Ratio (95% confidence interval) of Incident Type 2 Diabetes according to Intakes of Heme Iron, the Singapore Chinese Health Study, 1993-2010

	Quartiles of iron intake				*P* for trend[a]
	Q1	**Q2**	**Q3**	**Q4**	
Heme Iron					
Median intake, mg/d	0.21	0.37	0.47	0.64	
Cases/person-years	1,181/124,549	1,297/ 122,350	1,283/123,337	1,446/124,505	
Model 1[b]	1.00	1.11 (1.03, 1.21)	1.10 (1.01, 1.19)	1.24 (1.15, 1.34)	<0.001
Model 2[c]	1.00	1.11 (1.03, 1.21)	1.10 (1.02, 1.20)	1.24 (1.14, 1.34)	<0.001
Model 3[d]	1.00	1.11 (1.02, 1.21)	1.10 (1.01, 1.20)	1.23 (1.13, 1.34)	<0.001
Model 3[d] + poultry and fish	1.00	1.11 (1.01, 1.21)	1.10 (0.99, 1.22)	1.23 (1.09, 1.38)	0.001
Model 3[d] + red meat	1.00	1.10 (1.00, 1.21)	1.07 (0.96, 1.19)	1.14 (1.02, 1.28)	0.03
Non-heme Iron					
Median intake, mg/d	6.07	7.25	8.10	9.38	
Cases/person-years	1,347/127,128	1,314/ 124,655	1,251/122,778	1,295/120,180	
Model 1[b]	1.00	0.99 (0.92, 1.07)	0.97 (0.89, 1.05)	1.04 (0.96, 1.12)	0.45
Model 2[c]	1.00	1.01 (0.93, 1.09)	0.97 (0.89, 1.05)	1.02 (0.94, 1.11)	0.77
Model 3[d]	1.00	0.98 (0.90, 1.07)	0.92 (0.83, 1.01)	0.94 (0.83, 1.06)	0.26
Model 3[d] + poultry and fish	1.00	0.98 (0.90, 1.07)	0.93 (0.84, 1.02)	0.96 (0.85, 1.08)	0.44
Model 3[d] + red meat	1.00	0.97 (0.89, 1.06)	0.93 (0.84, 1.02)	0.97 (0.86, 1.09)	0.56

[a] Linear trend was tested by treating the median intake values of quartiles as a continuous variable using cox proportional hazards models;

[b] Multivariate model 1: adjusted for age, sex, dialect, year of interview, and educational level;

[c] Multivariate model 2: further adjusted for body mass index, physical activity, smoking status, alcohol use, baseline history of self-reported hypertension, vegetables–fruit–soy dietary pattern, and total energy intake;

[d] Multivariate model 3: except for dietary patterns, further adjusted for dietary intakes of egg, soy, non-soy legumes, vegetables, fruit, noodles, rice, nuts and seeds, coffee, and soda.

Web Table 4: Hazard ratio (95% confidence interval) of incident type 2 diabetes according to intakes of different meat types in men and women

	Quartiles of meat intake				P for trend[a]
	Q1	Q2	Q3	Q4	
Men					
Red meat					
Median intake, g/d	9.5	23.3	34.1	52.5	
Cases/person-years	519/53,120	544/52,200	532/52,238	600/51,690	
Model 1[b]	1.00	1.07 (0.94, 1.21)	1.07 (0.94, 1.21)	1.18 (1.05, 1.33)	0.006
Model 2[c]	1.00	1.07 (0.93, 1.23)	1.11 (0.95, 1.29)	1.24 (1.05, 1.47)	0.008
Poultry					
Median intake, g/d	3.2	13.5	22.0	38.1	
Cases/person-years	515/52702	565/51563	557/52478	558/52505	
Model 1[b]	1.00	1.16 (1.02, 1.31)	1.13 (1.00, 1.29)	1.12 (0.99, 1.27)	0.14
Model 2[c]	1.00	1.15 (1.01, 1.31)	1.13 (0.98, 1.31)	1.11 (0.94, 1.30)	0.37
Fish/shellfish					
Median intake, g/d	23.9	42.5	58.7	82.6	
Cases/person-years	513/51,566	532/52,167	549/52,810	601/52,705	
Model 1[b]	1.00	1.00 (0.88, 1.13)	1.00 (0.88, 1.13)	1.05 (0.93, 1.19)	0.25
Model 2[c]	1.00	1.00 (0.89, 1.14)	1.00 (0.88, 1.13)	1.04 (0.91, 1.18)	0.42
Women					
Red meat					
Median intake, g/d	13.8	24.5	32.7	46.5	
Cases/person-years	691/71,779	726/70,984	718/72,004	877/70,726	
Model 1[b]	1.00	1.05 (0.95, 1.17)	1.02 (0.91, 1.13)	1.28 (1.16, 1.42)	<0.001
Model 2[c]	1.00	0.96 (0.85, 1.08)	0.88 (0.77, 1.00)	1.05 (0.91, 1.21)	0.26
Poultry					
Median intake, g/d	7.9	15.6	22.2	35.1	
Cases/person-years	703/71,989	753/71,299	741/71,475	815/70,730	
Model 1[b]	1.00	1.08 (0.97, 1.20)	1.09 (0.98, 1.21)	1.22 (1.10, 1.35)	<0.001
Model 2[c]	1.00	1.00 (0.89, 1.12)	0.96 (0.85, 1.09)	1.00 (0.88, 1.15)	0.96
Fish/shellfish					
Median intake, g/d	31.3	47.1	61.2	82.8	

Cases/person-years	728/70,809	730/70,813	746/71,945	808/71,926	
Model 1[b]	1.00	0.97 (0.87, 1.07)	0.95 (0.86, 1.06)	1.05 (0.95, 1.17)	0.29
Model 2[c]	1.00	0.92 (0.83, 1.02)	0.88 (0.80, 0.98)	0.95 (0.85, 1.05)	0.38

[a] Linear trend was tested by treating the median intake values of quartiles as a continuous variable;

[b] Multivariate model 1: adjusted for age, sex, dialect, year of interview, and educational level, body mass index, physical activity, smoking status, alcohol use, baseline history of self-reported hypertension, vegetables–fruit–soy dietary pattern, and total energy intake;

[c] Multivariate model 2: further adjusted for heme-iron intake.

Web Table 5: Hazard ratio (95% confidence interval) of incident type 2 diabetes according to intakes of heme iron in men and women

	Quartiles of iron intake				P for trend[a]
	Q1	**Q2**	**Q3**	**Q4**	
Men					
Heme Iron					
Median intake, g/d	0.18	0.36	0.48	0.68	
Cases/person-years	514/52,936	573/50,930	526/52,157	582/53,225	
Model 1[b]	1.00	1.15 (1.02, 1.30)	1.07 (0.93, 1.22)	1.15 (1.00, 1.32)	0.08
Model 1[b]+ Poultry and fish	1.00	1.11 (0.97, 1.27)	1.02 (0.87, 1.19)	1.11 (0.92, 1.33)	0.31
Model 1 [b]+ Red meat	1.00	1.11 (0.97, 1.28)	0.99 (0.84, 1.16)	1.01 (0.85, 1.20)	0.96
Non-heme Iron					
Median intake, g/d	5.46	6.85	7.78	9.13	
Cases/person-years	586/56,033	553/52,896	523/51,220	533/49,099	
Model 1[b]	1.00	1.01 (0.89, 1.15)	0.97 (0.83, 1.13)	0.98 (0.82, 1.17)	0.77
Model 1[b]+ Poultry and fish	1.00	1.00 (0.88, 1.14)	0.97 (0.83, 1.13)	0.99 (0.82, 1.19)	0.85
Model 1 [b]+ Red meat	1.00	1.00 (0.88, 1.14)	0.97 (0.83, 1.13)	0.99 (0.83, 1.19)	0.91
Women					
Heme Iron					
Median intake, g/d	0.24	0.37	0.47	0.61	
Cases/person-years	659/72,409	737/70,680	749/70,736	867/71,668	
Model 1[b]	1.00	1.14 (1.02, 1.27)	1.17 (1.04, 1.31)	1.32 (1.18, 1.49)	<0.001
Model 1[b]+ Poultry and fish	1.00	1.17 (1.04, 1.32)	1.22 (1.07, 1.40)	1.37 (1.18, 1.60)	<0.001
Model 1 [b]+ Red meat	1.00	1.16 (1.03, 1.32)	1.20 (1.04, 1.37)	1.30 (1.12, 1.51)	0.001
Non-heme Iron					
Median intake, g/d	6.59	7.53	8.29	9.51	
Cases/person-years	772/72,835	749/71,786	722/71,134	769/69,738	
Model 1[b]	1.00	0.99 (0.89, 1.10)	0.95 (0.84, 1.08)	1.03 (0.88, 1.19)	0.75
Model 1[b]+ Poultry and fish	1.00	1.00 (0.89, 1.11)	0.97 (0.85, 1.10)	1.06 (0.91, 1.23)	0.46
Model 1 [b]+ Red meat	1.00	1.00 (0.89, 1.12)	0.98 (0.86, 1.11)	1.08 (0.92, 1.25)	0.35

[a] Linear trend was tested by treating the median intake values of quartiles as a continuous variable;

[b] Multivariate model 1: adjusted for age, sex, dialect, year of interview, educational level, body mass index, physical activity, smoking status, alcohol use, baseline history of self-reported hypertension, total energy intake, dietary intakes of egg, soy, non-soy legumes, vegetables, fruit, noodles, rice, nuts and seeds, coffee, and soda.