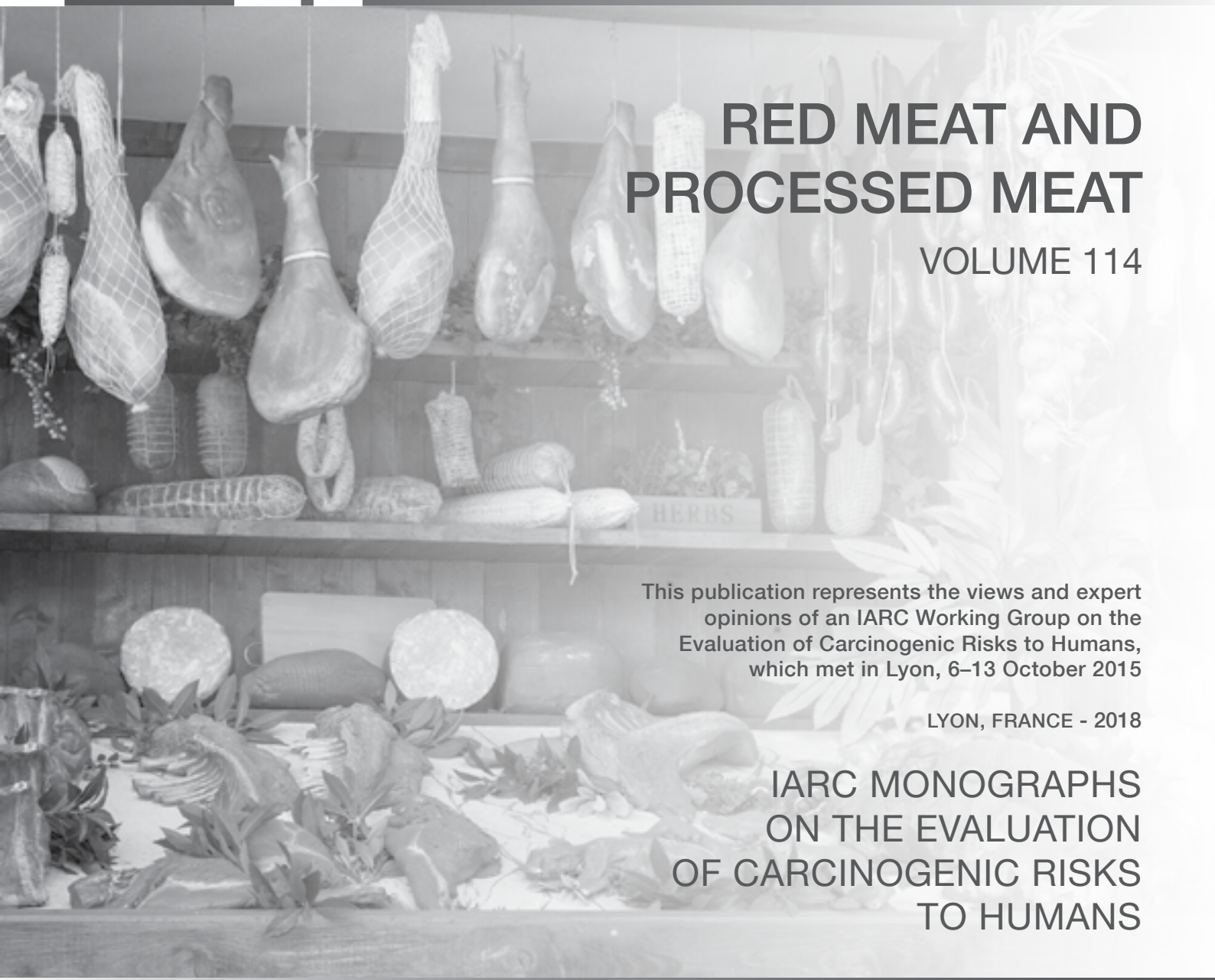
IARC MONOGRAPHS



RED MEAT AND PROCESSED MEAT

VOLUME 114

This publication represents the views and expert opinions of an IARC Working Group on the Evaluation of Carcinogenic Risks to Humans, which met in Lyon, 6–13 October 2015

LYON, FRANCE - 2018

IARC MONOGRAPHS ON THE EVALUATION OF CARCINOGENIC RISKS TO HUMANS

International Agency for Research on Cancer

World Health Organization

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Lubin et al. (1981) Alberta, Canada 1976–1977 population-based Case-Control	**Cases:** 577; Women aged 30–80 diagnosed with breast cancer in northern Alberta, from Alberta Cancer Registry **Controls:** 826; Age-stratified disease free women selected from the general population **Exposure assessment method:** Questionnaire; FFQ covered the frequency of consumption (never, not more than once per month, more than once per month but less than once per week, 1–3 days per week, 4–6 days per week, and daily) of eight food items including beef, other red meat, and pork.	Breast	Beef consumption: never – 3 days a week	197	1	Age
			4–6 days/week	274	2.25 (1.8–2.9)	
			Daily	87	1.53 (1.1–2.1)	
			Trend-test p-value:	< 0.001		
		Breast Cancer	Pork consumption: ≤ 1day/month	112	1	Age
			> 1day/month – < 1 day/week	120	1.76 (1.3–2.5)	
			≥ 1 day/week	320	2.16 (1.6–2.9)	
			Trend-test p-value:	< 0.001		
Hislop et al. (1986) British Columbia, Canada 1980–1982 population-based Case-Control	**Cases:** 846; Women under 70 years of age who were registered with breast cancer in the British Columbia Cancer Registry during 1980–1982. **Controls:** 862; A pool of age frequency-matched controls with no personal history of breast cancer was created from the neighbours or acquaintances of the cases. **Exposure assessment method:** Questionnaire; 31-food item FFQ. 4 time periods: childhood, teens, young adulthood, older adulthood. 4 frequency categories. Meat products included ground beef, bacon, ham, sausage, salami, fried sausage.	Breast	Beef, less than daily	657	1	Age
			Daily	163	1.47 (1.12–1.92)	
		Breast	Pork, less than weekly	287	1	Age
			Weekly	511	1.13 (0.92–1.39)	

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Toniolo et al. (1989) Province of Verecelli, Italy 1983–1984 population-based Case-Control	**Cases:** 250; Women age < 75 years, residents of the province of Verecelli, diagnosed with a microscopically confirmed invasive breast cancer, free of local or distant metastases, except in the regional lymph nodes. **Controls:** 499; A stratified random sample of the province's female residents chosen from local electoral rolls, frequency-matched to the cases within 10 year age strata in an approximately 2:1 ratio. **Exposure assessment method:** other; Italian modification of French INSERM dietary history questionnaire with 70 food categories. Means of intake were weighted on the basis of available estimated frequencies of consumption of specific components: lean pork, 2/3 ribs and 1/3 ham; horse and veal meat; cured meat products, all considered derived from pork; offal, 50% liver and 50% other; beef and mutton, 90% beef and 10% mutton.	Breast	Offal, Tertile 1	1.0	-	Age and calories
			Tertile 2	1.3	-	
			Tertile 3	0.9	-	
Ewertz and Gill (1990) Denmark 1983–1984 (1 year) population-based Case-Control	**Cases:** 1474; Women aged < 70 years identified from the Danish Cancer Registry and the nationwide clinical trial of the Danish Breast Cancer Cooperative Group. **Controls:** 1322; Age-stratified random sample of the general female population, selected from the Central Population Register. **Exposure assessment method:** Questionnaire; Self-administered semiquantitative FFQ, mailed 1 year after diagnosis. Colour photographs for portion sizes. Red or processed meat are not defined. Meat (hot dishes and	Breast	Pork-lean: Quartile 1	307	1	Age at diagnosis and place of residence
			Quartile 2	245	1.11 (0.86–1.42)	
			Quartile 3	182	1.16 (0.88–1.53)	
			Quartile 4	504	0.99 (0.81–1.22)	

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
	sandwich fillings), pork, meatballs and liver are mentioned.	Breast	Pork-medium-fat: Quartile 1	224	1	Same as above
			Quartile 2	319	1.13 (0.88–1.45)	
			Quartile 3	298	1.42 (1.1–1.83)	
			Quartile 4	366	1.34 (1.05–1.71)	
		Breast	Pork-fatty: Category 1	589	1	Same as above
			Category 2	282	0.99 (0.81–1.22)	
			Category 3	330	1.08 (0.88–1.32)	
		Breast	Liver,			Same as above
			category 1	533	1	
			Category 2	293	1.09 (0.88–1.34)	
			Category 3	310	0.89 (0.73–1.09)	

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Matos et al. (1991) Buenos Aires, Argentina 1979–1981 Case-Control	**Cases:** 196; Women age ≤□75 years (mean age 54 y) with newly diagnosed histologically confirmed breast cancer, who underwent surgery in the Institute of Oncology. **Controls:** 205; Women without a history of breast cancer who were friends or consanguineous family members of the cases. **Exposure assessment method:** Questionnaire; 40-food item FFQ including beef, pork meat and meat products, lamb; 6 levels of frequency; 20 years diet recall. Meat cooking methods recorded: deep frying, barbecuing, baking, boiling, stewing.	Breast	Beef intake, all methods of cooking:			Age, age at first birth, years of schooling
			0–3 times/week	23	1	
			4–7 times/week	101	1.2 (0.6–2.5)	
			> 7 times/week	72	1.4 (0.7–2.9)	
			Trend-test p-value: 0.3			
		Breast	Deep fried beef intake:			Same as above
			1–3 times/week	10	5.7 (0.7–44.2)	
			4–7 times/week	49	1.2 (0.6–2.3)	
			> 7 times/week	51	1.2 (0.5–2.6)	
		Breast cancer	Barbecued beef intake:			Same as above
			0–1 times/week	37	1	
			2–3 times/week	53	1.2 (0.6–2.2)	
			4–5 times/week	51	1.5 (0.8–2.9)	
			6–14 times/week	42	1 (0.5–1.98)	
		Breast	Beef, fried: never	74	1	Same as above
			Ever	113	1.5 (0.9–2.4)	
		Breast	Beef, other cooking method: < 1 time/week	43	1	Same as above
			1 time/week	30	1.1 (0.6–2.3)	
			2 times/week	33	0.7 (0.3–1.4)	
			> 2 times/week	78	1.2 (0.6–2.2)	

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Lee et al. (1992) Singapore 1986–1988 for cases, 1986–1990 for controls, hospital-based Case-Control	**Cases:** 200; Women aged 24–88 years with histologically confirmed breast cancer at Singapore General Hospital and the National University Hospital. **Controls:** 420; Women admitted to general surgery, eye, and orthopaedic wards in the same hospitals with approximately the same age distribution as the cases. **Exposure assessment method:** Questionnaire; 90-food FFQ- interview. 1-year dietary recall. Red meat intake was mostly pork, included also beef and mutton.	Breast	Premeonpausal, Red Meat (g/day), < 22.0	19	1	Age, age at first birth
			22.0–48.5	36	1.8 (0.9–3.5)	
			> 48.6	54	2.6 (1.3–4.9)	
			Trend-test p-value:	0.003		
		Breast	Postmenopausal, Red Meat (g/day), < 22.0	32	1	Age, nulliparity, height, education, and family history of breast cancer
			22.0–48.5	26	1 (0.5–2)	
			> 48.6	33	1.2 (0.6–2.4)	
			Trend-test p-value:	> 0.1		
Franceschi et al. (1995) Italy 1991–1994 hospital-based Case-Control	**Cases:** 2,569; Women aged 23–74 (median 55) years with histologically confirmed primary breast cancer diagnosed no longer than 1 year before the interview and with no previous diagnoses of cancer. **Controls:** 2,588; Female patients with no history of cancer admitted to major teaching and general hospitals in the same catchment areas of cases for acute, non-neoplastic, non-gynaecological conditions, unrelated to hormonal or digestive tract diseases, or to long-term modifications of diet. **Exposure assessment method:** Questionnaire; Validated 79 food item FFQ. Red meat included steak, roast beef, lean ground beef, boiled beef, beef or veal stew, wiener schnitzel, liver, pasta with meat sauce and with meat filling. Pork and processed meats included pork chop, prosciutto, ham, salami, and sausages.	Breast	Red meats (servings/wk), Q 1 (< 2.0)	NR	1	Age, centre, education, parity, energy and alcohol intake
			Q 2 (2.0 < 3.0)	NR	0.94 (0.79–1.12)	
			Q 3 (3.0 < 4.0)	NR	1.04 (0.87–1.24)	
			Q 4 (4.0 < 5.3)	NR	1.01 (0.84–1.21)	
			Q 5 (≥ 5.3)	NR	1.09 (0.9–1.31)	

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
De Stefani et al. (1997) Montevideo, Uruguay 1994–1996, hospital-based Case-Control	**Cases:** 352; Women with incident breast cancer diagnosed in the 6 major hospitals of Montevideo. **Controls:** 382; Women hospitalized in the same hospital for non-neoplastic diseases. **Exposure assessment method:** Questionnaire; 64 item FFQ interview, 2-year dietary recall. Red meat included beef, lamb and processed meat. Questionnaire included queries concerning meat cooking method (frying, broiling, barbecuing, and boiling).	Breast	Quartiles of red meat intake (servings/year) among all women			Age, residence, family history of breast cancer in a first-degree relative, age at menarche, parity, previous history of benign breast disease, total energy, vegetable intake, and fat intake.
			Q I (≤ 241)	56	1	
			Q II (242–386)	76	1.25 (0.77–2.05)	
			Q III (387–520)	99	1.76 (1.04–2.99)	
			Q IV (≥ 521)	121	2.62 (1.41–4.85)	
			Trend-test p-value: 0.001			
		Breast	Red Meat (servings/yr), Premenopausal, Q I (≤ 241)	9	1	Same as above
			Q II (242–386)	10	1.41 (0.38–5.29)	
			Q III (387–520)	24	2.13 (0.59–7.6)	
			Q IV (≥ 521)	32	3.01 (0.77–11.7)	
			Trend-test p-value: 0.09			
		Breast	Red Meat (servings/yr), Postmenopausal, Q I (≤ 241)	47	1	Same as above
			Q II (242–386)	66	1.29 (0.75–2.23)	
			Q III (387–520)	75	1.57 (0.86–2.89)	
			Q IV (≥ 521)	89	2.79 (1.35–5.75)	
			Trend-test p-value: 0.006			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
		Breast	Beef (servings/yr), All subject Q I (≤ 154)	54	1	Same as above
			Q II (155–234)	85	1.23 (0.76–1.99)	
			Q III (235–364)	98	2.09 (1.23–3.55)	
			Q IV (≥ 365)	115	3.84 (2.09–7.05)	
			Trend-test p-value: < 0.001			
		Breast	Beef (servings/yr), Premenopausal, Q I (≤ 154)	7	1	Same as above
			Q II (155–234)	20	1.91 (0.57–6.41)	
			Q III (235–364)	21	2.41 (0.69–8.41)	
			Q IV (≥ 365)	27	2.6 (0.69–9.82)	
			Trend-test p-value: 0.16			
		Breast	Beef (servings/yr), Postmenopausal, Q I (≤ 154)	47	1	Same as above
			Q II (155–234)	65	1.15 (0.67–1.97)	
			Q III (235–364)	77	2.02 (1.1–3.73)	
			Q IV (≥ 365)	88	4.75 (2.3–9.79)	
			Trend-test p-value: < 0.001			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
		Breast	Lamb (servings/yr), All subjects, Tertile I (≤ 12)	276	1	Same as above
			Tertile II (13–52)	24	1.05 (0.56–1.99)	
			Tertile III (≥ 53)	52	2.38 (1.27–4.47)	
			Trend-test p-value:	0.01		
		Breast	Lamb (servings/yr), Premenopausal, Tertile I (≤ 12)	56	1	Same as above
			Tertile II (13–52)	7	1.32 (0.32–5.36)	
			Tertile III (≥ 53)	12	1.45 (0.4–5.28)	
			Trend-test p-value:	0.53		
		Breast	Lamb, (servings/yr), Postmenopausal, Tertile I (≤ 12)	220	1	Same as above
			Tertile II (13–52)	17	0.88 (0.42–1.84)	
			Tertile III (≥ 53)	40	2.9 (1.34–6.27)	
			Trend-test p-value:	0.02		

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Witte et al. (1997) US and Canada (California, Connecticut, Quebec) 1957–1989, population-based Case-Control	**Cases:** 140; Survivors of bilateral premenopausal breast cancer with at least one sister who was alive in 1989, from a multicentre genetic epidemiology study of breast conducted in US and Canada in 1989. **Controls:** 222; Unaffected sisters (one or more) of the cases. **Exposure assessment method:** Questionnaire; 61 food item FFQ. 1-year dietary recall. Red meat was not defined.	Breast	Quartiles of red meat intake (median, servings/week)			Age, age at menarche, parity, oral contraceptive use, alcohol consumption, body mass index, and energy intake
			Q1 (4.5)	36	1	
			Q2 (7.7)	37	1.2 (0.6–2.5)	
			Q3 (9.9)	37	1 (0.5–1.9)	
			Q4 (14.1)	30	0.6 (0.3–1.3)	
			Trend-test p-value: 0.13			
Ambrosone et al. (1998) Erie and Niagara counties, New York, USA 1986–1991 Case-Control	**Cases:** 740; Caucasian women aged 40–85 years, diagnosed with incident, primary, histologically confirmed breast cancer, identified from all the major hospitals in Eire and Niagara counties. **Controls:** 810; Women under 65 years of age were randomly selected from the New York State Motor Vehicle Registry, and those 65 and over were identified from Health Care Finance Administration lists. **Exposure assessment method:** Questionnaire; Western New York Diet Study FFQ-interview by a trained interviewer, 2-year dietary recall, intake frequency and usual portion size of over 300 specific foods. Beef index included steak, round steak, hamburger patties, ground beef, other beef, including roasts and stews, veal, lamb and beef liver. Pork index included pork roast, chops and spareribs. Processed meats index included ham, hot dogs, sausages, bacon and cold cuts	Breast	Beef, Premenopausal: < 33 g/day	74	1	Age, education, age at menarche, age at first pregnancy, body mass index, family history of breast cancer, and total fruits and vegetables
			33–51 g/day	85	1.3 (0.8–2.1)	
			51–78 g/day	68	1 (0.6–1.6)	
			> 78 g/day	74	1.2 (0.8–1.9)	
			Trend-test p-value: 0.3			
		Breast	Beef, Postmenopausal: < 28 g/day	113	1	Same as above
			28–45 g/day	132	1.2 (0.8–1.7)	
			45–62 g/day	78	0.7 (0.5–1)	
			> 62 g/day	116	1 (0.7–1.4)	
			Trend-test p-value: 0.3			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
		Breast	Pork, Premenopausal: < 6 g/day	92	1	Same as above
			6–10 g/day	70	0.8 (0.5–1.2)	
			10–20 g/day	91	1 (0.6–1.5)	
			> 20 g/day	48	0.6 (0.4–1)	
			Trend-test p-value:	0.05		
		Breast	Pork, Postmenopausal: < 4 g/day	96	1	Same as above
			4–8 g/day	118	0.9 (0.6–1.3)	
			8–15 g/day	128	1 (0.7–1.4)	
			> 15 g/day	97	0.8 (0.5–1.2)	
			Trend-test p-value:	0.5		

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Männistö et al. (1999) Finland 1990–1995, population-based Case-Control	**Cases:** 310; Women aged 25–75 years, living in the catchment area of Kuopio University Hospital in 1990–1995, diagnosed with breast cancer following breast lump examination. **Controls:** 454 population controls; 506 referral controls; Two control groups: (1) women from the Finnish National Population Register. (2) women referred to breast examinations and declared healthy. **Exposure assessment method:** Questionnaire; 110 food item FFQ. 1 year dietary recall. Beef and pork were analysed.	Breast	1st versus 5th quintiles of beef and pork intake (< 37 versus > 77 g/day) among premenopausal women:			Age, area, age at menarche, age at first full-term pregnancy, use of oral contraceptives, use of estrogen replacement therapy, first-degree family history of breast cancer, history of benign breast disease, level of education, current alcohol intake, smoking habits, leisure activity and waist-to-hip ratio
			Using population controls	NR	0.6 (0.3–1.4)	
			Using referral controls	NR	0.5 (0.3–1.2)	
		Breast	1st versus 5th quintiles of beef and pork intake (< 29 versus > 68 g/day) among postmenopausal women:			Same as above
			Using population controls	NR	0.9 (0.5–1.7)	
			Using referral controls	NR	1 (0.5–2)	

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Tavani et al. (2000) Northern Italy 1983–1991, hospital-based Case-Control	**Cases:** 3,412; Women aged < 75 years with histologically confirmed cancer of the breast, admitted to the National Cancer Institute, to one of the university clinics or to the Ospedale Maggiore of Milan, which groups the 4 largest teaching and general hospitals in Milan. **Controls:** 7,990; Women admitted to the same network of hospitals as the cancer cases for a wide spectrum of acute non-neoplastic conditions. **Exposure assessment method:** Questionnaire; 2-year diet recall. A structured questionnaire asked frequency of intake of approximately 40 foods and total red meat consumption per week. Total red meat included beef, veal, and pork and excluded canned and preserved meat.	Breast	Red meat (portions/wk): ≤ 3	1091	1	Age, year of recruitment, sex, education, smoking habits and alcohol, fat, fruit and vegetable intakes.
			> 3 ≤ 6	1283	1.2 (1.1–1.4)	
			> 6	1038	1.2 (1.1–1.4)	
			Trend-test p-value: ≤ 0.01			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Dai et al. (2002) Shanghai, China 1996–1998, population-based Case-Control	**Cases:** 1459; Chinese women aged 25–64 years, residents of Shanghai, with a newly diagnosed breast cancer **Controls:** 1556; The Shanghai Resident Registry was used to randomly select controls from female residents, and frequency matched to cases by age. **Exposure assessment method:** Questionnaire; FFQ with 76 food items. Red meat included pork, beef, and lamb meats. No information was provided whether red meat included processed meat.	Breast	Never Deep Fried, Red Meat, ≤ 28.6 g/day	153	1	Age, education, family history of breast cancer, history of breast fibroadenoma, WHR, age at menarche, physical activity, ever had live birth, age at first live birth, menopausal status, age at menopause, and total energy
			≤ 44.6 g/day	118	0.9 (0.64–1.26)	
			≤ 62.2 g/day	129	1.01 (0.72–1.41)	
			≤ 87.1 g/day	110	0.84 (0.59–1.2)	
			> 87.1 g/day	165	1.49 (1.04–2.15)	
			Trend-test p-value: 0.11			
		Breast	Ever Deep Fried, Red Meat, ≤ 28.6 g/day	95	1	Same as above
			≤ 44.6 g/day	135	1.2 (0.84–1.71)	
			≤ 62.2 g/day	184	1.63 (1.15–2.3)	
			≤ 87.1 g/day	148	1.25 (0.88–1.78)	
			> 87.1 g/day	222	1.78 (1.24–2.55)	
			Trend-test p-value: 0.005			
		Breast	Well done Deep Fried, Red Meat, ≤ 28.6 g/day	81	1	Same as above
			≤ 44.6 g/day	122	1.31 (0.89–1.91)	
			≤ 62.2 g/day	164	1.71 (1.18–2.48)	
			≤ 87.1 g/day	133	1.44 (0.98–2.11)	
			> 87.1 g/day	200	1.92 (1.3–2.83)	
			Trend-test p-value: 0.002			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
		Breast	Red Meat, ≤ 28.6 g/day	NR	1	Same as above
			≤ 44.6 g/day	NR	1 (0.79–1.28)	
			≤ 62.2 g/day	NR	1.26 (0.98–1.59)	
			≤ 87.1 g/day	NR	1 (0.78–1.29)	
			> 87.1 g/day	NR	1.53 (1.19–1.96)	
			Trend-test p-value: 0.003			
Hermann et al. (2002) Freiburg and Rhine-Neckar-Odenwald, Germany 1992–1995; population-based Case-Control	**Cases:** 355; German-speaking women aged ≤ 50 years with incident in situ or invasive breast cancer. **Controls:** 838; Women randomly selected from population registries, matched by exact age and study region. **Exposure assessment method:** Questionnaire; 176-item validated FFQ similar to German EPIC FFQ. Food list based on German National Food Consumption Survey results. 1 year dietary recall. Red meat included beef, pork and lamb. Processed meat included liver sausage, sliced cold meat, sausages, salami, meat paste and meat in aspic.	Breast	Quartiles of red meat consumption (g/day)			Education, duration of breast feeding, 1st-degree family history of breast cancer, number of births, BMI, energy intake, alcohol consumption, and nonconsumer of each specific food group
			Q1 (1–21)	69	1	
			Q2 (22–39)	87	1.38 (0.94–2.02)	
			Q3 (40–64)	69	1.08 (0.71–1.62)	
			Q4 (≥ 65)	122	1.85 (1.23–2.78)	
			Trend-test p-value: 0.016			
		Breast cancer	Beef, 1–9 g/day	67	1	Same as above
			10–18 g/day	88	1.36 (0.92–1.99)	
			19–32 g/day	90	1.4 (0.95–2.06)	
			≥ 33 g/day	102	1.58 (1.06–2.36)	
			Trend-test p-value: 0.039			
		Breast cancer	Pork, 1–10 g/day	70	1	Same as above
			11–21 g/day	71	1.14 (0.76–1.7)	
			22–38 g/day	79	1.14 (0.77–1.69)	
			≥ 39 g/day	98	1.47 (0.98–2.21)	
			Trend-test p-value: 0.066			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Shannon et al. (2003) Western Washington, USA 1988–1990, population-based Case-Control	**Cases:** 441; Postmenopausal, white women, aged 50–64 years, diagnosed with breast cancer (in situ or invasive) and resided in King County, Washington, USA. **Controls:** 370; Frequency age-matched controls identified by random-digit dialing. **Exposure assessment method:** Questionnaire; FFQ with 95 food items. It was unclear whether red meat included processed meat or not.	Breast	Red Meat (servings/d), Q1, 0–0.29	92	1	Age, total energy intake, number of pregnancies and highest level of education
			Q2, > 0.29–0.51	92	1.12 (0.73–1.7)	
			Q3, > 0.51–0.82	106	1.35 (0.87–2.08)	
			Q4, > 0.82	151	2.03 (1.28–3.22)	
			Trend-test p-value:	0.002		
Brandt et al. (2004) Freiburg and Rhein-Neckar-Odenwald, Germany 1992–1995 population-based Case-Control	**Cases:** 311; German-speaking women aged ≤ 50 years with incident in situ or invasive breast cancer. **Controls:** 689; Women randomly selected from population registries, matched by exact age and study region. **Exposure assessment method:** Questionnaire; 176-item validated FFQ similar to German EPIC FFQ. Food list based on German National Food Consumption Survey results. 1 year dietary recall. Red meat included beef, pork and lamb. Processed meat included liver sausage, sliced cold meat, sausages, salami, meat paste and meat in aspic.	Breast	Quartiles of red meat consumption (g/day) among women with long/long EGFR genotype			Number of full-term pregnancies, age at menarche, duration of breastfeeding, menopausal status, and family history, alcohol consumption
			Q1 (1–21)	6	1	
			Q2 (22–39)	3	1.2 (0.12–12.4)	
			Q3 (40–64)	4	1.3 (0.16–10.58)	
			Q4 (≥ 65)	14	10.68 (1.57–72.58)	
			Trend-test p-value:	0.03		
		Breast	Red Meat, (EGFR, short/long allele): 1–21 g/day	39	1	Same as above
			22–39	33	1.1 (0.61–1.96)	
			40–64	30	0.97 (0.54–1.74)	
			≥ 65	27	1.07 (0.57–2.05)	
			Trend-test p-value:	0.95		

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
		Breast	Red Meat, (EGFR, short/short allele), 1–21 g/day	47	1	Same as above
			22–39	29	0.71 (0.41–1.23)	
			40–64	32	1.39 (0.78–2.5)	
			≥ 65	41	1.86 (1.06–3.27)	
			Trend-test p-value:	0.02		
Shannon et al. (2005) Shanghai, China 1995–2000, population-based Case-Control	**Cases:** 378; Textile factory workers born 1925–1958, participants of a breast self-examination trial and diagnosed with histologically confirmed breast cancer. **Controls:** 1070; Controls were selected from the unaffected women in the BSE trial cohort and age and menstrual status matched to cases. **Exposure assessment method:** Questionnaire; 115 food item FFQ. Red meat included beef, pork, pork chops, spareribs, pig trotters, ham, pork liver, beef, other red meats, and organ meat (except liver), and lamb or mutton.	Breast	Red meat (servings/wk), ≤ 3.0	84	1	Age, total energy, and breast feeding
			3.0 < 4.4	84	1.1 (0.69–1.77)	
			≥ 4.4- < 6.1	85	1.41 (0.87–2.31)	
			≥ 6.1	125	1.24 (0.77–1.99)	
			Trend-test p-value:	0.3		

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Kruk (2007) Poland 1999–2006 Case-Control	**Cases:** 858; Cases were identified from the Szczecin Regional Cancer Registry and were diagnosed with histologically confirmed invasive cancer. **Controls:** 1085; Controls were frequency matched on 5-year age group, and place of residence. Selected among patients admitted to ambulatories in the same area as cases for health controlling. Remaining 232 control subjects were selected from hospital patients. **Exposure assessment method:** Questionnaire; The study used FFQ modified from Block (US) and Franceschi (Italy) FFQs to include some Polish-specific foods.	Breast	Red Meat, Premenopausal: 0 servings/week	31	1	Age, recreational activity
			1 serving/week	71	1.6 (0.95–2.67)	
			2 servings/week	113	1.66 (1.02–2.7)	
			3–4 servings/week	65	1.66 (0.98–2.83)	
			≥ 5 servings/week	29	2.96 (1.49–5.91)	
			Trend-test p-value: 0.0091			
		Breast	Red Meat, Postmenopausal: 0 servings/week	95	1	Age
			1 serving/week	115	1.1 (0.75–1.61)	
			2 servings/week	194	0.92 (0.66–1.29)	
			3–4 servings/week	99	0.94 (0.64–1.39)	
			≥ 5 servings/week	44	1.51 (0.89–2.57)	
			Trend-test p-value: 0.65			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Steck et al. (2007) Long Island, NY, USA 1996–1997 (1 year); population-based Case-Control	**Cases:** 1508; Women, residents of Nassau and Suffolk counties, newly diagnosed with invasive or in situ breast cancer. **Controls:** 1556; Women under the age of 65 years were identified using random digit dialing; women 65 years and older were identified using Center for Medicare and Medicaid Services rosters. **Exposure assessment method:** Questionnaire; 100-food item Block FFQ, 1 year dietary recall. Questionnaire included assessment of lifetime intake of 4 categories of grilled/barbecued and smoked meats over each decade of life since the teenage years.	Breast	Premenopausal, Total over lifetime, Grilled/barbecued red meat: 0–630 times	124	1	Age, energy intake, and multivitamin use, fruit and vegetable intake
			631–2162 times	175	0.98 (0.67–1.42)	
			2163–17 217 times	158	0.85 (0.57–1.26)	
			Trend-test p-value: 0.24			
		Breast	Postmenopausal, Total over lifetime, Grilled/barbecued red meat: 0–630 times	289	1	Same as above
			631–2162 times	261	1.18 (0.89–1.57)	
			2163–17 217 times	366	1.32 (1.01–1.72)	
			Trend-test p-value: 0.1			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Kallianpur et al. (2008) China 1996–2005 Case-Control	**Cases:** 3452;.Shanghai Breast Cancer Study, a population-based case-control study. Cases were identified through the rapid case-ascertainment system of the Shanghai Cancer Registry and were permanent resident of urban Shanghai aged 25–70 years. **Controls:** 3474; Controls were randomly selected from women in the Shanghai Resident Registry and frequency-matched to cases by age in 5-year intervals **Exposure assessment method:** Questionnaire; 76 food item FFQ.	Breast	Animal source iron, Quartile 1	NR	1	Age, education, BMI, WHR, age at menarche, age at first live birth, family history of breast cancer, regular exercise, total energy intake, study phase, vitmains A, C, and E, folic acid, isoflavone intake, vitamin supplement use, saturated fat, mono-unsaturated fat intake, and age at menopause in postmenopausal women
			Quartile 2	NR	1.13 (0.97–1.33)	
			Quartile 3	NR	1.25 (1.03–1.52)	
			Quartile 4	NR	1.5 (1.19–1.88)	
			Trend-test p-value: < 0.01			
Mignone et al. (2009) Massachusetts, New Hampshire, Wisconsin 1997–2001 Case-Control	**Cases:** 2,686; Women of all races aged 20–69 years, with recent incident invasive breast cancer identified through state cancer registries of Massachusetts, New Hampshire and Wisconsin **Controls:** 3,508; Community controls were selected at random (within age strata) from lists of licensed drivers and Medicare beneficiaries with no history of breast cancer. **Exposure assessment method:** Questionnaire; Detailed 5-year recall on meat consumption and cooking practices. Women were asked to report on typical servings per week of grilled hamburger, fried hamburger, broiled hamburger, grilled steak, fried steak, broiled steak, grilled chicken, fried chicken, and broiled chicken. These questions were followed for each meat by a question on the degree of browning ("was the outside usually lightly browned, medium browned, or blackened /charred?") and for red meat the	Breast	All Women, Red meat (serving/wk): < 2	1215	1	Age, state of residence, body mass index, education, alcohol intake, age at menarche, menopausal status, age at first birth, family history of breast cancer, history of benign breast disease, parity, postmenopausal hormone use, multivitamin use, total fruits and vegetables intake, and smoking (smoking status and pack years).
			2 < 3	647	1.06 (0.93–1.21)	
			3 < 4	394	1.11 (0.95–1.3)	
			4 < 5	195	1.1 (0.89–1.35)	
			≥ 5	235	0.98 (0.81–1.18)	
			Trend-test p-value: 0.91			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
	degree of doneness ("was it usually rare, medium, or well done?"). Red meat presumably included processed meat.	Breast	Premenopausal, Red meat (serving/wk): < 2	520	1	Same as above
			2 < 3	242	1.04 (0.84–1.29)	
			3 < 4	156	1.16 (0.9–1.5)	
			4 < 5	66	0.98 (0.69–1.39)	
			≥ 5	82	0.82 (0.6–1.13)	
			Trend-test p-value: 0.55			
		Breast	Postmenopausal, Red meat (serving/wk): < 2	647	1	Same as above
			2 ≤ 3	380	1.07 (0.9–1.28)	
			3 < 4	223	1.11 (0.9–1.37)	
			4 < 5	123	1.24 (0.94–1.62)	
			≥ 5	146	1.02 (0.8–1.31)	
			Trend-test p-value: 0.35			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Zhang et al. (2009) Guangzhou, China 2007-2008 hospital-based Case-Control	**Cases:** 438; Women aged 25–70 years, natives of the province of Guangdon or having lived there for at least 5 years. Incident, primary, histologically confirmed breast cancer diagnosed no more than 3 months before the interview. **Controls:** 438; Patients with no history of cancer and admitted to the same hospitals during the same time period as the case subjects. Frequency matched by age (5 year interval) and residence (rural/urban) to the case patients. **Exposure assessment method:** Questionnaire; Validated, interviewer-administered 81-food item FFQ. 1-year dietary recall. Processed meat included sausage, ham, bacon, and hotdog. Organ meat included beef or pork liver, kidney, hearts, brain, and tongues. Red meat included pork, beef, lamb, offal meat, and processed meat.	Breast	Red Meat, Q1	92	1	Age at menarche, live birth and age at first live birth, BMI, history of benign breast disease, mother/sister/daughter with breast cancer, physical activity, passive smoking, use of deep-fried cooking method, total energy, vegetable, fruit, and soy food intake
			Q2	114	1.08 (0.71–1.65)	
			Q3	115	1.17 (0.76–1.8)	
			Q4	117	1.32 (0.84–2.09)	
			Trend-test p-value: 0.22			
		Breast	Offal meat, Q1	153	1	Same as above
			Q2	49	0.93 (0.57–1.52)	
			Q3	111	1.23 (0.84–1.8)	
			Q4	125	1.16 (0.79–1.71)	
			Trend-test p-value: 0.298			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Rabstein et al. (2010) Greater Region of Bonn, Germany 2000-2004, population-based Case-Control	**Cases:** 1020; Women aged up to 80 years, with histopathologically confirmed breast cancer, diagnosis within 6 months before enrollment. Current residence in the study region, and Caucasian ethnicity. **Controls:** 1047; Population controls frequency matched to cases by year of birth in 5-year classes with the same inclusion criteria as cases. **Exposure assessment method:** Questionnaire; Red meat and grilled food consumption within the last years was documented.	Breast: (ER+ breast cancer)	Red meat intake			Age
			< 1/month	60	1	
			1/mo ≤ 1/week	177	1.04 (0.73–1.49)	
			> 1/week	364	1.33 (0.95–1.87)	
		Breast: Estrogen Negative	Red Meat, Rare	14	1	Age
			Sometimes	50	1.26 (0.67–2.37)	
			Regular	105	1.71 (0.95–3.09)	
		Breast: Progesterone Positive	Red Meat, Rare	54	1	Age
			Sometimes	168	1.1 (0.76–1.59)	
			Regular	347	1.42 (1–2)	
		Breast: Progesterone Negative	Red Meat, Rare	19	1	Age
			Sometimes	57	1.05 (0.6–1.84)	
			Regular	119	1.43 (0.85–2.41)	

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
		Breast	Frequency of red meat consumption by NAT2 acetylator status:			Age, family history of breast cancer, hormonal therapy, breast feeding, physical activity, number of mammograms until 2 years before interview
			Slow acetylators: < 1/month	48	1	
			1/month–≤ 1/week	159	1.14 (0.75–1.73)	
			> 1/week	362	1.71 (1.15–2.55)	
			Fast acetylators: < 1/month	45	1.42 (0.82–2.45)	
			1/month ≤ 1/week	140	1.64 (1.06–2.45)	
			> 1/week	254	1.73 (1.15–2.61)	
		Breast	Red meat, Rare (< 1/month)	94	1	Age
			Sometimes	301	1.13 (0.83–1.54)	
			Regular (> 1/week)	625	1.59 (1.11–1.99)	
Fu et al. (2011) Nashville, TN 2001-2008; population-based Case-Control	**Cases:** 2,386; English-speaking women with a resident telephone, aged 25–77 years, with incident primary invasive or in situ breast cancer. No prior history of cancer other than nonmelanoma skin cancer. **Controls:** 1,703; Women with identical criteria to cases with the exception that they had no prior breast cancer diagnosis. Identified by random digit dialing of households. **Exposure assessment method:** Questionnaire; Interviewer-administered telephone interview on usual intake frequency and portion	Breast	Red Meat, Pre-Menopause Q1	212	1	Age group, ethnicity, educational attainment, family income, total energy intake, first degree relative breast cancer history, personal history of benign breast disease, hormone replacement therapy, age at menarche, have live birth, BMI, regular physical exercise, regular alcohol consumption, and
			Q2	263	1.2 (0.9–1.5)	
			Q3	208	1.4 (1.1–2)	
			Q4	124	1.3 (0.9–2)	
			Trend-test p-value: 0.031			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
	size of 11 meats in the previous year before interview (for controls) or cancer diagnosis (for cases). Data were obtained regarding intake frequency, usual portion size, cooking method, and doneness of each meat item. For food doneness the photograph booklet was in front of them during the telephone interview. Red meat included hamburgers, cheeseburgers, beef steaks, pork chops, ham steaks, and ribs (short ribs or spareribs). Processed meat included bacon, sausage, and hotdogs/franks.					study period
		Breast	Red Meat, Post-Menopause Q1	427	1	Same as above
			Q2	521	1.4 (1.1–1.7)	
			Q3	406	1.5 (1.2–1.9)	
			Q4	224	1.7 (1.3–2.4)	
			Trend-test p-value: < 0.001			
		Breast	Well done Red Meat, Pre-Menopause Q1	189	1	Same as above
			Q2	250	1.3 (1–1.7)	
			Q3	234	1.4 (1–1.9)	
			Q4	134	1.5 (1.1–2.2)	
			Trend-test p-value: 0.017			
		Breast	Well done Red Meat, Post-Menopause Q1	438	1	Same as above
			Q2	518	1.4 (1.1–1.8)	
			Q3	405	1.5 (1.2–2)	
			Q4	217	1.7 (1.2–2.3)	
			Trend-test p-value: < 0.001			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
		Breast	Red Meat, all cooking methods Q1	460	1	Same as above
			Q2	543	1.2 (1–1.5)	
			Q3	660	1.4 (1.2–1.7)	
			Q4	723	1.5 (1.2–1.8)	
			Trend-test p-value: < 0.001			
		Breast	Red Meat, high-temperature cooking methods, Q1	628	1	Same as above
			Q2	768	1.2 (1–1.5)	
			Q3	639	1.4 (1.1–1.7)	
			Q4	351	1.5 (1.3–1.9)	
			Trend-test p-value: < 0.001			
		Breast	Red Meat, grilled Q1	509	1	Same as above
			Q2	614	1.2 (1–1.5)	
			Q3	557	1.2 (1–1.4)	
			Q4	706	1.6 (1.3–1.9)	
			Trend-test p-value: < 0.001			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
		Breast	Red Meat, fried, Q1	766	1	Same as above
			Q2	399	1 (0.9–1.3)	
			Q3	579	1.5 (1.3–1.8)	
			Q4	642	1.3 (1.1–1.6)	
			Trend-test p-value: < 0.001			
Bao et al. (2012) Shanghai, China 1996–1998 (phase I), 2002–2004 (phase II) population-based Case-Control	**Cases:** 3443; Permanent residents of urban Shanghai, age 25–70 years, no prior history of any cancer. Ascertained by the Shanghai Cancer Registry, breast cancer cases were identified during phase I and phase II of the Shanghai Breast Cancer Study. **Controls:** 3474; Controls were randomly selected from women in the Shanghai Resident Registry and frequency-matched to cases by age in 5-year intervals. **Exposure assessment method:** Questionnaire; Validated, 76 food item FFQ including 19 animal foods. No information was provided how to define red meat.	Breast: All cancer cases	Red meat: < 26.34 g/d	564	1	Total energy, age, education level, ever diagnosed with benign breast disease, first-degree family history of breast cancer, participation in regular exercise, BMI, study phase (I and II), age at menarche, menopausal status, parity, total vegetable intake, and total fruit intake
			< 40.51 g/d	600	1.07 (0.91–1.25)	
			< 57.56 g/d	741	1.3 (1.11–1.52)	
			< 82.11 g/d	713	1.25 (1.07–1.47)	
			≥ 82.11 g/d	805	1.45 (1.22–1.72)	
			Trend-test p-value: < 0.0001			
		Breast: ER+/PR+ breast cancer	Red meat: < 26.34 g/d	211	1	Same as above
			< 40.51 g/d	262	1.24 (1–1.53)	
			< 57.56 g/d	298	1.36 (1.1–1.69)	
			< 82.11 g/d	310	1.43 (1.15–1.77)	
			≥ 82.11 g/d	323	1.51 (1.2–1.9)	
			Trend-test p-value: 0.0003			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
		Breast: ER–/PR– cases	Red meat: < 26.34 g/d	117	1	Same as above
			< 40.51 g/d	113	0.95 (0.72–1.27)	
			< 57.56 g/d	164	1.36 (1.04–1.78)	
			< 82.11 g/d	140	1.19 (0.9–1.57)	
			≥ 82.11 g/d	174	1.55 (1.16–2.07)	
			Trend-test p-value: 0.001			
		Breast: ER+/PR–	Red meat: < 26.34 g/d	40	1	Same as above
			< 40.51 g/d	56	1.39 (0.91–2.13)	
			< 57.56 g/d	60	1.49 (0.97–2.27)	
			< 82.11 g/d	76	1.91 (1.27–2.89)	
			≥ 82.11 g/d	68	1.81 (1.15–2.84)	
			Trend-test p-value: 0.002			
		Breast: ER–/PR+	< 26.34 g/d	43	1	Same as above
			< 40.51 g/d	45	1.03 (0.67–1.6)	
			< 57.56 g/d	54	1.19 (0.78–1.83)	
			< 82.11 g/d	51	1.12 (0.72–1.73)	
			≥ 82.11 g/d	59	1.29 (0.81–2.03)	
			Trend-test p-value: 0.28			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Ronco et al. (2012) Montevideo, Uruguay 2004-2010 hospital-based Case-Control	**Cases:** 253; premenopausal breast cancer cases were identified from the Pereira Rossell Women's Hospital, Uruguay **Controls:** 497; In the same time period and in the same institution, healthy women with a negative diagnostic mammogram performed the same day of the interview, were randomly selected as controls. **Exposure assessment method:** Questionnaire; A short food frequency questionnaire, including 12 items.	Breast	Red Meat II	NR	1.83 (1.09–3.09)	Age, age at menarche, number of live births, age at first delivery, years between menarche and first delivery, breastfeeding, oral contraception, family history of breast cancer, and family history of other cancers.
			III	NR	1.14 (0.7–1.86)	
			IV	NR	2.2 (1.35–3.6)	
			Trend-test p-value: 0.02			
Chandran et al. (2013) New York and New Jersey (USA) 2008 (NYC), 2012 (NJ) population-based Case-Control	**Cases:** 803 (African-American; AA), 755 (Caucasian); In NY, cases were recruited through major hospitals with large referral patterns for AA women in four boroughs of the metropolitan NYC area. In NJ, data collection was based at The Cancer Institute of New Jersey. Age 20–75 years at diagnosis. Histologically confirmed invasive or in situ breast cancer. **Controls:** 889 (AA), 701 (Caucasian); Women identified through random digit dialing (RDD) of residential telephone and cell phone numbers. **Exposure assessment method:** Questionnaire; Diet was assessed with FFQ with approximately 125 food items, which was validated in other US population. Red meat included processed and unprocessed red meat.	Breast	Quartiles of red meat intake (g/d/1000kcal), Caucasian women:			Age, ethnicity, country of origin, education, age at menarche, menopausal status, parity, age at first birth, breast-feeding status, family history of breast cancer, OC use, history of benign breast disease, HRT use, total energy intake, BMI
			Q1: ≤ 10.81	153	-	
			Q2: 10.82–22.45	171	1.08 (0.78–1.49)	
			Q3: 22.46–40.75	236	1.6 (1.16–2.2)	
			Q4: > 40.75	195	1.24 (0.9–1.72)	
			Trend-test p-value: 0.12			
		Breast	Caucasian, Premenopausal, Red Meat (Grams/day/1,000 kcal): ≤ 10.81	78	-	Same as above
			10.82–22.45	96	1.56 (0.99–2.45)	
			22.46–40.75	119	2.05 (1.31–3.23)	
			> 40.75	96	1.38 (0.88–2.19)	
			Trend-test p-value: 0.32			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
		Breast	Caucasians, Postmenopausal, Red Meat (Grams/day/1,000 kcal): ≤ 10.81	75	-	Same as above
			10.82–22.45	75	0.79 (0.48–1.3)	
			22.46–40.75	117	1.41 (0.86–2.3)	
			> 40.75	99	1.37 (0.83–2.26)	
			Trend-test p-value: 0.06			
		Breast	Caucasians, ER+, Red Meat (Grams/day/1,000 kcal): ≤ 10.81	74	1	Same as above
			10.82–22.45	92	1.2 (0.81–1.79)	
			22.46–40.75	127	1.71 (1.16–2.53)	
			> 40.75	120	1.51 (1.02–2.24)	
			Trend-test p-value: 0.03			
		Breast	Caucasians, ER-, Red Meat (Grams/day/1,000 kcal): ≤ 10.81	21	1	Same as above
			10.82–22.45	15	0.64 (0.31–1.32)	
			22.46–40.75	28	1.29 (0.67–2.46)	
			> 40.75	26	1.31 (0.68–2.51)	
			Trend-test p-value: 0.16			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
		Breast	AA, All women, Red Meat (Grams/day/1,000 kcal): ≤ 10.81	228	1	Same as above
			10.82–22.45	209	1.17 (0.89–1.55)	
			22.46–40.75	212	1.1 (0.82–1.46)	
			> 40.75	154	0.96 (0.7–1.3)	
			Trend-test p-value: 0.58			
		Breast	AA, Premenopausal, Red Meat (Grams/day/1,000 kcal): ≤ 10.81	119	1	Same as above
			10.82–22.45	104	1.36 (0.9–2.04)	
			22.46–40.75	103	1.22 (0.8–1.84)	
			> 40.75	82	1.15 (0.74–1.78)	
			Trend-test p-value: 0.76			
		Breast	AA, Postmenopausal, Red Meat (Grams/day/1,000 kcal): ≤ 10.81	109	-	Same as above
			10.82–22.45	105	1.03 (0.69–1.55)	
			22.46–40.75	109	1.01 (0.67–1.53)	
			> 40.75	72	0.79 (0.5–1.25)	
			Trend-test p-value: 0.29			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
		Breast	AA, ER+, Red Meat (Grams/day/1,000 kcal): ≤ 10.81	105	1	Same as above
			10.82–22.45	102	1.26 (0.89–1.78)	
			22.46–40.75 G	108	1.24 (0.87–1.77)	
			> 40.75	94	1.29 (0.89–1.86)	
			Trend-test p-value:	0.26		
		Breast	AA, ER-, Red Meat (Grams/day/1,000 kcal): ≤ 10.81	50	1	Same as above
			10.82–22.45	46	1.13 (0.71–1.81)	
			22.46–40.75	59	1.3 (0.82–2.06)	
			> 40.75	29	0.73 (0.42–1.24)	
			Trend-test p-value:	0.26		
		Breast	African American, all women, unprocessed red meat (g/d/1000kcal): Q1, ≤ 4.14	253	1	Same as above
			Q2, 4.15–11.76	237	0.95 (0.73–1.24)	
			Q3, 11.77–24.70	186	0.98 (0.74–1.3)	
			Q4, > 24.70	127	0.84 (0.61–1.14)	
			Trend-test p-value:	0.28		

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
		Breast	Caucasian, all women, unprocessed red meat (g/d/1000kcal): Q1, ≤ 4.14	129	1	Same as above
			Q2, 4.15–11.76	177	1.58 (1.12–2.24)	
			Q3, 11.77–24.70	207	1.4 (1.01–1.96)	
			Q4, > 24.70	242	1.4 (1.01–1.94)	
			Trend-test p-value:	0.29		

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Di Maso et al. (2013) Italy and Switzerland 1991–2009, hospital-based Case-Control	**Cases:** 3034; Women aged < 75 years with histologically confirmed breast cancer identified in the major teaching and general hospitals of the study areas within 1 year before the interview. **Controls:** 11 656; Women admitted to the same network of hospitals as patients for a wide spectrum of acute, non-neoplastic conditions unrelated to tobacco and alcohol consumption, to known risk factors for breast cancer or to conditions associated with long-term diet modification. **Exposure assessment method:** Questionnaire; Validated FFQ. 2-year dietary recall. Serving size was defined as an average serving in the Italian diet (e.g. 150 g for grilled steak; 120 g for boiled meat). Total red meat was calculated as the sum of food items for beef, veal, pork, horsemeat, and half of the first course including meat sauce (e.g. lasagne, pasta/rice with bologna sauce). Questions on different cooking methods (i.e. boiling/stewing, roasting/grilling, or frying/pan frying.	Breast	Red Meat: < 60 g/day	1019	-	Study centre, age, sex, education, body mass index, tobacco smoking, alcohol drinking, vegetable consumption, fruit consumption, menopausal status, parity, OC/HRT use
			60–89 g/day	903	0.93 (0.82–1.05)	
			≥ 90 g/day	1112	1.18 (1.04–1.33)	
			Trend-test p-value: < 0.01			
		Breast	Red Meat, Roasting/Grillin, per 50 g/d	3034	1.2 (1.08–1.34)	Same as above
			Red Meat, Boiling Stewing, per 50 g/d	3034	1.15 (1–1.33)	
			Red Meat, Frying/Pan Frying, per 50 g/d	3034	1.13 (0.89–1.43)	
			Trend-test p-value: 0.84			
		Breast	Red meat, per 50 g/day increase, pre- and perimenopausal women:	NR	1.14 (1.02–1.28)	Study centre, age (quinquennia), education (< 7; 7–11; ≥ 12 years), body mass index (< 25; 25- < 30; ≥ 30 kg m-2), tobacco smoking (never; former; current: < 15, ≥ 15 cigarettes/day), alcohol drinking (never, former, current: < 3, 3–4, 5–7, ≥ 8 drinks/day), vegetables consumption (< 1.5; 1.5- < 3; ≥ 3 servings/day), and fruit consumption (< 3; 3- < 4; ≥ 4 servings/day), parity
			Postmenopausal	NR	1.1 (1.01–1.19)	

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
						(0–1; 2; ≥ 3) and use of oral contraceptive and/or hormone replacement therapy (never; ever).
Kruk and Marchlewicz (2013) Western Pomerania, Poland 1999–2006 hospital-based Case-Control	**Cases:** 858; Women aged 25–79 years with histologically confirmed invasive breast cancer, and operated between 1999 and 2006. **Controls:** 1,085; Women aged 25–79 years with no cancer history or earlier physical limitation, selected among patients admitted to ambulatories in the same area as cases for health controlling (*n* = 853) and among hospital patients (*n* = 232). **Exposure assessment method:** Questionnaire; FFQ included 18 main Polish-specific food groups: red meats (pork, beef, lamb; boiled, fried, canned) and alternatives, animal fat (bacon etc.)	Breast	Tertiles of red meat intake (servings/wk) among women with total lifetime physical activity level < 105 MET-h/wk:			Age, BMI, education, breast-feeding, psychological stress, multivitamins supplement, family history of breast cancer, passive smoking
			T1 (≤ 2/wk)	210	1	
			T2 (3–4/wk)	55	1.12 (0.69–1.82)	
			T3 (≥ 5/wk)	33	2.7 (1.21–6.03)	
			Trend-test p-value: < 0.02			
		Breast	105 < 138 MET-h/week, Red Meat: T1 (≤ 2/wk)	158	1	Same as above
			T2 (3–4/wk)	44	1.01 (0.62–1.65)	
			T3 (≥ 5/wk)	10	1.14 (0.44–2.96)	
			Trend-test p-value: < 0.59			
		Breast	138 < 170 MET-h/week, Red Meat: ≤ 2/wk	101	1	Same as above
			3–4/wk	29	1.02 (0.57–1.81)	
			≥ 5/wk	7	1.16 (0.39–3.44)	
			Trend-test p-value: < 0.79			

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
		Breast	≥ 170 MET-h/week, Red Meat: ≤ 2/wk	152	1	Same as above
			3–4/wk	36	1 (0.52–1.92)	
			≥ 5/wk	23	1.45 (0.77–2.73)	
			Trend-test p-value: < 0.30			
Laamiri et al. (2014) Rabat, Morocco 2008–2010 Case-Control	**Cases:** 400; Moroccan women of all ages with a new diagnosis of breast cancer confirmed by mammography, biopsy and/or surgery by specialists of the National Institute of Oncology. **Controls:** 400; Women with no evidence of breast cancer in screening mammography performed at the same Institute. **Exposure assessment method:** Questionnaire; Evaluation concentrated on foods high in animal fats such as red meat, processed meat.	Breast	Red meat, unknown increment	NR	4.61 (2.26–9.44)	Age, Not specified
Mourouti et al. (2015) Athens, Greece 2010–2012, population-based Case-Control	**Cases:** 250; Women with incident breast cancer diagnosed within 6 months in one of five major general hospitals in Athens, Greece. **Controls:** 250; Age-matched (± 3 years) with the cancer patients and selected from the catchment area of the patients **Exposure assessment method:** Questionnaire; Interview using validated 86-food item FFQ. One year dietary recall. Red meat included beef, lamb, veal and pork. Processed meat included cured and smoked meats; ham, bacon, sausages and salami. Adherence to the	Breast	Red meat, ≤ 1 time/wk	NR	1	Age, years of education, body mass index, smoking ever, physical activity, family history of breast cancer, menopausal status, use of hormone replacement therapy and MedDietScore
			2–3 times/wk	NR	0.89 (0.56–1.41)	
			4–5 times/wk	NR	1.04 (0.51–2.14)	
			6–7 times/wk	NR	1.52 (0.74–3.16)	
			8–10 times/wk	NR	0.99 (0.31–3.12)	

Table 2.6.3 Case-control studies: Red meat and cancer of the breast (web only)

Reference, location enrolment/follow-up period, study design	Population size, description, exposure assessment method	Organ site	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
	Mediterranean dietary pattern was assessed using a dietary index containing the main 11 components of the Mediterranean diet.					

References

Ambrosone CB, Freudenheim JL, Sinha R, Graham S, Marshall JR, Vena JE, et al. (1998). Breast cancer risk, meat consumption and N-acetyltransferase (NAT2) genetic polymorphisms. Int J Cancer. 75(6):825–30. http://dx.doi.org/10.1002/(SICI)1097-0215(19980316)75:6<825::AID-IJC2>3.0.CO;2-X PMID:9506525

Bao PP, Shu XO, Zheng Y, Cai H, Ruan ZX, Gu K, et al. (2012). Fruit, vegetable, and animal food intake and breast cancer risk by hormone receptor status. Nutr Cancer. 64(6):806–19. http://dx.doi.org/10.1080/01635581.2012.707277 PMID:22860889

Brandt B, Hermann S, Straif K, Tidow N, Buerger H, Chang-Claude J (2004). Modification of breast cancer risk in young women by a polymorphic sequence in the egfr gene. Cancer Res. 64(1):7–12. http://dx.doi.org/10.1158/0008-5472.CAN-03-2623 PMID:14729599

Chandran U, Zirpoli G, Ciupak G, McCann SE, Gong Z, Pawlish K, et al. (2013). Racial disparities in red meat and poultry intake and breast cancer risk. Cancer Causes Control. 24(12):2217–29. http://dx.doi.org/10.1007/s10552-013-0299-5 PMID:24091794

Dai Q, Shu XO, Jin F, Gao YT, Ruan ZX, Zheng W (2002). Consumption of animal foods, cooking methods, and risk of breast cancer. Cancer Epidemiol Biomarkers Prev. 11(9):801–8. PMID:12223422

De Stefani E, Ronco A, Mendilaharsu M, Guidobono M, Deneo-Pellegrini H (1997). Meat intake, heterocyclic amines, and risk of breast cancer: a case-control study in Uruguay. Cancer Epidemiol Biomarkers Prev. 6(8):573–81. PMID:9264269

Di Maso M, Talamini R, Bosetti C, Montella M, Zucchetto A, Libra M, et al. (2013). Red meat and cancer risk in a network of case-control studies focusing on cooking practices. Ann Oncol. 24(12):3107–12. http://dx.doi.org/10.1093/annonc/mdt392 PMID:24121119

Ewertz M, Gill C (1990). Dietary factors and breast-cancer risk in Denmark. Int J Cancer. 46(5):779–84. http://dx.doi.org/10.1002/ijc.2910460505 PMID:2228305

Franceschi S, Favero A, La Vecchia C, Negri E, Dal Maso L, Salvini S, et al. (1995). Influence of food groups and food diversity on breast cancer risk in Italy. Int J Cancer. 63(6):785–9. http://dx.doi.org/10.1002/ijc.2910630606 PMID:8847134

Fu Z, Deming SL, Fair AM, Shrubsole MJ, Wujcik DM, Shu XO, et al. (2011). Well-done meat intake and meat-derived mutagen exposures in relation to breast cancer risk: the Nashville Breast Health Study. Breast Cancer Res Treat. 129(3):919–28. http://dx.doi.org/10.1007/s10549-011-1538-7 PMID:21537933

Hermann S, Linseisen J, Chang-Claude J (2002). Nutrition and breast cancer risk by age 50: a population-based case-control study in Germany. Nutr Cancer. 44(1):23–34. http://dx.doi.org/10.1207/S15327914NC441_4 PMID:12672638

Hislop TG, Coldman AJ, Elwood JM, Brauer G, Kan L (1986). Childhood and recent eating patterns and risk of breast cancer. Cancer Detect Prev. 9(1-2):47–58. PMID:3731194

Kallianpur AR, Lee SA, Gao YT, Lu W, Zheng Y, Ruan ZX, et al. (2008). Dietary and lifestyle predictors of age at natural menopause and reproductive span in the Shanghai Women's Health Study. Breast Cancer Res Treat. 107(1):123–32. http://dx.doi.org/10.1007/s10549-007-9538-3 PMID:17431764

Kruk J (2007). Association of lifestyle and other risk factors with breast cancer according to menopausal status: a case-control study in the Region of Western Pomerania (Poland). Asian Pac J Cancer Prev. 8(4):513–24. PMID:18260721

Kruk J, Marchlewicz M (2013). Dietary fat and physical activity in relation to breast cancer among Polish women. Asian Pac J Cancer Prev. 14(4):2495–502. http://dx.doi.org/10.7314/APJCP.2013.14.4.2495 PMID:23725163

Laamiri FZ, Bouayad A, Otmani A, Ahid S, Mrabet M, Barkat A (2014). Dietery factor obesity microenvironnement and breast cancer. Gland Surg. 3(3):165–73. PMID:25207209

Lee HP, Gourley L, Duffy SW, Estève J, Lee J, Day NE (1992). Risk factors for breast cancer by age and menopausal status: a case-control study in Singapore. Cancer Causes Control. 3(4):313–22. http://dx.doi.org/10.1007/BF00146884 PMID:1617118

Lubin JH, Burns PE, Blot WJ, Ziegler RG, Lees AW, Fraumeni JF Jr (1981). Dietary factors and breast cancer risk. Int J Cancer. 28(6):685–9. http://dx.doi.org/10.1002/ijc.2910280605 PMID:7333703

Männistö S, Pietinen P, Virtanen M, Kataja V, Uusitupa M (1999). Diet and the risk of breast cancer in a case-control study: does the threat of disease have an influence on recall bias? J Clin Epidemiol. 52(5):429–39. http://dx.doi.org/10.1016/S0895-4356(99)00010-4 PMID:10360338

Matos EL, Thomas DB, Sobel N, Vuoto D (1991). Breast cancer in Argentina: case-control study with special reference to meat eating habits. Neoplasma. 38(3):357–66. PMID:1857455

Mignone LI, Giovannucci E, Newcomb PA, Titus-Ernstoff L, Trentham-Dietz A, Hampton JM, et al. (2009). Meat consumption, heterocyclic amines, NAT2, and the risk of breast cancer. Nutr Cancer. 61(1):36–46. http://dx.doi.org/10.1080/01635580802348658 PMID:19116874

Mourouti N, Kontogianni MD, Papavagelis C, Plytzanopoulou P, Vassilakou T, Psaltopoulou T, et al. (2015). Meat consumption and breast cancer: a case-control study in women. Meat Sci. 100:195–201. http://dx.doi.org/10.1016/j.meatsci.2014.10.019 PMID:25460125

Rabstein S, Brüning T, Harth V, Fischer HP, Haas S, Weiss T, et al.; GENICA Network (2010). N-Acetyltransferase 2, exposure to aromatic and heterocyclic amines, and receptor-defined breast cancer. Eur J Cancer Prev. 19(2):100–9. http://dx.doi.org/10.1097/CEJ.0b013e328333fbb7 PMID:19996973

Ronco AL, De Stefani E, Deneo-Pellegrini H (2012). Risk factors for premenopausal breast cancer: a case-control study in Uruguay. Asian Pac J Cancer Prev. 13(6):2879–86. http://dx.doi.org/10.7314/APJCP.2012.13.6.2879 PMID:22938477

Shannon J, Cook LS, Stanford JL (2003). Dietary intake and risk of postmenopausal breast cancer (United States). Cancer Causes Control. 14(1):19–27. http://dx.doi.org/10.1023/A:1022506507984 PMID:12708721

Shannon J, Ray R, Wu C, Nelson Z, Gao DL, Li W, et al. (2005). Food and botanical groupings and risk of breast cancer: a case-control study in Shanghai, China. Cancer Epidemiol Biomarkers Prev. 14(1):81–90. PMID:15668480

Steck SE, Gaudet MM, Eng SM, Britton JA, Teitelbaum SL, Neugut AI, et al. (2007). Cooked meat and risk of breast cancer–lifetime versus recent dietary intake. Epidemiology. 18(3):373–82. http://dx.doi.org/10.1097/01.ede.0000259968.11151.06 PMID:17435448

Tavani A, La Vecchia C, Gallus S, Lagiou P, Trichopoulos D, Levi F, et al. (2000). Red meat intake and cancer risk: a study in Italy. Int J Cancer. 86(3):425–8. http://dx.doi.org/10.1002/(SICI)1097-0215(20000501)86:3<425::AID-IJC19>3.0.CO;2-S PMID:10760833

Toniolo P, Riboli E, Protta F, Charrel M, Cappa AP (1989). Calorie-providing nutrients and risk of breast cancer. J Natl Cancer Inst. 81(4):278–86. http://dx.doi.org/10.1093/jnci/81.4.278 PMID:2913325

Witte JS, Ursin G, Siemiatycki J, Thompson WD, Paganini-Hill A, Haile RW (1997). Diet and premenopausal bilateral breast cancer: a case-control study. Breast Cancer Res Treat. 42(3):243–51. http://dx.doi.org/10.1023/A:1005710211184 PMID:9065608

Zhang CX, Ho SC, Chen YM, Lin FY, Fu JH, Cheng SZ (2009). Meat and egg consumption and risk of breast cancer among Chinese women. Cancer Causes Control. 20(10):1845–53. http://dx.doi.org/10.1007/s10552-009-9377-0 PMID:19533390