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RED MEAT AND PROCESSED MEAT

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IARC MONOGRAPHS ON THE EVALUATION OF CARCINOGENIC RISKS TO HUMANS

Table 2.6.1 Cohort 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
Mills et al. (1989) California, US Enrollment 1976; follow-up 6 years Cohort	Cohort 20 341/215 cases; Non-Hispanic white California Seventh-day Adventist women aged 25–99 years. **Exposure assessment method:** Questionnaire; Current meat intake and past intake by decade was obtained. A variable reflecting parental religion and whether a vegetarian lifestyle was practiced in the home was used as an indicator of meat consumption in the years before and during menarche.	Breast	Frequency of combined hamburger, steak, and other beef/veal consumption (= beef index)			Age at entry, age at first live birth, age at menarche, menopausal status, history of benign breast disease, maternal history of breast cancer, educational attainment, and body mass index
			Never	80	1	
			< 1 X /wk	54	0.98 (0.69–1.38)	
			≥ 1 X /wk	68	1.05 (0.75–1.47)	
			Trend-test p-value: 0.84			
Toniolo et al. (1994) New York Enrollment 1985–1991; median follow-up 22.2 months Nested Case-Control	**Cases:** 180; Members of the New York University Women's Health Study cohort (age 35–65 years, no use of hormonal medications and no pregnancy during 6 months preceding enrollment), with incident invasive breast cancer. **Controls:** 829; Randomly selected cohort members free of breast cancer, matched individually 1:5 by date of birth, menopausal status at enrollment, date of enrollment and number and dates of repeat blood donations. **Exposure assessment method:** Questionnaire; Self-administered 71-food item modified Block FFQ. Meat included beef, veal, lamb, or pork preparations, processed luncheon meats (ham, cold cuts, turkey rolls).	Breast	Quintiles of red meat and processed meat consumption (mean g/day)			Total energy intake
			Q1 (4)	24	1	
			Q2 (15)	27	1.11 (0.62–2.02)	
			Q3 (25)	45	1.87 (1.09–3.21)	
			Q4 (40)	39	1.62 (0.93–2.82)	
			Q5 (79)	45	1.87 (1.09–3.21)	
			Trend-test p-value: 0.01			
Zheng et al. (1998) Iowa 1992–1994 Nested Case-Control	**Cases:** 273; Members of Iowa Women's Health Study cohort (age 55–69 y in 1986), diagnosed with breast cancer during 1992–1994 **Controls:** 657; Randomly selected from cohort that was free of cancer on January 1, 1992, and participated in the 1992 follow-up survey. **Exposure assessment method:** Questionnaire; All eligible subjects were asked to	Breast	Doneness levels and tertiles of intake of hamburgers, beefsteak and bacon:			Age, total energy intake, family history of breast cancer, hormone replacement therapy, and waist-to-hip ratio
			Rare/Medium: Low intake	13	1	
			Medium intake	25	1.78 (0.84–3.77)	
			High intake	20	1.49 (0.68–3.27)	
			Mostly well done: Low intake	20	2.03 (0.92–4.48)	

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	complete a self-administered food-frequency questionnaire on meat intake habits during the "reference" year. This questionnaire included questions on usual intake and preparation of 15 meats. The "red meat" category included hamburgers, cheeseburgers, beefsteaks, pork chops, bacon, breakfast sausage links, breakfast sausage patties, other sausages, bratwurst, and hot dogs or franks. A doneness score was also calculated to describe the eating preferences of participants on the basis of their responses to the colour photographs. Doneness levels of rare or medium, well done, and very well done were given scores of 1, 2, and 3, respectively. The doneness score was defined as the sum of the doneness preferences for each of the three meat photographs.		Medium intake	20	2.31 (1.04–5.13)	
			High intake	31	3.36 (1.58–7.16)	
			Very well done: Low intake	32	2.57 (1.23–5.35)	
			Medium intake	39	3.35 (1.63–6.9)	
			High intake	42	3.01 (1.47–6.17)	
		Breast	**Doneness levels of hamburger:**			Same as above
			Rare or medium	123	1	
			Well done	90	1.23 (0.89–1.71)	
			Very well done	34	1.54 (0.96–2.47)	
			Trend-test p-value: 0.04			
		Breast	**Doneness level of beefsteak:**			Same as above
			Rare or medium	146	1	
			Well done	74	1.22 (0.87–1.72)	
			Very well done	29	2.21 (1.3–3.77)	
			Trend-test p-value: 0.01			
		Breast	**Doneness levels of bacon:**			Same as above
			Rare or medium	18	1	
			Well done	130	1.26 (0.71–2.22)	
			Very well done	112	1.64 (0.92–2.93)	
			Trend-test p-value: 0.02			

Table 2.6.1 Cohort 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	**Doneness score of beefsteak, hamburger and bacon**			Same as above
			3	6	1	
			4	54	1.14 (0.44–2.94)	
			5	71	1.9 (0.74–4.9)	
			6	57	2.28 (0.87–5.95)	
			7	31	1.56 (0.58–4.22)	
			8	13	2.89 (0.91–9.19)	
			9	12	4.62 (1.36–15.7)	
			Trend-test p-value: 0.001			
Deitz et al. (2000) Iowa, USA 1992–1994 Nested Case-Control	**Cases:** 174; Iowa Women's Health Study Cohort members (age 55–69 years in 1986), diagnosed with breast cancer between 1992 and 1994, and NAT2 genotyping results. **Controls:** 387; Random sample of cohort members who were cancer free in 1992, and NAT2 genotyping results. **Exposure assessment method:** Questionnaire; FFQ assessed usual intake and preparation methods of 15 different meats. Using a series of colour photographs, information on meat doneness level was obtained for hamburger, beef steak, and bacon. DNA analysis from buccal cell samples and blood samples.	Breast	Tertiles of red meat intake among slow acetylators:			Age
			T1 (low)	27	1	
			T2	36	1.2 (0.7–2.2)	
			T3	29	0.9 (0.5–1.7)	
			Trend-test p-value: 0.3			
		Breast	Tertiles of red meat intake among rapid/intermediate acetylators:			Age
			T1 (low)	19	1	
			T2	28	1.3 (0.6–2.5)	
			T3	35	1.7 (0.9–3.4)	
			Trend-test p-value: 0.11			

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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	NAT2 (slow), meat doneness score, 3–4 (low)	24	1	Age
			5	20	1.2 (0.6–2.3)	
			6	26	3 (1.4–6.1)	
			7	5	0.4 (0.2–1.3)	
			8	3	2.2 (0.5–10.8)	
			9	4	3.9 (0.8–18.9)	
			Trend-test p-value: 0.22			
		Breast	NAT2 (rapid/intermediate), meat doneness score, 3–4 (low)	13	1	Age
			5	25	3.2 (1.5–7)	
			6	17	3 (1.3–7)	
			7	12	3 (1.2–7.7)	
			8	4	4 (0.9–17)	
			9	3	7.6 (1.1–50.4)	
			Trend-test p-value: 0.003			

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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
Zheng et al. (2001) Iowa, USA 1992–1994 Nested Case-Control	**Cases:** 156; Members of Iowa Women's Health Study cohort (age 55–69 y in 1986), diagnosed with breast cancer 1992–1994, with SULT1A1 genotyping results. **Controls:** 332; Randomly selected from the cohort members who were cancer free as of January 1, 1992, with SULT1A1 genotyping results. **Exposure assessment method:** Questionnaire; FFQ assessed usual intake and preparation methods of different meats. Using a series of colour photographs, information on meat doneness level was obtained for hamburger, beef steak, and bacon. SULT1A1 genotyping from DNA extracted from peripheral blood leukocytes.	Breast	SULT1A1 Arg/Arg, Red meat, Rare/Medium	7	1	Age, waist-to-hip ration, and number of live births
			Mostly well done	14	4 (1.4–11.1)	
			Consistently well done	25	3.6 (1.4–9.3)	
			Trend-test p-value: 0.01			
		Breast	SULT1A1 Arg/His, Red meat, Rare/Medium	17	1	Same as above
			Mostly well done	17	1.4 (0.6–3.1)	
			Consistently well done	31	1.8 (0.9–3.8)	
			Trend-test p-value: 0.1			
		Breast	SULT1A1 His/His, Red meat, Rare/Medium	10	1	Same as above
			Mostly well done	10	1.7 (0.5–6.1)	
			Consistently well done	8	1 (0.3–3.7)	
			Trend-test p-value: 0.98			

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Table 2.6.1 Cohort 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
Missmer et al. (2002) North America and western Europe Enrollment mainly in 1980s; up to 15 years of follow-up Cohort	Pooled cohort 351 041/pooled cases 7379; Eight prospective cohort studies from North America and western Europe with at least 200 incident breast cancer cases, assessment of usual food and nutrient intakes, and a validation study of the dietary assessment instrument. **Exposure assessment method:** Questionnaire; Red meat included both fresh and processed red meat, blood pudding, liver and kidney.	Breast	Red meat consumption Quartile 1	NR	1	Age at menarche (≤ 11, 12, 13, 14, ≥ 15 years), interaction between parity (0, 1–2, ≥ 3) and age at first birth (≤ 20, 21–25, 26–29, ≥ 30 years), oral contraceptive use (ever, never), history of benign breast disease (no, yes), family history of breast cancer (no, yes), menopausal status at follow-up (premenopausal, postmenopausal, uncertain), body mass index (weight [kg]/height [m]2; continuous), the interaction of body mass index and menopausal status at follow-up, postmenopausal hormone use (ever, never), smoking status (ever, never), education (< high school graduate, high school graduate, > high school graduate), height (< 1.60, 1.60–< 1.65, 1.65–< 1.70, 1.70–< 1.75, ≥ 1.75 m), alcohol intake (g/day; continuous), and total energy intake (continuous).
			Quartile 2	NR	1 (0.91–1.09)	
			Quartile 3	NR	0.99 (0.92–1.06)	
			Quartile 4	NR	0.94 (0.87–1.02)	
			Trend-test p-value: 0.13			
		Breast Cancer	**Red meat**, 100 g/day increment, All women	NR	0.98 (0.93–1.04)	Age at menarche, parity, age at first birth, OC use, history of benign breast disease, family history of breast cancer, smoking status, education, BMI, alcohol intake, total energy intake, height
			Premenopausal women	NR	0.97 (0.79–1.2)	
			Postmenopausal women	NR	0.97 (0.91–1.03)	

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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
Voorrips et al. (2002) the Netherlands 1986–1992 (mean follow-up 6.3 years) Cohort	62 573 cohort /941 cases; the Netherlands Cohort Study on Diet and Cancer (NLCS) included 62 573 women aged 55–69 y at the beginning of the study, originating from 204 municipalities with computerized population registries. **Exposure assessment method:** Questionnaire; 150-item FFQ. Red meat, which was presented as 'fresh meat', included beef and pork and did not include processed meat.	Breast	Red meat, Q1	168	1	Age, history of benign breast disease, maternal breast cancer, breast cancer in one or more sisters, age at menarche, age at menopause, oral contraceptive use, parity, age at first childbirth, Quetelet index, education, alcohol use, current cigarette smoking, and energy intake
			Q2	154	0.95 (0.71–1.27)	
			Q3	151	0.81 (0.61–1.09)	
			Q4	156	1 (0.74–1.35)	
			Q5	154	0.98 (0.73–1.33)	
			Trend-test p-value: 1			
		Breast	Beef, Q1	140	1	Same as above
			Q2	158	1.22 (0.9–1.64)	
			Q3	169	1.1 (0.82–1.49)	
			Q4	139	0.99 (0.72–1.36)	
			Q5	177	1.23 (0.92–1.66)	
			Trend-test p-value: 0.36			
		Breast	Pork, Q1	182	1	Same as above
			Q2	160	0.93 (0.7–1.25)	
			Q3	165	0.9 (0.67–1.2)	
			Q4	129	0.77 (0.57–1.04)	
			Q5	147	0.8 (0.6–1.08)	
			Trend-test p-value: 0.02			

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Zheng et al. (2002) Iowa, USA 1992–1994 Nested Case-Control	**Cases:** 202; Iowa Women's Health Study Cohort members (age 55–69 years in 1986), diagnosed with breast cancer between 1992 and 1994, with GSTM1 AND GSTT1 genotyping results. **Controls:** 481; Randomly selected from cohort members who were cancer free as of January 1, 1992, and had GSTM1 AND GSTT1 genotyping results. **Exposure assessment method:** Questionnaire; Exposure to well done meat was measured by assessing usual doneness levels of hamburger, beef steak, and bacon using colour photographs in the questionnaire. Doneness levels of rare or medium, well done, and very well done were given scores of 1, 2, or 3, respectively, for each food to describe participants usual eating habits. A doneness score, defined as the sum of the usual doneness level for each of these three meats, was then calculated. The scores ranged from 3 to 9, with three representing the usual intake of rare/medium done, and nine representing the usual intake of very well done. To enhance the stability of risk estimates, several levels of the doneness score were combined to form the following three groups: rare/medium, scores 3–4; mostly well done, score 5; and consistently well or very well done, scores 6–9.	Breast (174)	GSTM1 present: Red meat Rare or Medium doneness	23	1	Age, waist-to-hip ratio, number of live births, and family history
			Mostly well done	33	2.5 (1.3–4.8)	
			Consistently well/very well done	35	1.6 (0.9–3)	
			GSTM1 null: Rare or medium	21	1 (0.5–1.9)	
			Mostly well done	21	1.3 (0.6–2.5)	
			Consistently well/very well done	46	2.5 (1.3–4.5)	
			Trend-test p-value: 0.04			
		Breast (174)	GSTT1 present: Red meat, Rare or Medium doneness	26	1	Same as above
			Mostly well done	28	1.9 (1–3.6)	
			Consistently well/very well done	47	1.9 (1.1–3.4)	
			GSTT1 null: Rare or medium	7	1.1 (0.4–3.8)	
			Mostly well done	12	2.4 (1–5.8)	
			Consistently well/very well done	16	3.2 (1.4–7.2)	
			Trend-test p-value: 0.78			

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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 (174)	Both GSTM1 and GSTT1 Present: Red meat, Rare or Medium doneness	13	1	Same as above
			Mostly well done	13	2.4 (0.9–6.1)	
			Consistently well/very well done	17	1.3 (0.6–3)	
			Either one null: Rare or medium	20	1.2 (0.6–2.8)	
			Mostly well done	27	2.2 (1–4.8)	
			Consistently well/very well done	46	3.4 (1.6–7.1)	
			Trend-test p-value: 0.14			

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Holmes et al. (2003) USA Follow-up 1980–1998 Cohort	Cohort 88 647/4107 cases; In 1976, the Nurses' Health Study (NHS) cohort was established when 121 700 female registered nurses from across the United States, aged 30–55 years, answered a mailed questionnaire on risk factors for cancer and cardiovascular disease. **Exposure assessment method:** Questionnaire; In 1980, a 61-item food-frequency questionnaire designed to assess dietary intake was used. In 1984, 1986, 1990 and 1994, an expanded food-frequency questionnaire was used. The validity and reproducibility of the food frequency questionnaires have been documented.	Breast	All women, Red meat, ≤ 0.55 servings/d	NR	-	Age, total energy intake, alcohol intake, parity and age at first birth, body mass index at age 18, weight change since age 18, height, family history of breast cancer, history of benign breast disease, age at menarche, menopausal status, age at menopause and hormone replacement therapy use., duration of menopause
			0.56–0.76	NR	0.99 (0.9–1.09)	
			0.77–0.99	NR	0.99 (0.89–1.09)	
			1.00–1.31	NR	1 (0.91–1.11)	
			≥ 1.32	NR	0.94 (0.84–1.05)	
			Trend-test p-value: 0.45			
		Breast	Premenopausal women: ≤ 0.55 servings/d	NR	-	Same as above
			0.56–0.76	NR	0.95 (0.75–1.2)	
			0.77–0.99	NR	1.03 (0.82–1.3)	
			1.00–1.31	NR	1.11 (0.89–1.41)	
			≥ 1.32	NR	0.94 (0.72–1.22)	
			Trend-test p-value: 0.90			
		Breast	Postmenopausal women: ≤ 0.55 servings/d	NR	-	Same as above
			0.56–0.76	NR	1.03 (0.92–1.15)	
			0.77–0.99	NR	1 (0.89–1.13)	
			1.00–1.31	NR	0.99 (0.88–1.12)	
			≥ 1.32	NR	0.99 (0.86–1.13)	
			Trend-test p-value: 0.66			

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van der Hel et al. (2004) Amsterdam, Maastricht and Doetinchem, the Netherlands Enrollment 1987–1991: follow-up 1987–1997 Nested Case-Control	**Cases:** 229; Women enrolled at age 20–55 in the Monitoring Project on Cardiovascular Disease Risk Factors, with first incident breast cancer and a with blood sample.	Breast	Red meat, < 30 g/day	70	1	Age, menopausal status, town, energy intake, smoking, alcohol, age at menarche and BMI
			30–44 g/day	77	1.3 (0.82–2.06)	
			≥ 45 g/day	82	1.32 (0.84–2.08)	
	Controls: 264; Random sample from the same cohort, with blood samples, matched to the cases on age, menopausal status, and residence.	Breast	GSTM1 present: Red meat, < 30 g/day	25	1	Same as above
			30–44 g/day	35	1.49 (0.75–2.98)	
			> 45 g/day	40	1.8 (0.92–3.51)	
	Exposure assessment method: Questionnaire; Meat consumption was recorded at baseline by use of a validated self-administered FFQ. Portion sizes of every meat type were derived from a Dutch national reference book on portion sizes and food coding. Red meat intake in grams per day was calculated by adding up intake of beef and pork.		GSTM1 null: Red meat, < 30 g/day	45	2.04 (1.06–3.94)	
			30–44 g/day	46	2.37 (1.22–4.6)	
			> 45 g/day	42	2.11 (1.08–4.14)	
Kabat et al. (2007) Canada Enrollment 1980–1985; average follow-up 16.4 years Cohort	Cohort 49 654/2491 cases; Canadian National Breast Screening Study, a randomized controlled trial of screening for breast cancer involving women aged 40 to 59 at baseline.	Breast	All women, Heme iron, < 1.58 mg/d	NR	1	Age, body mass index, menopausal status, parity, age at menarche, family history of breast cancer in a first-degree relative, history of benign breast disease, oral contraceptive use, HRT, total calorie intake, alcohol intake, education, study centre, and randomization group
	Exposure assessment method: Questionnaire; The validated FFQ elicited information on usual portion size and consumption of 86 food items, including photographs of portion sizes to assist respondents in quantifying intake. Heme iron intake was computed by two different methods using different proportions for heme iron from different types of meat: 69% for beef; 39% for pork, ham, bacon, pork-based luncheon meats, and veal; 26% for chicken and fish; and 21% for liver (20); and, alternatively, using 40% as the average proportion of heme iron in all meats.		1.58 < 1.99	NR	1.03 (0.91–1.18)	
			1.99 < 2.40	NR	1.1 (0.97–1.25)	
			2.40 < 2.95	NR	1.15 (1.01–1.31)	
			> 2.95	NR	1.03 (0.9–1.18)	
			Trend-test p-value: 0.25			

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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	Premenopausal women, heme iron < 1.58 mg/d	NR	1	Same as above
			1.58 < 1.99	NR	1.06 (0.88–1.27)	
			1.99 < 2.40	NR	1.08 (0.89–1.3)	
			2.40 < 2.95	NR	1.14 (0.94–1.37)	
			> 2.95	NR	1.03 (0.84–1.25)	
			Trend-test p-value: 0.56			
		Breast	Postmenopausal women, heme iron < 1.58 mg/d	NR	1	Same as above
			1.58 < 1.99	NR	1 (0.82–1.23)	
			1.99 < 2.40	NR	1.07 (0.87–1.3)	
			2.40 < 2.95	NR	1.15 (0.94–1.41)	
			> 2.95	NR	0.97 (0.78–1.2)	
			Trend-test p-value: 0.71			
		Breast	All women, red meat < 14.25 g/d	NR	1	Same as above
			14.25 < 21.02	NR	0.98 (0.87–1.11)	
			21.02 < 28.74	NR	1.04 (0.92–1.16)	
			28.74 < 40.30	NR	1.03 (0.9–1.18)	
			≥ 40.30	NR	0.98 (0.86–1.12)	
			Trend-test p-value: 0.91			

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		Breast	Premenopausal women, red meat < 14.25 g/d	NR	1	Same as above
			14.25 < 21.02	NR	1.1 (0.91–1.34)	
			21.02 < 28.74	NR	1.29 (1.07–1.58)	
			28.74 < 40.3	NR	1.18 (0.97–1.43)	
			≥ 40.30	NR	1.14 (0.94–1.39)	
			Trend-test p-value: 0.16			
		Breast	Postmenopausal women, red meat < 14.25 g/d	NR	1	Same as above
			14.25 < 21.02	NR	0.99 (0.81–1.19)	
			21.02 < 28.74	NR	0.87 (0.71–1.06)	
			28.74 < 40.30	NR	0.89 (0.72–1.09)	
			≥ 40	NR	0.89 (0.72–1.09)	
			Trend-test p-value: 0.13			

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Taylor et al. (2007) England, Wales, Scotland Enrollment 1995–1998; median follow-up 8 years Cohort	Cohort 35 372/678 cases; Participants of United Kingdom Women's Cohort Study, aged 35–69 y, living in England, Wales and Scotland. The cohort was constructed to have similar, large numbers of three groups: vegetarians, meat-eaters and fish-eaters. **Exposure assessment method:** Questionnaire; Diet was assessed between 1995 and 1998 using a 217-item postal FFQ developed from that of the EPIC study. Red meat consisted of beef, pork, lamb and other red meats included in mixed dishes, for example, meat lasagne, moussaka, ravioli and filled pasta with sauce. Processed meat consisted of bacon, ham, corned beef, spam, luncheon meats, sausages, pies, pasties, sausage rolls, liver pate, salami and meat pizza.	Breast	Red Meat, Premenopausal: 0 g/day	113	1	Age, energy intake, BMI, physical activity, smoking status, HRT use, OCP use, parity, total fruit and vegetable intake
			< 32 g/day	50	0.8 (0.55–1.17)	
			32–57 g/day	59	1.19 (0.83–1.7)	
			> 57 g/day	61	1.32 (0.93–1.88)	
			Trend-test p-value: 0.08			
		Breast	Red Meat, Postmenopausal: 0 g/day	73	1	Same as above
			< 32 g/day	112	1.63 (1.15–2.31)	
			32– 57 g/day	104	1.64 (1.15–2.34)	
			> 57 g/day	106	1.56 (1.09–2.23)	
			Trend-test p-value: 0.040			
		Breast	Combined pre-and postmenopausal: red meat (g/day), none	186	1	Same as above
			< 32 g/day	162	1.21 (0.95–1.54)	
			32–57 g/day	163	1.4 (1.1–1.78)	
			> 57 g/day	167	1.41 (1.11–1.81)	
			Trend-test p-value: 0.007			

Table 2.6.1 Cohort 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
Egeberg et al. (2008) Copenhagen and Aarhus, Denmark Enrollment 1993–1997; median follow-up 4.2 years Nested Case-Control	**Cases:** 378; Participants of 'Diet, Cancer, and Health' cohort study, postmenopausal at baseline (age 50–64), with incident breast cancer before end of year 2000. **Controls:** 378; Cohort participant postmenopausal women free of cancer at the exact age at diagnosis of the case. Matched on age at inclusion into the cohort. **Exposure assessment method:** Questionnaire; Meat consumption was estimated from a validated 192-item FFQ completed at baseline covering the participants' habitual diet during the preceding 12 months. Intake of red meat in grams per day was calculated by adding up intake of beef, veal, pork, lamb and offal. NAT1 and NAT2 genotyping was performed blinded to case-control and exposure status.	Breast	Red Meat: < 50 g/day	89	1	Parity, age at first birth, education, duration of hormone replacement therapy use, intake of alcohol and body mass index
			50 < 65 g/day	102	1.64 (1.08–2.48)	
			65 < 80 g/day	83	1.81 (1.16–2.82)	
			> 80 g/day	104	1.65 (1.09–2.5)	
			Trend-test p-value: 0.03			
		Breast	Red Meat per 25 g/d: NAT1 slow	710	1.03 (0.87–1.23)	Same as above
			NAT1 fast	710	1.27 (0.98–1.64)	
			NAT2 slow	734	1 (0.85–1.18)	
			NAT2 intermediate/fast	734	1.37 (1.07–1.76)	
			Trend-test p-value: 0.04			

Table 2.6.1 Cohort 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
Ferrucci et al. (2009) USA Enrollment 1993–2001/ mean follow-up 5.5 years Cohort	Cohort 52 158/1205 cases; Members of the PLCO Cancer Screening Trial cohort to evaluate screening methods for the early detection of prostate, lung, colorectal, and ovarian cancer: women aged 55–74 years, recruited from 10 centres in the US. **Exposure assessment method:** Questionnaire; 124 food item FFQ. Haem iron estimated from meat using the NCI heme iron database based on the measured values of haem iron from meat samples cooked by a range of methods to varying doneness levels. Red meat included bacon, beef, cheeseburgers, cold cuts, ham, hamburgers, hot dogs, liver, pork, sausage, veal, venison, and red meat from mixed dishes. Processed meat included bacon, cold cuts, hams, hot dogs, and sausage.	Breast	Red meat: ≤ 15 g/1000 kcal	215	1	Age, race, education, study centre, randomization group, family history of breast cancer, age at menarche, age at menopause, age at first birth and number of live births, history of benign breast disease, number of mammograms during past 3 years, menopausal hormone therapy use, body mass index, alcohol intake, total fat intake, total energy intake
			> 15–23	280	1.32 (1.1–1.58)	
			> 23–31	228	1.09 (0.9–1.32)	
			> 31–43	239	1.16 (0.96–1.42)	
			> 43–196	243	1.23 (1–1.51)	
			Trend-test p-value: 0.22			
		Breast	Heme iron from meat ≤ 0.07 mg/1000 kcal	216	1	Same as above
			> 0.07–0.11	259	1.22 (1.02–1.47)	
			> 0.11–0.16	254	1.21 (1.01–1.46)	
			> 0.16–0.23	250	1.22 (1.01–1.47)	
			> 0.23–1.49	226	1.12 (0.92–1.38)	
			Trend-test p-value: 0.59			
Kabat et al. (2009) USA Enrollment 1995–1996; follow-up 8 years Cohort	Cohort 120 755/3,818 cases; AARP cohort members, women aged 50–71 years, residing in six US states (California, Florida, Louisiana, New Jersey, North Carolina, and Pennsylvania) and two metropolitan areas (Atlanta, GA, and Detroit, MI), who completed questionnaires. **Exposure assessment method:** Questionnaire; Self-administered validated NCI FFQ with 124 food items. Red meat included bacon, beef, cold cuts, ham, hamburgers, hot dogs, liver, pork, sausage, and steak. Processed meat included bacon, red meat sausage, poultry sausage, luncheon meat (red and white meat), cold cuts (red and white meat), ham, regular hot dogs, and low-fat hot dogs made from poultry.	Breast	Red meat: Quintile 1	718	1	Age, BMI, age at menarche, age at first live birth, family history of breast cancer, hormone replacement therapy, education, race, total energy intake, saturated fat intake, alcohol intake, physical activity, smoking, age at menopause, number of breast biopsies
			Quintile 2	791	1.09 (0.98–1.21)	
			Quintile 3	818	1.13 (1.02–1.26)	
			Quintile 4	768	1.07 (0.97–1.2)	
			Quintile 5	723	1.05 (0.93–1.18)	
			Trend-test p-value: 0.66			

Table 2.6.1 Cohort 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
Larsson et al. (2009) Central Sweden Enrollment 1987–1990; mean follow-up 17.4 years Cohort	Cohort 66 651/2952 cases; Members of Swedish Mammography Cohort: women born 1917–1948 in Västmanland County and 1914–1948 in Uppsala County screened by mammography. **Exposure assessment method:** Questionnaire; 67 and 96 food item FFQs at baseline and in 1997, respectively. Fresh red meat included all fresh and minced pork, beef and veal. Processed meats included ham, bacon, sausages, salami, processed meat cuts, liver paté and blood sausages. Total red meat was the sum of fresh red meat and processed meat.	Breast Total breast cancer	Red meat < 46 g/d	604	1	Age in months at the start of each follow-up period (baseline and 1997) and calendar year of the questionnaire cycle and simultaneously adjusted for education (primary school, high school and university), body mass index (< 18.5, 18.5–24.9, 25–29.9,P30 kg/ m2), height (in cm), parity and age at first birth (nulliparous, parity 1–2 and age at first birth < 26 years, parity 1–2 and age at first birth 26–30 years, parity 1–2 and age at first birth P31, parity P3 and age at first birth < 26 years, parity P3 and age at first birth 26–30, parity P3 and age at first birth P31 years), age at menarche (612, 13, P14 years), age at menopause (< 51, P51 years), use of oral contraceptives (ever/never), use of postmenopausal hormones (ever/never), family history of breast cancer (yes/no) and intakes of total energy (in kcal/d) and alcohol (non-drinkers, < 3.4, 3.4–9.9, P10.0 g/d)
			46–61	602	0.99 (0.88–1.11)	
			62–76	615	1.03 (0.92–1.16)	
			77–97	577	0.98 (0.86–1.1)	
			≥ 98	554	0.98 (0.86–1.12)	
			Trend-test p-value: 0.72			

Table 2.6.1 Cohort 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+ tumours	Red meat < 46 g/d	273	1	Same as above
			46–61	263	0.95 (0.8–1.13)	
			62–76	257	0.98 (0.82–1.17)	
			77–97	248	1 (0.83–1.2)	
			≥ 98	245	1.1 (0.9–1.34)	
			Trend-test p-value: 0.21			
		Breast ER+/PR– tumours	Red meat < 46 g/d	82	1	Same as above
			46–61	87	0.98 (0.72–1.34)	
			62–76	92	1.02 (0.75–1.39)	
			77–97	91	1.02 (0.74–1.4)	
			≥ 98	65	0.86 (0.6–1.23)	
			Trend-test p-value: 0.41			
		Breast ER–/PR– tumours	Red meat < 46 g/d	43	1	Same as above
			46–61	54	1.26 (0.83–1.9)	
			62–76	66	1.62 (1.08–2.42)	
			77–97	61	1.49 (0.98–2.26)	
			≥ 98	42	1.12 (0.7–1.79)	
			Trend-test p-value: 0.91			

Table 2.6.1 Cohort 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
Pala et al. (2009) Denmark, France, Germany, Greece, Italy, Norway, Spain, Sweden, Netherlands, United Kingdom Enrollment 1992–2003/median follow-up 8.8 years Cohort	Cohort 319 826/7119 cases; EPIC cohort members: cancer free women aged 20–70 years. In most centres, participants came from the general population. **Exposure assessment method:** Questionnaire; Diet was assessed by using country-specific (in Italy and Sweden centre-specific) validated FFQs designed to capture habitual consumption of food over the preceding year. Red meat consisted of fresh, minced, and frozen beef, veal, pork, and lamb. Processed meats were mostly pork and beef preserved by methods other than freezing, such as salting, smoking, marinating, air-drying, or heating and included ham, bacon, sausages, blood sausages, liver paté, salami, mortadella, tinned meat, and others.	Breast	Quintiles of red meat intake (g/day, median) among postmenopausal women:			Energy, height, weight, years of schooling, alcohol intake, and smoking; stratified by centre and age
			Q1: 1.4 g/d	622	1	
			Q2: 21.3 g/d	634	1.03 (0.92–1.16)	
			Q3: 36.0 g/d	693	1.03 (0.92–1.15)	
			Q4: 54.4 g/d	860	1.13 (1.01–1.26)	
			Q5: 84.6 g/d	864	1.05 (0.94–1.18)	
			Trend-test p-value: 0.22			
		Breast	Red Meat, Premenopausal: 1.4 g/d	343	1	Same as above
			21.3 g/d	306	0.99 (0.84–1.17)	
			36.0 g/d	299	0.96 (0.81–1.13)	
			54.4 g/d	341	0.98 (0.83–1.15)	
			84.6 g/d	410	0.94 (0.8–1.1)	
			Trend-test p-value: 0.42			
		Breast Cancer	Red meat, median intake by quintile, 1.4 g/day	1266	1	Energy, height, weight, years of schooling, smoking, menopause, stratified by centre and age
			21.3 g/day	1244	1.04 (0.96–1.14)	
			36.0 g/day	1322	1.03 (0.95–1.12)	
			54.4 g/day	1537	1.06 (0.98–1.15)	
			84.6 g/day	1750	1.06 (0.98–1.14)	
			Trend-test p-value: 0.19			

Table 2.6.1 Cohort 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
Loh et al. (2010) Norfolk, East Anglia, United Kingdom Enrollment 1993–1997, follow-up till end of 2006 Nested Case-Control	**Cases:** 276; Women aged 40–79 years at baseline from EPIC-Norfolk cohort, diagnosed with breast cancer. **Controls:** 1498; Women, members of EPIC cohort, cancer free and had genotyping data for the specific gene polymorphism studied. **Exposure assessment method:** Questionnaire; Dietary data using a 7-day diary of all food and drink consumed. The diary booklet contains colour food portion photographs and detailed instructions in which the description, preparation and amounts of foods eaten at main meals, snacks and between meals over a week can be recorded. The first day of the food diary was an interviewed 24-hour recall. Red meat (beef, lamb/mutton, pork, veal, rabbit and venison including all muscle cuts and meats in composite dishes, excluding offal), processed meat (meat that has undergone smoking, curing, salting or the addition of chemical preservatives, including bacon, fresh and dried sausage and ham).	Breast	Red and Processed Meat, MGMT Ile/Ile, < 46 g/d	98	1	Age, date of entry to study, cigarette smoking status, BMI
			Ile/Ile, ≥ 46 g/d	95	1 (0.73–1.38)	
			Ile/Val + Val/Val, < 46 g/d	41	1.43 (0.94–2.18)	
			Ile/Val + Val/Val, ≥ 46 g/d	37	0.75 (0.45–1.24)	
			Trend-test p-value: 0.33			

Table 2.6.1 Cohort 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
Genkinger et al. (2013) USA, > 17 states Enrollment 1995; follow-up 12 years Cohort	Cohort 52 062/1268 cases; Participants of the Black Women's Health Study, African-American women aged 21–69 years at baseline in 1995. Women were subscribers to Essence magazine, members of several professional organizations, and friends and relatives of early respondents enrolled by completing health questionnaires on diet, lifestyle factors, medical and reproductive history, and medication use. Study participants reside in more than 17 states. **Exposure assessment method:** Questionnaire; Diet during the past year was estimated from a 68-item modified Block FFQ including 13 meat items, completed at baseline in 1995. In 2001, a modified version asked about 85 food items including 15 meat items was administered to collect updated dietary information.	Breast	Red meat: < 100 g/wk	492	1	Age, energy intake, age at menarche, body mass index, family history of breast cancer, education, parity and age at first live birth, oral contraceptive use, menopausal status, age at menopause, menopausal hormone use, vigorous physical activity, smoking status, and alcohol intake
			100–199.9 g/wk	335	1 (0.86–1.15)	
			200–299.9 g/wk	172	0.9 (0.75–1.09)	
			300–399.9 g/wk	102	0.95 (0.76–1.19)	
			≥ 400 g/wk	167	1.02 (0.83–1.24)	
			Trend-test p-value: 0.83			
		Breast	Premenopausal: Red meat < 100 g/wk	203	1	Same as above
			100–199.9 g/wk	151	1.01 (0.83–1.22)	
			200–299.9 g/wk	75	0.9 (0.7–1.14)	
			300–399.9 g/wk	49	0.98 (0.73–1.31)	
			≥ 400 g/wk	95	1.01 (0.78–1.3)	
			Trend-test p-value: 0.89			
		Breast	Postmenopausal: Red meat < 100 g/wk	223	1	Same as above
			100–199.9 g/wk	140	0.96 (0.77–1.19)	
			200–299.9 g/wk	67	0.86 (0.65–1.15)	
			300–399.9 g/wk	38	0.92 (0.64–1.32)	
			≥ 400 g/wk	52	0.86 (0.62–1.2)	
			Trend-test p-value: 0.39			

Table 2.6.1 Cohort 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. (2013) USA Follow-up 1990–2004 Nested Case-Control	**Cases:** 579; Participants in the Nurses Health Study, diagnosed with postmenopausal invasive breast cancer 1990–2004, who provided blood samples for a genome-wide association study. **Controls:** 981; NHS cohort members, postmenopausal women not diagnosed with breast cancer during follow-up until June 1, 2004. Controls matched by year of birth and post-menopausal hormone use at the time of blood collection. **Exposure assessment method:** Questionnaire; Dietary intake data were collected in 1980, 1984, 1986, 1990. Total red meat intake was calculated as cumulative average intake up to 1990. The cooking method questionnaire administered in 1996 was designed to estimate the intake of heterocyclic amines and meat-derived mutagenity. HCA and MDM intakes were calculated from the data provided on the 1996 cooking method questionnaire and dietary data in 1994 using the "CHARRED Database" from the National Cancer Institute. SNPs data were extracted on CYP1A2 and NAT2 from previous GWAS of breast cancer. Determination of NAT2 acetylator status was based on imputed SNPs information.	Breast (174)	Tertiles of red meat intake (servings/day, median)			Age, smoking status, BMI at 18 yr, weight gain from 18 yr, age at menarche, family history of breast cancer, parity and age at first birth, postmenopausal hormone use, history of benign breast disease, total calorie and alcohol intake
			Tertile 1 (0.6)	344	1	
			Tertile 2 (1.0)	340	0.95 (0.76–1.19)	
			Tertile 3 (1.5)	373	1.06 (0.83–1.36)	
			Trend-test p-value: 0.59			
		Breast	Tertiles of red meat intake (servings/day) <u>NAT2 slow acetylators:</u>			Same as above
			Tertile 1	214	1	
			Tertile 2	208	0.93 (0.7–1.24)	
			Tertile 3	216	0.96 (0.69–1.32)	
			Trend-test p-value: 0.81			
		Breast	<u>NAT2 fast acetylators:</u>			Same as above
			NAT2 fast acetylator Red meat,, Tertile 1	130	1	
			Tertile 2	132	1 (0.69–1.43)	
			Tertile 3	157	1.24 (0.83–1.84)	
			Trend-test p-value: 0.27			
		Breast	CYP1A2 AA genotype:			Same as above
			Tertile 1	194	1	
			Tertile 2	170	0.73 (0.53–1)	
			Tertile 3	191	0.83 (0.58–1.18)	
			Trend-test p-value: 0.38			

Table 2.6.1 Cohort 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	CYP1A2 AC/CC genotype:			Same as above
			Tertile 1	150	1	
			Tertile 2	170	1.28 (0.93–1.77)	
			Tertile 3	182	1.44 (1–2.06)	
			Trend-test p-value: 0.05			
Farvid et al. (2014) USA Enrollment 1991; follow-up 20 years Cohort	Cohort 88 803/2830 cases; Premenopausal women aged 26–45 years, members of the Nurses' Health Study II cohort. **Exposure assessment method:** Questionnaire; Diet was assessed by validated FFQ with approximately 130 food items. Red meat included unprocessed red meat (beef, pork, or lamb as a sandwich, pork as a main dish, beef or lamb as a main dish, and hamburger) and processed red meat (hot dogs, bacon, and other processed meat such as sausage, salami, and bologna).	Breast	**Quintiles of total red meat intake (median, servings/day) All women:**			Age, smoking, height, parity and age at first birth, BMI, age and menarche, family history of breast cancer, history of benign breast disease, oral contraceptive use, alcohol intake, energy intake
			Quintile 1 (0.14)	493	1	
			Quintile 2 (0.49)	698	1.1 (0.98–1.24)	
			Quintile 3 (0.70)	522	1.12 (0.99–1.28)	
			Quintile 4 (0.99)	564	1.1 (0.97–1.25)	
			Quintile 5 (1.5)	553	1.22 (1.06–1.4)	
			Trend-test p-value: 0.01			
		Breast	Premenopausal women: Quintile 1	275	1	Same as above
			Quintile 2	361	1.02 (0.87–1.19)	
			Quintile 3	285	1.11 (0.94–1.32)	
			Quintile 4	297	1.05 (0.88–1.25)	
			Quintile 5	293	1.12 (0.93–1.35)	
			Trend-test p-value: 0.22			

Table 2.6.1 Cohort 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	Postmenopausal women: Quintile 1	151	1	Same as above
			Quintile 2	226	1.18 (0.96–1.46)	
			Quintile 3	180	1.26 (1–1.57)	
			Quintile 4	184	1.19 (0.95–1.5)	
			Quintile 5	177	1.23 (0.96–1.57)	
			Trend-test p-value: 0.18			
		Breast	**Quintiles of heme iron intake (median, mg/day) All women:**			Race, height, BMI at 18 y, hormone use and menopausal status, age at menopause, age, family history of breast cancer in mother or sisters, history of benign breast disease, smoking, age at menarche, parity and age at first birth, oral contraceptive use, alcohol intake, energy intake
			Q1 (0.6)	431	1	
			Q2 (0.9)	583	1.14 (1–1.29)	
			Q3 (1.0)	566	1.04 (0.92–1.18)	
			Q4 (1.3)	663	1.08 (0.95–1.22)	
			Q5 (1.6)	587	1.12 (0.99–1.28)	
			Trend-test p-value: 0.17			
		Breast	Premenopausal women:			Same as above
			Q1 (0.6)	238	1	
			Q2 (0.9)	332	1.16 (0.98–1.37)	
			Q3 (1.0)	303	1.03 (0.87–1.23)	
			Q4 (1.3)	326	1.06 (0.89–1.26)	
			Q5 (1.6)	312	1.15 (0.97–1.37)	
			Trend-test p-value: 0.26			

Table 2.6.1 Cohort 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	Postmenopausal women:			Same as above
			Q1 (0.6)	219	1	
			Q2 (0.9)	191	0.96 (0.79–1.17)	
			Q3 (1.0)	184	1 (0.82–1.22)	
			Q4 (1.3)	130	0.91 (0.73–1.13)	
			Q5 (1.6)	194	0.96 (0.79–1.17)	
			Trend-test p-value: 0.66			
Pouchieu et al. (2014) France Enrollment 1994–1995; mean follow-up 11.3 years Cohort	Cohort 4684/190 cases; Women aged 35–60 years from the general population, participating in SU.VI.MAX randomized, placebo-controlled prevention trial of antioxidant vitamins and minerals. **Exposure assessment method:** other; During the follow-up period, participants completed a 24h dietary record every 2 months. Dietary records from the first 2 years of follow-up were used in the analysis. Total daily intake of red meat and processed meat in g/day were measured. Red meat consisted of fresh, minced and frozen beef, veal, pork, and lamb. Processed meats were mostly pork and beef preserved by methods other than freezing, such as salting, smoking, marinating, air-drying or heating and included ham, bacon, sausages, blood sausages, liver paté, salami, mortadella, tinned meat and others.	Breast	**Quartiles of red meat intake (g/day),** All women			Age, intervention group, number of dietary records, smoking status, educational level, physical activity, height, BMI, family history of breast cancer, menopausal status at baseline, use of HTM at baseline, number of live births, without-alcohol energy intake, alcohol intake, total lipid intake, processed meat intake
			Q1 < 24.9 g/d	NR	1	
			Q2 24.9 < 42.5 g/d	NR	0.82 (0.58–1.36)	
			Q3 42.5 < 63.7 g/d	NR	1.05 (0.7–1.58)	
			Q4 ≥ 63.7 g/d	NR	1.19 (0.79–1.8)	
			Trend-test p-value: 0.3			
		Breast	Placebo group, red meat, < 24.9 g/d	NR	1	Same as above
			24.9 < 42.5 g/d	NR	0.73 (0.4–1.31)	
			42.5–63.7 g/d	NR	1.03 (0.6–1.77)	
			≥ 63.7 g/d	NR	1.01 (0.58–1.74)	
			Trend-test p-value: 0.7			

Table 2.6.1 Cohort 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	Antioxidant-supplemented group, red meat, < 24.9 g/d	NR	1	Same as above
			24.9 < 42.5 g/d	NR	1.11 (0.59–2.1)	
			42.5 < 63.7 g/d	NR	1.14 (0.6–2.14)	
			≥ 63.7 g/d	NR	1.46 (0.78–2.72)	
			Trend-test p-value: 0.2			
Farvid et al. (2015) USA 1998; follow-up 13 years Cohort	Cohort 44 231/1132 cases; Women aged 33–52 years, members of the Nurses' Health Study II cohort who in 1998 completed a questionnaire about diet during adolescence. **Exposure assessment method:** Questionnaire; Adolescent diet was measured using a 124-item validated high-school FFQ. Total red meat intake included unprocessed red meat (hamburger, beef, lamb, pork and meatloaf) and processed red meat items (hot dog, bacon and other processed meat such as sausage, salami and bologna).	Breast	Quintiles of total red meat intake (median servings/day), all women			Age, race, smoking status, height, adolescent total energy intake, family history of breast cancer, history of benign breast disease, menopausal status, age at menarche, parity, age at first birth, weight gain since age 18 y, BMI at age 18 y, oral contraceptive, adolescent alcohol intake, adult alcohol use, adolescent energy intake, postmenopausal hormone use, menopausal status, and age at menopause
			Quintile 1 (0.70)	223	1	
			Quintile 2 (1.13)	200	0.88 (0.73–1.08)	
			Quintile 3 (1.42)	229	1.04 (0.85–1.26)	
			Quintile 4 (1.78)	236	1.07 (0.88–1.31)	
			Quintile 5 (2.43)	244	1.17 (0.94–1.44)	
			Trend-test p-value: 0.048			
		Breast	Premenopausal women, total red meat, Quintile 1	104	1	Same as above
			Quintile 2	98	1.01 (0.76–1.34)	
			Quintile 3	104	1.04 (0.78–1.39)	
			Quintile 4	115	1.27 (0.95–1.7)	
			Quintile 5	125	1.43 (1.05–1.94)	
			Trend-test p-value: 0.007			

Table 2.6.1 Cohort 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	Postmenopausal women, total red meat, Quintile 1	103	1	Same as above
			Quintile 2	88	0.8 (0.59–1.07)	
			Quintile 3	95	0.86 (0.64–1.15)	
			Quintile 4	93	0.84 (0.62–1.15)	
			Quintile 5	104	0.99 (0.72–1.37)	
			Trend-test p-value: 0.73			
		Breast	All women, red meat, Quintile 1	249	1	Same as above
			Quintile 2	174	1.06 (0.87–1.28)	
			Quintile 3	229	1.02 (0.85–1.23)	
			Quintile 4	249	1.11 (0.92–1.34)	
			Quintile 5	231	1.17 (0.95–1.43)	
			Trend-test p-value: 0.11			
		Breast	Premenopausal women, red meat, Quintile 1	101	1	Same as above
			Quintile 2	111	1.12 (0.85–1.48)	
			Quintile 3	113	1.11 (0.84–1.48)	
			Quintile 4	114	1.17 (0.88–1.56)	
			Quintile 5	107	1.22 (0.9–1.66)	
			Trend-test p-value: 0.22			

Table 2.6.1 Cohort 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	Postmenopausal women, red meat, Quintile 1	109	1	Same as above
			Quintile 2	93	0.98 (0.74–1.3)	
			Quintile 3	72	0.74 (0.54–1.01)	
			Quintile 4	105	1.05 (0.79–1.4)	
			Quintile 5	104	1.09 (0.8–1.48)	
			Trend-test p-value: 0.42			
		Breast	All women, heme iron, Quintile 1	236	1	Age, race, family history of breast cancer in mother or sisters, history of benign breast disease, smoking, height, weight gain since age 18, BMI at age 18 years, age at menarche, parity and age at first birth, oral contraceptive use, adolescent alcohol intake, adult alcohol intake, and adolescent energy intake, hormone use and menopausal status, age at menopause
			Quintile 2	229	1.01 (0.84–1.21)	
			Quintile 3	219	0.95 (0.79–1.15)	
			Quintile 4	229	0.98 (0.81–1.18)	
			Quintile 5	219	1.01 (0.83–1.22)	
			Trend-test p-value: 1			
		Breast	Premenopausal women, heme iron, Quintile 1	86	1	Same as above
			Quintile 2	110	1.16 (0.87–1.54)	
			Quintile 3	105	1.12 (0.84–1.5)	
			Quintile 4	123	1.27 (0.96–1.69)	
			Quintile 5	122	1.14 (0.86–1.51)	
			Trend-test p-value: 0.36			

Table 2.6.1 Cohort 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	Postmenopausal women, heme iron, Quintile 1	98	1	Same as above
			Quintile 2	107	0.95 (0.72–1.26)	
			Quintile 3	79	0.72 (0.53–0.97)	
			Quintile 4	92	0.81 (0.61–1.08)	
			Quintile 5	107	0.92 (0.69–1.22)	
			Trend-test p-value: 0.49			
		Breast Cancer	Total red meat, per 1 serving/day, all women, ER+/PR+	694	1.06 (0.94–1.19)	Same as above
			Premenopausal women, ER+/PR+	350	1.23 (1.06–1.44)	
			Postmenopausal women, ER+/PR+	283	0.91 (0.75–1.1)	
			All women, ER–/PR–	160	1.06 (0.84–1.32)	
			Premenopausal women, ER–/PR–	83	1.18 (0.87–1.6)	
			Postmenopausal women, ER–/PR–	65	0.9 (0.62–1.3)	

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