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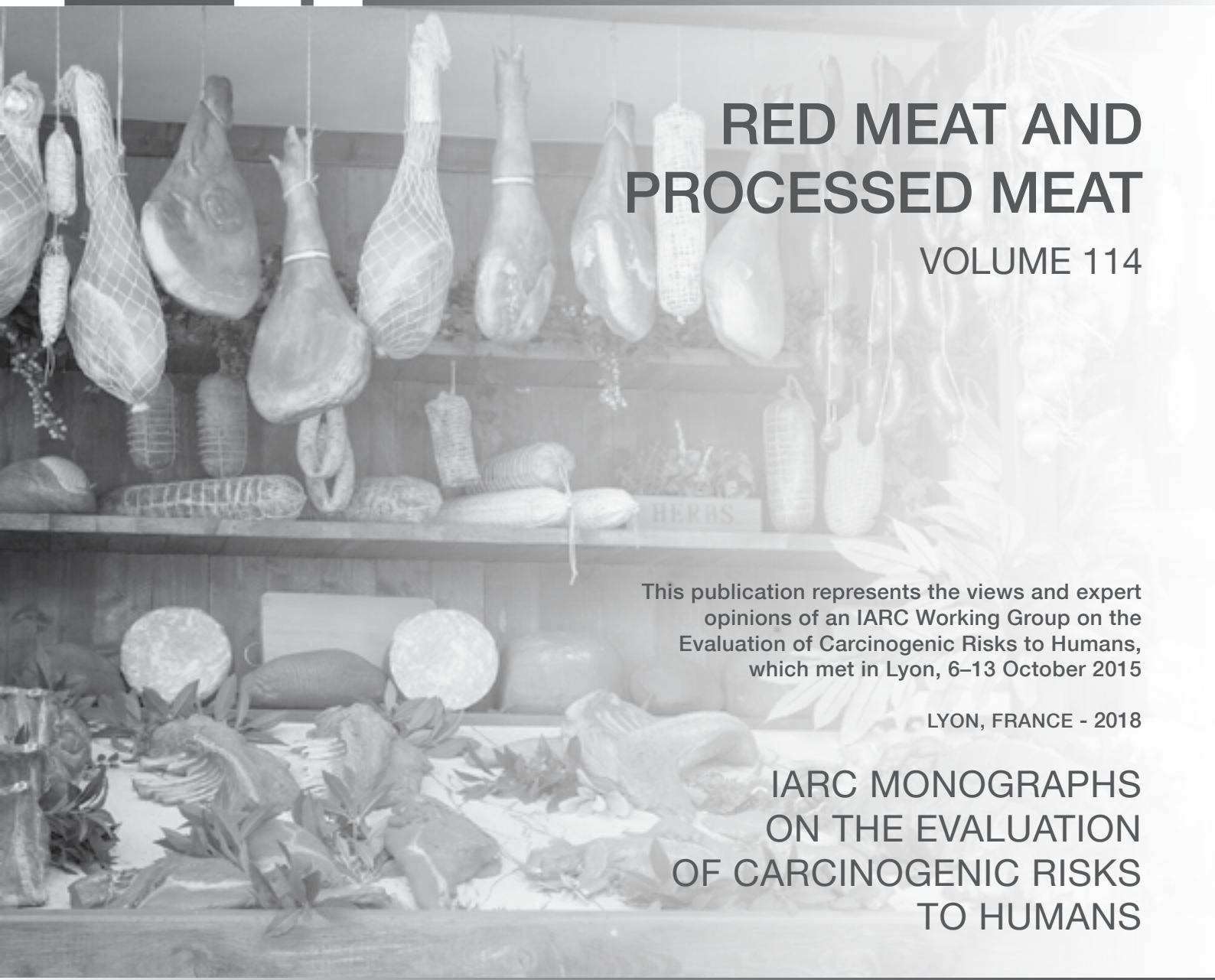

RED MEAT AND PROCESSED MEAT

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International Agency for Research on Cancer

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Table 2.6.4 Case-control studies: Processed 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. These were: 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	Cured meat: Quartile 1	1.0	-	Age and calories
			Quartile 2	1.1	-	
			Quartile 3	1.8	-	
			Quartile 4	1.3	-	

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Richardson et al. (1991) Southern France 1983–1987, hospital-based Case-Control	**Cases:** 409; Women age 28–66 years with histologically confirmed primary carcinoma of the breast, hospitalized in a cancer institute and had not previously undergone any therapy. **Controls:** 515; Women in the same age group, admitted for the first time to neurological, neurosurgical wards in a nearby hospital or hospitalized for general surgery in a large clinic. **Exposure assessment method:** Questionnaire; Block type 55-food item FFQ, ≥ 1 year dietary recall. Meat, processed pork and offal were evaluated.	Breast	Processed pork meat, ≤ 25 g/week	100	1	Age, menopausal status, alcohol consumption, family history of breast cancer, past history of benign breast disease, age at menopause, age at menarche, parity, age at first full-term pregnancy, Education level.
			25–87.5 g/week	154	1.4 (1–2)	
			> 87.5 g/week	155	1.4 (0.9–2)	
			Trend-test p-value: 0.094			
Goodman et al. (1992) Oahu, Hawaii 1975–1980, population-based Case-Control	**Cases:** 272; Postmenopausal Caucasian and Japanese women, residents of Oahu, aged 45–74 years, with histologically confirmed breast cancer.	Breast	Tertiles of sausage intake (g/week)			Age, ethnicity, age at first birth, and age at menopause.
			T1 (none)	NR	1	
			T2 (> 0–60)	NR	1.4	
			T3 (> 60)	NR	2.4	

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	Controls: 296; One neighbourhood control who had never had breast cancer was matched to each case by age (within 5 years), ethnic background, and Oahu residency. **Exposure assessment method:** Questionnaire; Reproducible and valid 43-food item FFQ; 1 week dietary recall; colour photographs to illustrate 3 most representative serving sizes. Red meat or processed meat not defined. Separate analyses for all meats combined, sausage, bacon, liver and pork, and other meats including spam, luncheon meats, beef, and lamb.		Trend-test p-value: < 0.01			
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. Pork and processed meats included pork chop, prosciutto, ham, salami, and sausages.	Breast	Pork and processed meats (serving/week), Q1 (< 1)	NR	1	Age, centre, education, parity, energy and alcohol intake
			Q2 (1 < 2)	NR	0.92 (0.77–1.09)	
			Q3 (2 < 3)	NR	1 (0.84–1.2)	
			Q4 (3 < 4.5)	NR	1.22 (1.01–1.47)	
			Q5 (≥□4.5)	NR	1.09 (0.89–1.33)	
			Trend-test p-value: < 0.05			

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De Stefani et al. (1997) Montevideo, Uruguay May 1994–November 1996 Case-Control	**Cases:** 352; Newly diagnosed cases of breast cancer **Controls:** 382; patient hospitalized in the same hospital for non-neoplastic diseases **Exposure assessment method:** Questionnaire; 64 item FFQ	Breast	Processed Meat, All Subjects, Quartile I	92	1	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.
			Quartile II	68	0.8 (0.5–1.27)	
			Quartile III	85	0.85 (0.53–1.34)	
			Quartile IV	107	0.88 (0.54–1.43)	
			Trend-test p-value: 0.64			
		Breast	Processed Meat, Premenopausal, Quartile I	17	1	Same as above
			Quartile II	12	0.66 (0.2–2.16)	
			Quartile III	13	0.48 (0.15–1.58)	
			Quartile IV	33	1.3 (0.43–3.92)	
			Trend-test p-value: 0.56			
		Breast	Processed Meat, Postmenopausal, Quartile I	75	1	Same as above
			Quartile II	56	0.8 (0.47–1.35)	
			Quartile III	72	0.91 (0.54–1.53)	
			Quartile IV	74	0.73 (0.42–1.3)	
			Trend-test p-value: 0.38			

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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
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 (Pre-Menopausal)	Quartiles of processed meat intake (g/day) (= bacon, breakfast sausages, ham, hot dogs, bologna and other cold cuts)			Age, education, age at menarche, age at first pregnancy, body mass index, family history of breast cancer, and total fruits and vegetables
			Q1 (< 14)	65	1	
			Q2 (14–29)	94	1.5 (1–2.4)	
			Q3 (29–48)	60	1 (0.6–1.6)	
			Q4 (> 48)	82	1.4 (0.9–2.3)	
			Trend-test p-value: 0.09			

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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	Processed meat 1–21 g/day 22–40 g/day 41–72 g/day > 72 g/day Trend-test p-value: 0.165	79 73 92 104	1 0.99 (0.67–1.45) 1.18 (0.81–1.72) 1.29 (0.86–1.95)	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
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	Breast	Tertiles of processed meat (servings per day) T1 (0–0.05) T2 (> 0.05–0.14) T3 (> 0.14) Trend-test p-value: 0.50	 211 104 119	 1 1.13 (0.79–1.62) 1.12 (0.79–1.62)	Age, total energy intake, number of pregnancies and highest level of education

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Shannon et al. (2005) China 1995–2000 Case-Control	**Cases:** 378;.The study was nested within a randomized trial of breast self-examination (BSE). Cases were 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	Breast	Cured meat (servings/m), ≤ 0.5	148	1	Age, total energy, and breast feeding
			0.5– < 1.2	109	1.1 (0.75–1.61)	
			≥ 2.0	121	1.2 (0.82–1.74)	
			Trend-test p-value: 0.35			
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 (174)	Premenopausal, Total over lifetime, Smoked red meat: 0–810 times	163	1	Age, energy intake, and multivitamin use, fruit and vegetable consumption
			811–2277 times	132	0.97 (0.68–1.39)	
			2278–24 253 times	82	0.94 (0.6–1.47)	
			Trend-test p-value: 0.29			
		Breast (174)	Postmenopausal, Total over lifetime, Smoked red meat: 0–810 times	187	1	Same as above
			811–2277 times	240	1.45 (1.09–1.93)	
			2278–24 253 times	332	1.3 (0.99–1.69)	
			Trend-test p-value: 0.22			
		Breast (174)	Premenopausal, Total over lifetime, Total grilled/barbecued and smoked red meat: 0–2562 times	153	1	Same as above

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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
			2565–6081 times	161	0.98 (0.68–1.4)	
			6085–51 652 times	143	1.03 (0.68–1.54)	
			Trend-test p-value: 0.98			
		Breast (174)	Postmenopausal, Total over lifetime, Total grilled/barbecued and smoked red meat: 0–2562 times	280	1	Same as above
			2565–6081 times	287	1.47 (1.11–1.95)	
			6085–51 652 times	390	1.47 (1.12–1.92)	
			Trend-test p-value: 0.02			
Zhang et al. (2009) Guangzhou, China 2007–2008, hospital-based Case-Control	**Cases:** 438; Women aged 25–70 years, natives of the province of Guangdong 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. **Exposure assessment method:** Questionnaire; Validated, interviewer-administered 81-food item FFQ. 1-year dietary recall. Processed meat included sausage, ham, bacon, and hotdog.	Breast	Processed Meat, Q1	124	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	66	1.12 (0.71–1.74)	
			Q3	123	1.23 (0.84–1.81)	
			Q4	125	1.44 (0.97–2.15)	
			Trend-test p-value: 0.066			

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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
Fu et al. (2011) Nashville, TN, USA 2001–2008 population-based Case-Control	**Cases:** 2386; English-speaking women with a resident telephone, aged 25–75 years, with newly diagnosed primary breast cancer (invasive ductal or ductal carcinoma in situ), with no prior history of cancer other than nonmelanoma skin cancer. **Controls:** 1703; identical criteria to cases with the exception that they had no prior breast cancer diagnosis. 87% identified by random digit dialing of households, the rest mostly from women with a normal finding in screening mammography. **Exposure assessment method:** Questionnaire	Breast	Well done bacon: Q1 (Low)	1335	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 study period
			Q2	312	1.1 (0.9–1.4)	
			Q3	360	1.4 (1.2–1.7)	
			Q4	379	1.2 (1–1.4)	
			Trend-test p-value: 0.006			
		Breast	Well done sausage: Q1 (Low)	1670	1	Same as above
			Q2	313	1.1 (0.9–1.3)	
			Q3	253	1.1 (0.9–1.4)	
			Q4	150	1 (0.7–1.3)	
			Trend-test p-value: 0.612			
		Breast	Well done hotdogs/franks: Q1 (Low)	1864	1	Same as above
			Q2	192	1.2 (0.9–1.5)	
			Q3	174	1.1 (0.8–1.4)	
			Q4	156	1 (0.8–1.3)	
			Trend-test p-value: 0.633			
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	Breast	Caucasians, All women, Processed Meat (Grams/day/1,000 kcal), ≤ 2.35	186	-	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
			2.36–7.57	231	1.41 (1.05–1.89)	
			7.58–15.19	167	1.13 (0.82–1.55)	
			> 15.19	171	1.48 (1.07–2.04)	

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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
	Jersey. **Controls:** 889 (AA), 701 (Caucasian); In NY and NJ, controls were identified through random digit dialing (RDD) of residential telephone and cell phone numbers. **Exposure assessment method:** Questionnaire		Trend-test p-value: 0.07			
		Breast	Caucasian, Premenopausal, Processed Meat (Grams/day/1,000 kcal), ≤ 2.35	97	-	Same as above
			2.36–7.57	112	1.25 (0.82–1.91)	
			7.58–15.19	92	1.01 (0.66–1.54)	
			> 15.19	88	1.39 (0.88–2.2)	
			Trend-test p-value: 0.27			
		Breast	Caucasian, Postmenopausal, Processed Meat (Grams/day/1,000 kcal), ≤ 2.35	89	-	Same as above
			2.36–7.57	119	1.69 (1.08–2.64)	
			7.58–15.19	75	1.54 (0.93–2.54)	
			> 15.19	83	1.74 (1.06–2.87)	
			Trend-test p-value: 0.08			
		Breast	African Americans, all women, Processed meat (g/d/1000kcal) Q1, ≤ 2.35	185	1	Same as above
			Q2, 2.36–7.57	185	1.03 (0.76–1.39)	
			Q3, 7.58–15.19	196	1.12 (0.82–1.52)	
			Q4, > 15.19	237	1.21 (0.89–1.64)	
			Trend-test p-value: 0.18			

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Kruk and Marchlewicz (2013) Poland 1999–2006 Case-Control	**Cases:** 858; Case subjects were diagnosed with histologically confirmed invasive breast cancer, age between 25 and 79, and operated between 1999 through 2006. **Controls:** 1,085; Controls were frequency matched on 5-year age group and place of residence. They were required to have no personal history cancer and earlier physical limitation. **Exposure assessment method:** Questionnaire	Breast	< 105 MET-h/week, Processed Meat, ≤ 2/wk	100	1	Age, BMI, education, breast-feeding, psychological stress, multivitamins supplement, family history of breast cancer, passive smoking
			3–4/wk	121	1.39 (0.88–2.18)	
			5–6/wk	54	1.62 (0.9–2.91)	
			≥ 7	23	1.78 (1.04–3.59)	
			Trend-test p-value: 0.05			
		Breast	105- < 138 MET-h/week, Processed Meat, ≤ 2/wk	87	1	Same as above
			3–4/wk	77	1.26 (0.77–2.04)	
			5–6/wk	33	1.84 (0.97–3.48)	
			≥ 7	16	1.62 (0.68–3.88)	
			Trend-test p-value: < 0.07			
		Breast	138- < 170 MET-h/week, Processed Meat, ≤ 2/wk	58	1	Same as above
			3–4/wk	56	1.21 (0.72–2.03)	
			5–6/wk	15	0.83 (0.4–1.72)	
			≥ 7	9	1.72 (0.62–4.8)	
			Trend-test p-value: < 0.95			
		Breast	≥ 170 MET-h/week, Processed Meat, ≤ 2/wk	83	1	Same as above
			3–4/wk	77	1.01 (0.67–1.53)	
			5–6/wk	33	1.11 (0.65–1.89)	
			≥ 7	16	1.25 (0.59–2.62)	

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			Trend-test p-value: < 0.56			
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	Processed meat, unknown increment	NR	9.78 (4.73–20.24)	Age, Not specified
Mourouti et al. (2015) Athens, Greece November 1, 2010 and July 31, 2012 Case-Control	**Cases:** 250; Newly (within 6 months) diagnosed breast cancer that visited pathology-oncology clinics of five major general hospitals in Athens, Greece **Controls:** 250; Control subjects were age-matched (± 3 years)with the cancer patients and selected from the same catchment area of the patients **Exposure assessment method:** Questionnaire	Breast	Processed meat consumption			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
			Never	NR	1	
			< 1 time/m	NR	2.18 (1.22–3.9)	
			2–3 times/m	NR	1.52 (0.7–3.33)	
			1–2 times/wk	NR	2.65 (1.36–5.14)	
			3–4 times/wk	NR	2.33 (1–5.45)	
			≥ 6 times/wk	NR	2.81 (1.13–6.96)	

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