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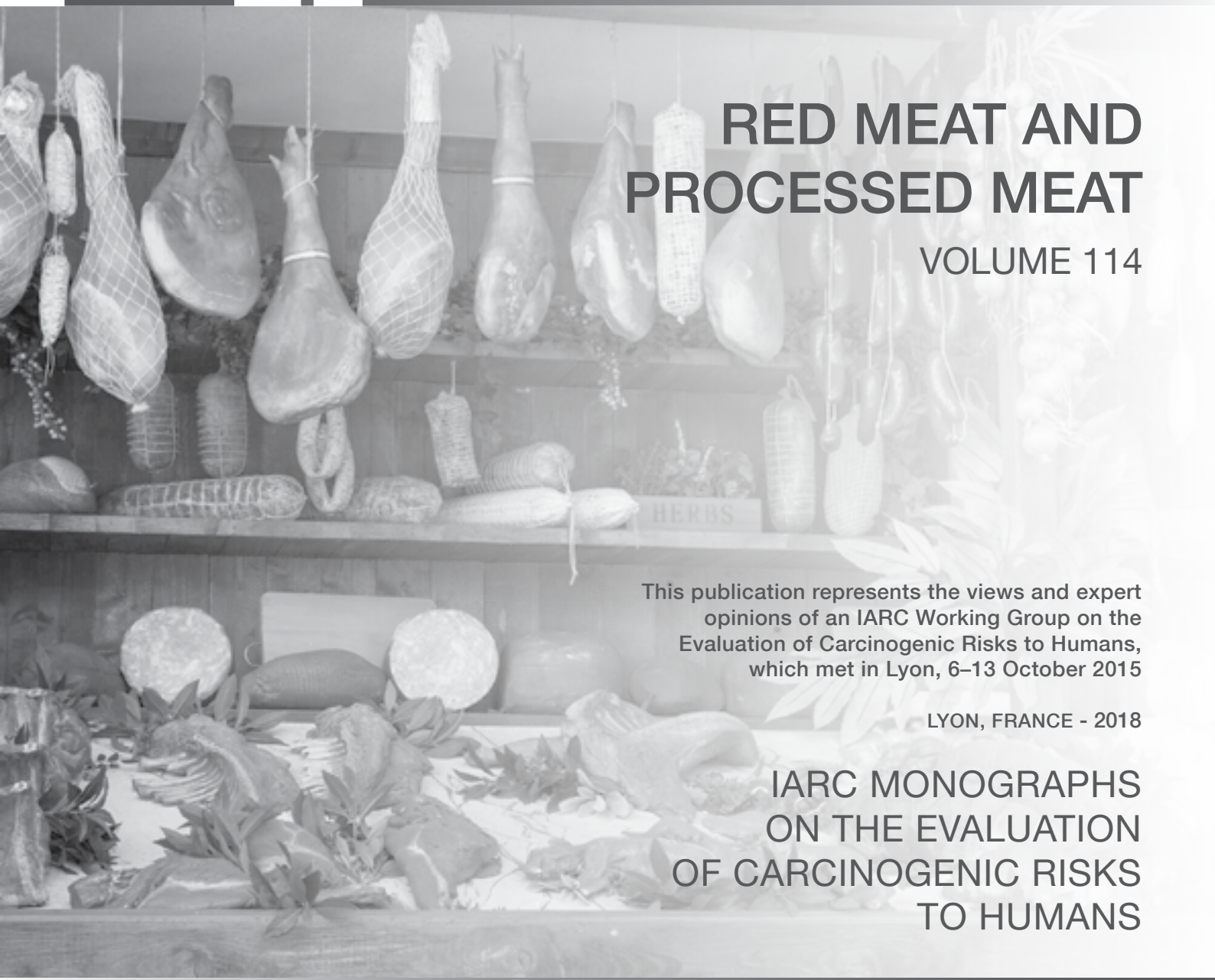

RED MEAT AND PROCESSED MEAT

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International Agency for Research on Cancer

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Table 2.9.2 Cohort studies: Processed meat and other cancers (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
Chiu et al. (1996) Iowa, United States 1986, 7 years of follow-up Cohort	35 156; Women aged 55–69 years from the Iowa Women's Health Study, randomly selected from the State of Iowa Automobile driver's license list **Exposure assessment method:** Questionnaire; 126-item validated food frequency questionnaire from Willet. Processed meat was not defined.	NHL: Non-Hodgkin's lymphoma (ICD-O)	Tertiles of processed meat consumption (servings/month)			Age, total energy intake
			T1 (< 4 servings/month)	33	1	
			T2 (4–6 servings/month)	29	0.94 (0.57–1.55)	
			T3 (> 6 servings/month)	42	1.11 (0.68–1.79)	
			Trend-test p-value: 0.67			
Nagano et al. (2000) Japan 1979–1981 Cohort	39 824/114 cases; members of the Life-Span Study (LSS) cohort **Exposure assessment method:** Questionnaire; Study subjects who filled in 22-item food-frequency questionnaire were members of the Life-Span Study (LSS), 14 years of follow-up. The study has not been performed in a general population and it is limited by low statistical power.	Urinary bladder	Ham/sausage 0/week	25	1	Age, gender, radiation dose, smoking status, education level, body-mass index, and calendar time
			1/week	32	0.54 (0.32–0.95)	
			2+/week	26	0.73 (0.42–1.28)	
			Trend-test p-value: 0.34			
Larsson and Wolk (2005) Sweden, Uppsala and Västmanland counties 1987–2004 1987–2004; average follow-up 14.7 years Cohort	61 057/288 cases; All women aged 40–76 years, living in the 2 counties. Energy intake within 3 SD from the loge-transformed mean in the cohort. No previous cancer diagnosis, no bilateral oophorectomy, or a hysterectomy with unknown number of ovaries removed at baseline. **Exposure assessment method:** Questionnaire; Validated FFQ. Swedish Mammography Cohort with follow-up from 1987 to 2004, 2 dietary assessments (1987 and 1997).	Ovary: Epithelial ovarian cancer	Sausage consumption (servings/week)			Age, BMI, education, use of oral contraceptives and postmenopausal hormones, total energy intake, consumption of fruits, vegetables, and dairy products.
			Rarely or never	NR	1	
			≥ 2	NR	1.37 (0.83–2.24)	

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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
Michaud et al. (2006) USA 1986/1976 Cohort	149 991/ 808 cases; Participants of the HPFS study are dentists (57.6%), veterinarians (19.6%), pharmacists (8.1%), optometrists (7.3%), osteopathic physicians (4.3%), and podiatrists (3.1%).The NHS includes 121 700 female registered nurses aged 30–55 y responded to a mailed questionnaire. **Exposure assessment method:** Questionnaire; Including the health professionals follow-up study8HPFS, 51 529 men) and the Nurses Health Study (NHS, 98 462 women) was based om long-term diet (repeated validated food-frequency questionnaires over time). Unprocessed red meat (beef, pork, lamb). Processed meat (sausage, salami, bologne, hot dogs, hamburger, bacon)	Urinary bladder	Men Processed meats 0	117	1	Age, caloric intake, and pack-years of smoking and for geographic region and total fluid intake in the HPFS
			1–3 servings/mo	152	0.98 (0.76–1.25)	
			1 serving/wk	101	0.94 (0.71–1.23)	
			2–4 serving/wk	105	0.98 (0.74–1.3)	
			≥ 5 servings/wk	29	1.09 (0.71–1.69)	
		Urinary bladder	Women Processed meats 0	48	1	Same as above
			1–3 servings/mo	115	1.07 (0.76–1.52)	
			1 serving/wk	71	1.25 (0.86–1.84)	
			2–4 serving/wk	60	0.98 (0.65–1.46)	
			≥ 5 servings/wk	10	0.81 (0.4–1.63)	
		Urinary bladder	Men Bacon 0	158	1	Same as above
			1–3 servings/mo	150	1.08 (0.86–1.37)	
			1 serving/wk	105	1.09 (0.84–1.41)	
			2–4 serving/wk	69	1.1 (0.82–1.49)	
			≥ 5 servings/wk	22	1.63 (1.02–2.62)	
		Urinary bladder	Women Bacon 0	55	1	Same as above
			1–3 servings/mo	117	0.9 (0.65–1.25)	
			1 serving/wk	78	1.06 (0.74–1.51)	
			2–4 serving/wk	46	1 (0.67–1.51)	
			> 5 serving/wk	8	1.48 (0.7–3.16)	

Table 2.9.2 Cohort studies: Processed meat and other cancers (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
		Urinary bladder	Men Hot dogs 0	173	1	Same as above
			1–3 servings/mo	211	1.02 (0.83–1.25)	
			1 serving/wk	87	1.02 (0.78–1.34)	
			2–4 serving/wk	33	0.86 (0.58–1.27)	
		Urinary bladder	Women Hot dogs 0	58	1	Same as above
			1–3 servings/mo	143	0.91 (0.66–1.24)	
			1 serving/wk	77	0.89 (0.63–1.27)	
			2–4 serving/wk	26	0.77 (0.47–1.24)	
		Urinary bladder	Quintiles of bacon intake, men and women			Same as above
			No intake	NR	1	
			1–3 servings/month	NR	1.03 (0.75–1.41)	
			1 serving/week	NR	1.15 (0.82–1.6)	
			2–4 servings/week	NR	1.25 (0.87–1.79)	
			≥ 5 servings/week	NR	2.1 (1.24–3.55)	
			Trend-test p-value: 0.006			
Cross et al. (2007) USA Enrollment 1995–1996; follow-up 8.2 years Cohort	494 036; NIH-AARP Diet and Healthy Study, analytic cohort of individuals aged 50–71 from six states and 2 metropolitan areas, followed-up for cancer incidence **Exposure assessment method:** Processed meat was defined as bacon, red meat sausage, poultry sausage, luncheon meats (red and white meat), cold cuts (red and white meat), ham, regular hotdogs, and low-fat hot dogs made from poultry	Liver: hepatocellular carcinoma (ICD-O–3)	Quintiles of processed meat consumption (with nutrient density energy adjusted median intakes in g/1000 kcal)			Age, sex, education, marital status, family history of cancer, race, BMI, smoking status, frequency of vigorous physical activity, total energy intake, alcohol intake, fruit and vegetable consumption
			Q1 (1.6 g/1000kcal)	64	1	
			Q2 (4.4 g/1000kcal)	77	1.13 (0.81–1.59)	
			Q3 (7.6 g/1000 kcal)	80	1.11 (0.79–1.56)	
			Q4 (12.3 g/1000 kcal)	90	1.16 (0.82–1.64)	
			Q5 (22.6 g/1000 kcal)	92	1.09 (0.77–1.53)	
			Trend-test p-value: 0.82			

Table 2.9.2 Cohort studies: Processed meat and other cancers (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
Cross et al. (2007) USA 1995; follow-up to 2003 Cohort	119 312/ 552 cases; Women, aged 50–71 y, from six states in the United States (California, Florida, Louisiana, New Jersey, North Carolina, and Pennsylvania) and two metropolitan areas (Atlanta, Georgia; and Detroit, Michigan). **Exposure assessment method:** Questionnaire; Processed meat included combined red and white meat products such as bacon, cold cuts (red and white meat), ham, hamburger, hot dogs (regular and from poultry), sausages (red and white meat), luncheon meats (red and white). A 124-item food frequency questionnaire (FFQ), based on the Diet History Questionnaire.	Ovary: ovarian cancer ICD-0–3	Quintiles of processed meat consumption (median, g/1000 kcal)			Age, sex, education, marital status, family history of cancer, race, BMI, smoking, frequency of vigorous physical activity, total energy intake, alcohol intake, fruit and vegetable intake.
			Q1 (1.6)	145	1	
			Q2 (4.4)	136	1.14 (0.87–1.5)	
			Q3 (7.6)	109	1.21 (0.91–1.59)	
			Q4 (12.3)	96	1.13 (0.85–1.51)	
			Q5 (22.6)	66	1.23 (0.92–1.63)	
			Trend-test p-value: 0.30			
Schulz et al. (2007) Europe: Denmark, France, Germany, Greece, Italy, the Netherlands, Norway, Spain, Sweden, United Kingdom 1992–2000; follow-up to 2004 Cohort	325 731/ 581 cases of primary invasive ovarian cancer; Study participants from 10 European countries, mostly from the general population, recruited between 1992 and 2000. Women free of any cancer at baseline, with at least one intact ovary, and with non-missing dietary and follow-up information were included. **Exposure assessment method:** Questionnaire; Dietary intake was assessed by several different instruments that had been developed and validated previously in a series of studies within the various source populations participating in EPIC: Extensive self-administrated quantitative dietary questionnaires, containing up to 260 food items and estimating individual average portions systematically, questionnaires	Ovary: ovarian cancer ICD-10 C56	Quintiles of processed meat intake (g/day)			Body mass index, parity, menopausal status, ever use of oral contraceptives, total energy intake, education, smoking, unilateral ovariectomy, and hormone replacement therapy use at baseline.
			Q1(< 17)	92	1	
			Q2 (17– < 26)	127	0.98 (0.69–1.37)	
			Q3 (26– < 33)	129	1.1 (0.76–1.59)	
			Q4 (33– < 42)	119	1.09 (0.74–1.62)	
			Q5 (> 42)	114	1.25 (0.81–1.92)	
			Trend-test p-value: 0.23			

Table 2.9.2 Cohort studies: Processed meat and other cancers (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
	but structured by meals, face-to-face dietary interview using a computerised dietary program, semiquantitative food-frequency questionnaires with standard portions, or combined dietary methods: both a semiquantitative FFQ and a 7-day record, or combining a short non-quantitative FFQ with a 14-day record on hot meals (lunches and dinners). Definition of processed red meat not presented.					
Lee et al. (2008) USA, Canada, Australia, Netherland, Sweden, Finland. 7–20 years Cohort	530 469 women and 244 483 men; pooled analysis of13 prospective studies. 530 469 women and 244 483 men/1478 cases (709 women and 769 men) **Exposure assessment method:** Questionnaire; 7–20 years of follow up, all cohorts have used validated FFQ. Processed meat (sausage, bacon, hot dog, ham, and luncheon meat).	Kidney: renal cell cancer O-2	Processed meat intake category			Age, history of hypertension, body mass index, pack-years of smoking, combination of parity and age at first child's birth < 25 years and parity of 1 or 2; age at first child's birth ≥ 25 years and parity of 1 or 2, or nulliparous; age at first child's birth < 25 years and parity of ≥ 3; and age at first child's birth ≥ 25 years and parity of ≥ 3), fruit and vegetable consumption (tertiles), alcohol intake (continuous), and total energy intake (continuous).
			< 4 g/day	335	1.09 (0.87–1.38)	
			4 to < 8 g/day (referent)	201	1	
			8 to < 12 g/day	145	1 (0.79–1.25)	
			12 to < 27 g/day	386	1.06 (0.88–1.28)	
			≥ 27 g/day = 1 serving/day	411	1.21 (0.97–1.51)	
			Trend-test p-value: 0.31			

Table 2.9.2 Cohort studies: Processed meat and other cancers (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) Sweden 1997 Cohort	82 002/ 485 cases; participants of the Swedish Mammography Cohort (SMC) and the Cohort of Swedish Men (COSM). **Exposure assessment method:** Questionnaire; diet was assessed using a self-administered food frequency questionnaire (FFQ) with 96 food items. 9.4 years of follow-up, and the EPIC study in 10 European countries. Processed meat (ham, salami, sausage and cold cuts).	Urinary bladder: (C67.0–C67.9)	Frequency of processed meats intake			Adjusted for age, sex, education, smoking status, pack-years of smoking, and total energy intake
			0–3 servings/month	113	1	
			1–4 servings/week	157	0.87 (0.68–1.11)	
			≥ 5 servings/week	215	1.01 (0.8–1.28)	
			Trend-test p-value: 0.40			
		Urinary bladder: (C67.0–C67.9)	Frequency of sausage intake (fried, grilled or boiled)			Same as above
			0–3 servings/month	219	1	
			1–4 servings/week	225	0.99 (0.82–1.2)	
			≥ □5 servings/week	41	1.21 (0.86–1.71)	
			Trend-test p-value: 0.37			
Ferrucci et al. (2010) USA 1995–1996 Cohort	300 933/ 854; the NIH-AARP Diet and Health Study enrolled men and women, aged 50 to 71 years, from 6 US states (California, Florida, Louisiana, New Jersey, North Carolina, Pennsylvania) and 2 metropolitan areas (Atlanta, Georgia; Detroit, Michigan) **Exposure assessment method:** Questionnaire; NIH-AARP Diet and Health Study of 300 933 American men and women who filled in a validated 124-items food-frequency questionnaire, and during 7 years of follow-up. Median g/1000 kcal Processed meat (bacon, sausage, luncheon, ham, and hotdogs).	Urinary bladder: (C67.0–C67.9)	Quintiles of processed meat consumption (median, g/1,000 kcal)			Age, sex, smoking, and intakes of fruit, vegetables, beverages, and total energy.
			Q1 (1.6)	117	1	
			Q2 (4.3)	150	1.09 (0.85–1.39)	
			Q3 (7.4)	169	1.1 (0.86–1.41)	
			Q4 (12.1)	218	1.28 (1.01–1.62)	
			Q5 (22.3)	200	1.1 (0.86–1.4)	
			Trend-test p-value: 0.55			

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Ma et al. (2010) USA, median follow-up 7.5 years 1995–2003 Cohort	491 163 cohort; 338 AML cases; Members of the American Association of Retired Persons) from 6 states (California, Florida, Louisiana, New Jersey, North Carolina, Pennsylvania) who returned questionnaire. **Exposure assessment method:** Questionnaire. Processed meat included all types of cold cuts, bacon, ham, hot dogs, and sausages from red and white meats.	Leukaemia: Acute myeloid leukaemia (AML)	Quintiles of processed meat consumption (g/1,000 kcal)			Age at baseline, gender, smoking status, total energy intake, Nonprocessed meat intake
			Q1 ≤ 3.1	69	1	
			Q2 > 3.1– ≤ 5.9	61	0.78 (0.55–1.11)	
			Q3 > 5.9– ≤ 9.6	66	0.79 (0.56–1.12)	
			Q4 > 9.6– ≤ 16.1	65	0.73 (0.52–1.04)	
			Q5 > 16.1	77	0.84 (0.6–1.18)	
			Trend-test p-value: 0.64			
Tsai et al. (2010) USA 11.2 years of follow up Cohort	525 982; this is a pooled analysis of NIH-AARP Diet and Health Study and the PLCO cancer screening trial. Criteria is different for the two studies **Exposure assessment method:** Questionnaire; Diet History Questionnaire was used	NHL: Chronic lymphocytic leukaemia and small lymphocytic lymphoma (SLL/CLL)	Processed meat, g/1,000 kcal)			Age, sex, BMI
			0.0–3.8	262	1	
			3.8–7.6	282	0.98 (0.83–1.17)	
			7.6–13.8	313	1.04 (0.87–1.23)	
			13.8–256.4	272	0.88 (0.74–1.05)	
			Trend-test p-value: 0.14			
Gilsing et al. (2011) Netherlands 1986; follow-up to 2002 Cohort	62 573/ 340 cases; the Netherlands Cohort Study (NCLS) was initiated in September 1986 and includes 62 573 women, aged 55–69 y at baseline, who originated from 204 municipalities with computerized population registries **Exposure assessment method:** Questionnaire; 16,3 years of follow-up. 150-item semiquantitative food-frequency questionnaire (FFQ) at baseline that estimated the average frequency and amounts of foods and beverages consumed over the previous 12 months. Processed red meat not specified.	Ovary	Quintiles of processed meat intake: median g/day			Age, total energy intake, parity, and use of oral contraceptives
			Q1: 0	80	1	
			Q2: 2.7	53	0.71 (0.49–1.03)	
			Q3: 6.8	70	0.91 (0.64–1.29)	
			Q4: 13.0	70	0.93 (0.65–1.31)	
			Q5: 25.6	67	0.83 (0.59–1.2)	
			Trend-test p-value: 0.74			

Table 2.9.2 Cohort studies: Processed meat and other cancers (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
Rohrmann et al. (2011) Europe 1992; 8,5 years of follow-up Cohort	410 411; Participants from the European Prospective Investigation into Cancer and Nutrition (EPIC) study, most centres recruited from the general population. However, French participants were female members of a health insurance for school and university employees. Spanish and Italian participants were recruited among blood donors, members of health insurance programs, employees of enterprises, civil servants and the general population. In Utrecht and Florence, participants in mammographic screening programs were recruited. In Oxford, half of the cohort consisted of "health conscious" subjects from England, Wales, Scotland and Northern Ireland, including a high percentage of vegans, ovo-lacto vegetarians, fish eaters (consuming fish but no meat) and meat eaters. The cohorts of France, Norway, Utrecht and Naples include women only. **Exposure assessment method:** Questionnaire; Diet was assessed over the previous 12 months by structured questions regarding meals or food groups, individual average portions, or standard portion. The questionnaires were validated and calibrated with 24-hour dietary recall data. Processed meat is defined as all meat products, including ham, bacon, different types of sausages, canned/smoked/dried meat, pate, hamburger and meat balls.	NHL: Non-Hodgkin's lymphoma (ICD-O–3)	Quintiles of processed meat consumption (g/day)			HR stratified by age in 1-yr categories, centre and sex; adjusted for energy, alcohol, education, fruits, vegetables and smoking
			Q1: < 20	489	1	
			Q2: 20– < 40	391	1.05 (0.91–1.21)	
			Q3: 40– < 60	184	0.91 (0.75–1.09)	
			Q4: 60– < 80	95	0.95 (0.74–1.21)	
			Q5: ≥ 80	108	1.06 (0.82–1.37)	
			Trend-test p-value: 0.82			
		NHL: B-cell Chronic Lymphatic Leukaemia (BCLL)	Quintiles of processed meat consumption (g/day)			Same as above
			Q1: < 20	90	1	
			Q2: 20– < 40	62	0.99 (0.69–1.4)	
			Q3: 40– < 60	38	1.24 (0.81–1.89)	
			Q4: 60– < 80	17	1.2 (0.68–2.12)	
			Q5: ≥ 80	27	2.19 (1.27–3.77)	
			Trend-test p-value: 0.01			

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van Lonkhuijzen et al. (2011) Canada 1992–1998 Cohort	26 024/ 107 cases; alumni from two Ontario universities, with a small portion of the cohort consisting of volunteers recruited through the Canadian Cancer Society **Exposure assessment method:** Questionnaire; quantitative food–frequency questionnaire with 166 food items, average follow-up = 6.5 years for cases and 11.7 years for subcohort members. Processed red meat (bacon, sausages, luncheon meat, salted, dried and pickled meat).	Endometrium	Quartiles of processed meat intake (g/day)			Age, BMI, age at menarche, number of live births, breastfeeding, years of OC use, avg exercise/wk, Kcal intake/d, intake of cruciferous vegetables, menopausal status at baseline, HRT
			Q1: < 3.80	23	1	
			Q2: 3.80– < 10.47	19	0.75 (0.39–1.44)	
			Q3: 10.47– < 23.53	28	1.23 (0.68–2.23)	
			Q4: ≥ 23.53	37	1.45 (0.8–2.61)	
			Trend-test p-value: 0.058			
Daniel et al. (2012a) United States 1995–1996; 9 years of follow-up Cohort	492 186; Men and women from the NIH-AARP Diet and Health Study aged 50–71 years old from 6 states (CA, FL, LA, NJ, NC, PA) and 2 metropolitan areas (Atlanta, GA and Detroit, MI) **Exposure assessment method:** Questionnaire; 124-item FFQ developed and validated by the National Cancer Institute. Intake of meat expressed per 1000 kcal. Total processed meat included bacon, cold cuts, ham, hotdogs, and sausage, all defined as red processed meat, and processed poultry (poultry cold cuts, low-fat sausages, and low-fat hot dogs).	NHL: Non-Hodgkin's lymphoma (ICD-O–3)	Quintiles of total processed meat consumption (median g/1000kcal)			Age, sex, education, family history of any cancer, race, BMI, smoking status, physical activity, intake of alcohol, intake of fruit, intake of vegetables, total energy, other meat intake
			Q1 (2.2)	705	1	
			Q2 (5.3)	729	1.03 (0.93–1.15)	
			Q3 (8.6)	767	1.09 (0.98–1.22)	
			Q4 (13.3)	719	1.03 (0.92–1.15)	
			Q5 (23.6)	691	0.99 (0.89–1.11)	
			Trend-test p-value: 0.45			

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		NHL: Non-Hodgkin's lymphoma (ICD-O–3)	Quintiles of processed red meat consumption (median g/1,000 kcal)			Same as above
			Q1 (1.4)	681	1	
			Q2 (3.7)	748	1.1 (0.99–1.23)	
			Q3 (6.4)	747	1.12 (1–1.25)	
			Q4 (10.1)	730	1.1 (0.98–1.24)	
			Q5 (19.9)	705	1.07 (0.95–1.2)	
			Trend-test p-value: 0.91			
Daniel et al. (2012b) USA 1995–1996; follow-up until end of 2006 Cohort	492 186, 1814 cases; US men and women, aged 50–71 y, residing in 6 states (California, Florida, Louisiana, New Jersey, North Carolina, and Pennsylvania) and 2 metropolitan areas (Atlanta, GA, and Detroit, MI). **Exposure assessment method:** Same as above	Kidney: Renal cell carcinoma, ICD-O–3	Quintiles of processed red meat consumption (median, g/1,000 kcal)			Age, sex, total energy intake, other types of meat intake, education, marital status, family history of cancer, race, BMI, smoking status, history of diabetes, history of hypertension, intakes of alcohol, fruit, and vegetables
			Q1 (1.4)	333	1	
			Q2 (3.7)	330	0.96 (0.82–1.12)	
			Q3 (6.4)	371	1.05 (0.89–1.23)	
			Q4 (10.1)	347	0.95 (0.8–1.12)	
			Q5 (19.9)	433	1.12 (0.95–1.32)	
			Trend-test p-value: 0.16			
		Kidney: clear cell carcinoma, ICD-O–3	Quintiles of processed red meat consumption (median, g/1,000 kcal)			Same as above
			Q1 (1.4)	92	1	
			Q2 (3.7)	77	0.8 (0.58–1.1)	
			Q3 (6.4)	99	1 (0.73–1.36)	
			Q4 (10.1)	94	0.92 (0.67–1.27)	
			Q5 (19.9)	136	1.26 (0.92–1.71)	
			Trend-test p-value: 0.04			

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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
Genkinger et al. (2012) Sweden 1987–1990, follow-up 21 years Cohort	60 895 cohort/ 720 cancer cases; Women without cancer history or hysterectomy, living in Uppsala County in central Sweden, born between 1914 and 1948 and all women living in the adjacent Västmanland County, born between 1917 and 1948. **Exposure assessment method:** Questionnaire; Validated 67-items FFQ at baseline 1987–1990. Processed meat (sausage, hot dogs, bacon, ham, salami, lunch meat, and blood pudding/sausage).	Endometrium	Quartiles of processed meat baseline intake (g/wk, median)			Age, energy, BMI, parity, education
			Q1: 53.8	194	1	
			Q2: 145.73	291	1.28 (1.06–1.53)	
			Q3: 237.57	161	1.31 (1.05–1.62)	
			Q4: 367.40	70	1.12 (0.84–1.49)	
			Trend-test p-value: 0.12			
		Endometrium	Quartiles of baseline sausage intake (g/wk, median)			Same as above
			Q1: 50.40	250	1	
			Q2: 139.50	296	0.99 (0.74–1.31)	
			Q3: 238.00	117	1.18 (0.9–1.53)	
			Q4: 352.90	53	1.22 (0.92–1.62)	
			Trend-test p-value: 0.24			
Arem et al. (2013) USA 1995–1996, mean follow-up 9.3 years Cohort	111 356 analytic cohort; 1,486 cancers; Women aged 50–71 years satisfactorily completed mailed questionnaires in 1995–1996 **Exposure assessment method:** Questionnaire; Based on NIH-AARP Diet and Health Study, validated 124-items FFQ. 9.3 years of follow-up. Processed red meat (bacon, cold cuts, ham, hot dogs, and sausage).	Endometrium	Quintiles of daily processed meat intake (g/1000kcal, mean)			Age; BMI; smoking status; continuous total energy intake; mutually adjusted for other meat intake; age at menarche, age at first child's birth, parity, age at menopause, HT use, OC use, diabetes and physical activity
			Q1: 3.4	255	1	
			Q2: 5.5	268	0.97 (0.82–1.16)	
			Q3: 7.4	289	1 (0.84–1.19)	
			Q4: 9.8	273	0.91 (0.76–1.09)	
			Q5: 14.5	319	1.02 (0.86–1.21)	
			Trend-test p-value: 0.695			

Table 2.9.2 Cohort studies: Processed meat and other cancers (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
Fedirko et al. (2013) Europe Enrolment 1992–2000; mean follow-up 11.4 years Cohort	477 206 (142 194 men and 335 012 women); Participants of the European Prospective Investigation into Cancer and Nutrition (EPIC) study. Mostly from the general population. However, French participants were female members of a health insurance for school and university employees. Spanish and Italian participants were blood donors, members of health insurance programs, employees of enterprises, civil servants and the general population. In Utrecht and Florence, participants in mammographic screening programs were recruited. In Oxford, half of the cohort consisted of "health conscious" subjects from England, Wales, Scotland and Northern Ireland, including a high percentage of vegans, ovo-lacto vegetarians, fish eaters, and meat eaters. The cohorts of France, Norway, Utrecht and Naples include women only. **Exposure assessment method:** Questionnaire. Processed meat: included mostly pork and beef that were preserved by methods other than freezing, such as salting/smoking/marinating/air drying/ heating. Processed meat included ham, bacon, sausages, salami, bologna and corned beef for example and mainly refers to processed red meat but may contain small amounts of processed white meat.	Liver: hepatocellular carcinoma (ICD10)	Quartiles of processed meat consumption (g/day)			Non-alcohol energy, baseline alcohol intake, smoking status, sex-specific physical activity, self-reported diabetes status, life-time alcohol intake pattern, continuous measures of body mass index, basline intake of coffee, baseline intake of dietary fibre, intake of other types of meat (red meat, poultry and total fish)
			Q1 (0–11.4 g/day)	38	1	
			Q2 (11.4–25.5 g/day)	46	1.13 (0.68–1.88)	
			Q3 (25.5–44.4 g/day)	39	0.83 (0.48–1.43)	
			Q4 (> 44.4 g/day)	68	0.9 (0.52–1.55)	
			Trend-test p-value: 0.414			
		Liver: hepatocellular carcinoma (ICD10)	Continuous processed meat consumption (10 g/day)			Same as above
			Processed meat consumption (per 10 g/day)	191	0.96 (0.9–1.01)	

Table 2.9.2 Cohort studies: Processed meat and other cancers (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
Saberi-Hosnijeh et al. (2014) Europe, multicentre (Denmark, France, Greece, Germany, Italy, Netherlands, Norway, Spain, Sweden, United Kingdom) Enrollment: 1992–2000. Follow-up: end of 2010 Cohort	477 325; 142 259 men, 335 066 women, mostly age 35–70 y at recruitment, without cancer history **Exposure assessment method:** Questionnaire; Standardized lifestyle and personal history questionnaires and anthropometric data were collected from most participants. Diet over the previous 12 months measured at recruitment by validated country-specific questionnaires designed to ensure high compliance and better measures of local dietary habits. Processed meat not defined.	Leukaemia: All leukaemia	Quintiles of processed meat intake, (g/day)			BMI, education, smoking, alcohol consumption, physical activity, total energy intake
			Q1: 0–7.37	124	1	
			Q2: 7.38–18.54	151	0.97 (0.75–1.27)	
			Q3: 18.55–30.96	157	1.01 (0.78–1.32)	
			Q4: 30.97–49.94	150	0.96 (0.73–1.28)	
			Q5: 49.95–770.84	191	1.1 (0.82–1.48)	
			Calibrated HR per 50 g/day	773	1.08 (0.85–1.35)	
			Trend-test p-value: 0.53			
		Leukaemia: Myeloid leukaemia	Quintiles of processed meat intake (g/day)			Same as above
			Q1: 0–7.37	55	1	
			Q2: 7.38–18.54	72	1.17 (0.78–1.74)	
			Q3: 18.55–30.96	71	1.18 (0.78–1.78)	
			Q4: 30.97–49.94	63	1.05 (0.68–1.62)	
			Q5: 49.95–770.84	81	1.23 (0.78–1.92)	
			Calibrated HR per 50 g/day	342	1.03 (0.92–1.16)	
			Trend-test p-value: 0.63			

Table 2.9.2 Cohort studies: Processed meat and other cancers (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
		Leukaemia: Lymphoid leukaemia	Quintiles of processed meat intake (g/day)			Same as above
			Q1: 0–7.37	57	1	
			Q2: 7.38–18.54	70	0.82 (0.54–1.23)	
			Q3: 18.55–30.96	70	0.9 (0.6–1.36)	
			Q4: 30.97–49.94	77	0.92 (0.61–1.42)	
			Q5: 49.95–770.84	99	1.16 (0.75–1.81)	
			Calibrated HR per 50 g/day	373	1.29 (0.93–1.77)	
			Trend-test p-value: 0.27			
		Leukaemia: Acute myeloid leukaemia (AML)	Quartiles of processed meat intake (g/day)			Same as above
			Q1: 0–10.5	45	1	
			Q2: 10.6–24.2	59	1.07 (0.71–1.63)	
			Q3: 24.3–43.8	32	0.59 (0.36–0.97)	
			Q4: 43.9–770.8	51	0.88 (0.53–1.46)	
			Calibrated HR per 50 g/day	187	0.82 (0.49–1.35)	
			Trend-test p-value: 0.90			
		Leukaemia: Chronic myeloid leukaemia (CML)	Quartiles of processed meat intake (g/day)			Same as above
			Q1: 0–10.5	14	1	
			Q2: 10.6–24.2	23	1.46 (0.69–3.1)	
			Q3: 24.3–43.8	21	1.3 (0.59–2.88)	
			Q4: 43.9–770.8	22	1.24 (0.53–2.92)	
			Calibrated HR per 50 g/day	80	0.67 (0.31–1.46)	
			Trend-test p-value: 0.81			

Table 2.9.2 Cohort studies: Processed meat and other cancers (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
		Leukaemia: Chronic lymphoid leukaemia (CLL)	Quartiles of processed meat intake (g/day)			Same as above
			Q1: 0–10.5	63	1	
			Q2: 10.6–24.2	83	1.02 (0.72–1.45)	
			Q3: 24.3–43.8	83	0.98 (0.68–1.41)	
			Q4: 43.9–770.8	104	1.23 (0.83–1.82)	
			Calibrated HR per 50 g/day	333	1.23 (0.87–1.72)	
			Trend-test p-value: 0.32			
Rohrmann et al. (2015) Europe 1992–2000 Cohort	477 231/ 691 cases; In most centres, the participants were recruited from the general population. However, French participants were female members of a health insurance for school and university employees. Spanish and Italian participants were recruited among blood donors, members of several health insurance programs, employees of several enterprises, civil servants, but also the general population. In Utrecht and Florence, participants in mammographic screening programs were recruited for the study. In Oxford, half of the cohort consisted of "health conscious" subjects from England, Wales, Scotland and Northern Ireland, which includes a high percentage of vegans, ovo-lacto vegetarians, fish eaters (consuming fish but no meat), and meat eaters. The cohorts of France, Norway, Utrecht and Naples include women only. **Exposure assessment method:**	Kidney: renal cell cancer O-2	Processed meat consumption (g/day)			Adjusted for age, centre, sex (if appropriate), education, BMI, history of hypertension, smoking status, duration of smoking, energy intake from fat sources, energy intake from non-fat sources, alcohol consumption, fruit consumption, vegetable consumption.
			0–9.9 g/day	100	1	
			10–19.9	119	1.16 (0.87–1.54)	
			20–39.9	195	1.14 (0.87–1.5)	
			40–79.9	192	1.18 (0.88–1.58)	
			≥ 80	85	1.23 (0.84–1.79)	
			Trend-test p-value: 0.31			
		Kidney: renal cell cancer O-2	Processed meat consumption among men (g/day)			Same as above
			0–9.9 g/day	45	1	
			10–19.9	52	1.16 (0.75–1.81)	
			20–39.9	109	1.18 (0.78–1.79)	
			40–79.9	118	1.03 (0.67–1.58)	
			≥ □80	64	0.97 (0.58–1.61)	
			Trend-test p-value: 0.62			

Table 2.9.2 Cohort studies: Processed meat and other cancers (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
	Questionnaire	Kidney: renal cell cancer O-2	Processed meat consumption among women (g/day)			Same as above
			0–9.9 g/day	55	1	
			10–19.9	67	1.17 (0.81–1.7)	
			20–39.9	86	1.1 (0.76–1.59)	
			40–79.9	74	1.44 (0.96–2.17)	
			≥ 80	21	2.14 (1.18–3.88)	
			Trend-test p-value: 0.03			

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