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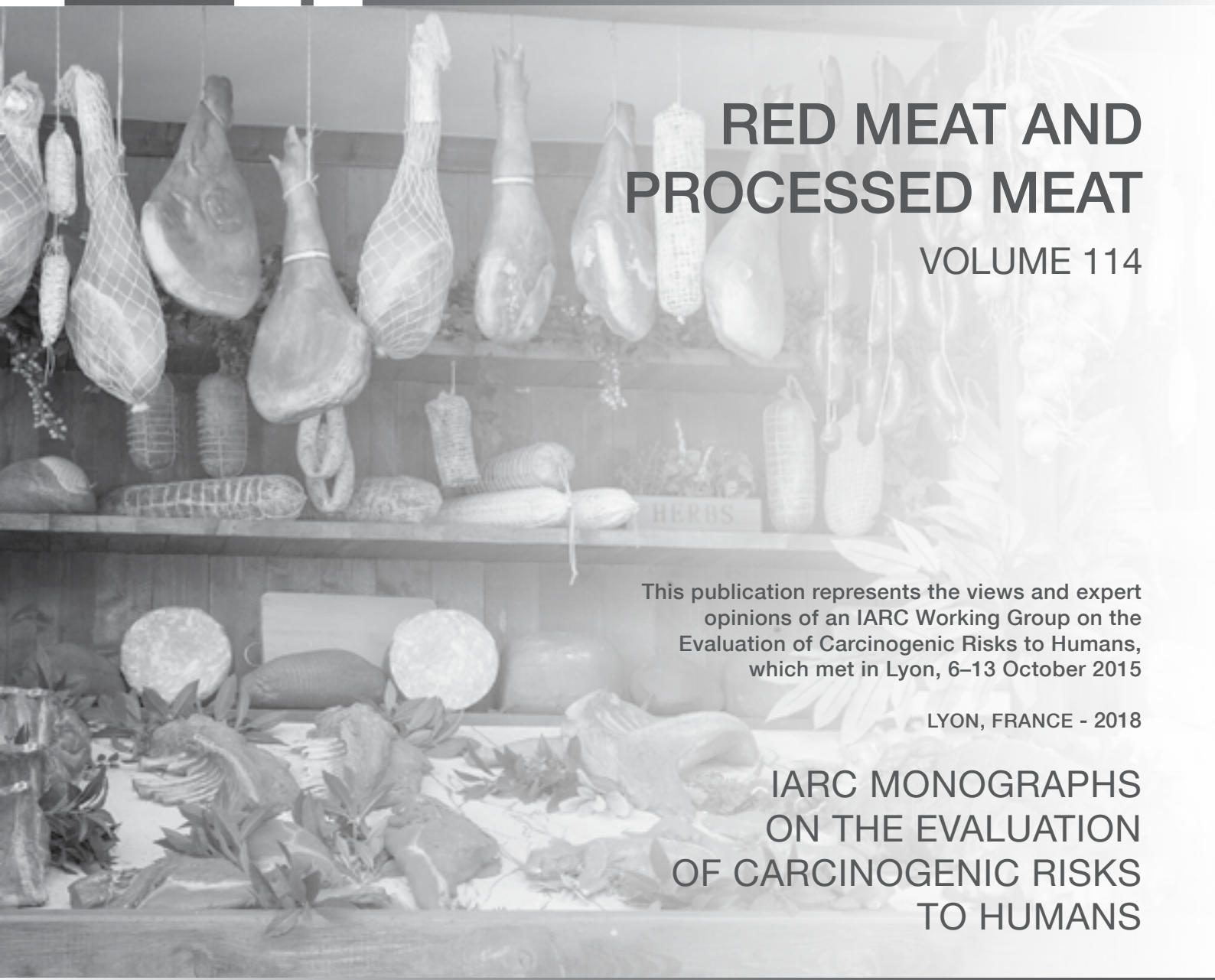

RED MEAT AND PROCESSED MEAT

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IARC MONOGRAPHS ON THE EVALUATION OF CARCINOGENIC RISKS TO HUMANS

International Agency for Research on Cancer

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Table 2.8.2 Cohort studies: Processed meat and cancer of the oesophagus (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. (2011) United States of America (California, Florida, Louisiana, New Jersey, North Carolina, Pennsylvania + two metropolitan areas: Atlanta, Georgia and Detroit, Michigan) End of 2006	494 979; Men and women, aged 5–71 years, enrolled in 1995–1996. The following individuals were excluded: duplicates, participants who died or moved before the baseline questionnaire was received or withdrew from the study, who did not return the baseline questionnaire, whose baseline questionnaire was filled in by someone else on their behalf, who had prevalent cancer according to the cancer registry or self-report, those with extreme daily total energy intake. **Exposure assessment method:** Questionnaire; Dietary intake of various food items was assessed through a 124-item food frequency questionnaire (usual frequency of consumption and portion size information of foods over the previous twelve months). Portion sizes and daily nutrient intakes were calculated from the 1994–1996 US Department of Agriculture's Continuing Survey of Food Intakes by Individuals. "Processed Meat" = Bacon, red meat sausage, poultry sausage, luncheon meats (red and white meat), cold cuts (red and white meat), ham, regular hotdogs and low-fat hotdogs made from poultry. Meat added to complex food mixtures, such as pizza, chili, lasagna, and stew, contributed to the relevant meat type.	Stomach/gastric cancer: Oesophagus (ICD-O-3 C15.0–C15.9); Squamous cell carcinomas (histology codes 8050–8076)	Processed meat, Quintile median (µg/1000kcals)			Age, sex, body mass index, education, ethnicity, tobacco smoking, alcohol drinking, usual physical activity at work, vigorous physical activity, daily intake of fruit, daily intake of vegetables, daily intake of saturated fat, daily intake of calories
			Q1 (1.7)	34	1	
			Q2 (4.5)	38	1.03 (0.64–1.66)	
			Q3 (7.8)	34	0.86 (0.52–1.42)	
			Q4 (12.6)	49	1.15 (0.72–1.86)	
			Q5 (23.2)	60	1.32 (0.83–2.1)	
			All – Processed Meat – Continuous (per 10 g/1000kcals)	NR	1.08 (0.96–1.21)	
			Trend-test p-value: 0.085			
		Stomach/gastric cancer: Oesophagus (ICD-O-3 C15.0–C15.9); Adenocarcinomas (histology codes 8140, 8141, 8190–8231, 8260–8263, 8310, 8430, 8480–8490, 8560, 8570–8572)	Processed meat, Quintile median (µg/1000kcals)			Same as above
			Q1 (1.7)	83	1	
			Q2 (4.5)	101	0.92 (0.68–1.24)	
			Q3 (7.8)	128	0.98 (0.74–1.32)	
			Q4 (12.6)	137	0.91 (0.68–1.22)	
			Q5 (23.2)	181	1.08 (0.81–1.43)	
			All – Processed Meat – Continuous (per 10 g/1000kcals)	NR	1.03 (0.96–1.11)	
			Trend-test p-value: 0.262			

Table 2.8.2 Cohort studies: Processed meat and cancer of the oesophagus (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
	A risk to a subcohort of 303 156 persons factor questionnaire sent six months later elicited detailed information on meat intake and cooking preferences. Nitrate and nitrite intake from processed meat were estimated using a database of measured values from ten types of processed meats, which represent 90% of processed meats consumed in the US.	Stomach/gastric cancer: Oesophagus (ICD-O-3 C15.0–C15.9); Squamous cell carcinomas (histology codes 8050–8076)	Nitrate, Quintile median (µg/1000kcals)			Age, sex, body mass index, education, ethnicity, tobacco smoking, alcohol drinking, usual physical activity at work, vigorous physical activity, daily intake of fruit, daily intake of vegetables, daily intake of saturated fat, daily intake of calories
			Q1 (24.2)	22	1	
			Q2 (66.9)	25	1.06 (0.59–1.91)	
			Q3 (112.7)	15	0.6 (0.3–1.18)	
			Q4 (174.5)	25	0.9 (0.49–1.67)	
			Q5 (298.0)	41	1.3 (0.72–2.35)	
			All – Nitrate – Continuous (per 100 µg/1000kcals)	NR	1.08 (0.96–1.23)	
			Trend-test p-value: 0.153			
		Stomach/gastric cancer: Oesophagus (ICD-O-3 C15.0–C15.9); Squamous cell carcinomas (histology codes 8050–8076)	Nitrite, Quintile median (µg/1000kcals)			Same as above
			Q1 (12.1)	20	1	
			Q2 (34.6)	30	1.36 (0.76–2.43)	
			Q3 (61.4)	19	0.82 (0.43–1.57)	
			Q4 (102.9)	28	1.15 (0.63–2.11)	
			Q5 (199.2)	31	1.21 (0.67–2.2)	
			All – Nitrite – Continuous (per 100 µg/1000kcals)	NR	1 (0.83–1.21)	
			Trend-test p-value: 0.651			

Table 2.8.2 Cohort studies: Processed meat and cancer of the oesophagus (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
		Stomach/gastric cancer: Oesophagus (ICD-O-3 C15.0–C15.9); Adenocarcinomas (histology codes 8140, 8141, 8190–8231, 8260–8263, 8310, 8430, 8480–8490, 8560, 8570–8572)	Nitrate, Quintile median (µg/1000kcals)			Same as above
			Q1 (24.2)	47	1	
			Q2 (66.9)	61	0.97 (0.66–1.43)	
			Q3 (112.7)	68	0.91 (0.62–1.35)	
			Q4 (174.5)	89	1.01 (0.7–1.47)	
			Q5 (298.0)	112	1.1 (0.75–1.6)	
			All – Nitrate – Continuous (per 100 µg/1000kcals)	NR	1.04 (0.96–1.12)	
			Trend-test p-value: 0.35			
		Stomach/gastric cancer: Oesophagus (ICD-O-3 C15.0–C15.9); Adenocarcinomas (histology codes 8140, 8141, 8190–8231, 8260–8263, 8310, 8430, 8480–8490, 8560, 8570–8572)	Nitrite, Quintile median (µg/1000kcals)			Same as above
			Q1 (12.1)	50	1	
			Q2 (34.6)	60	0.89 (0.61–1.3)	
			Q3 (61.4)	66	0.82 (0.56–1.2)	
			Q4 (102.9)	81	0.88 (0.61–1.27)	
			Q5 (199.2)	120	1.19 (0.84–1.68)	
			All – Nitrite – Continuous (per 100 µg/1000kcals)	NR	1.05 (0.95–1.15)	
			Trend-test p-value: 0.029			

Table 2.8.2 Cohort studies: Processed meat and cancer of the oesophagus (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
Keszei et al. (2012) the Netherlands 1986–2002	120 852 were recruited and finally 3923 subcohort members were used in the analysis (case-cohort design). The sample was selected from 204 municipal population registries throughout the Netherlands by gender-stratified random sampling. **Exposure assessment method:** Questionnaire, FFQ follow-up were identified using annual computerized record linkage to the Netherlands Cancer Registry and the nationwide network and registry of histo- and cytopathology in the Netherlands (PALGA). The completeness of the cancer registries was estimated to be over 95%	Oesophagus carcinomas included squamous cell carcinomas C15 (ESCC), histology codes: 8050–8076, and adenocarcinomas (EAC) C15, histology codes: 8140, 8141, 8190–8231, 8260–8263, 8310, 8430, 8480–8490, 8560, and 8570–8572	Risk by quintile			Adjusted for age (years), smoking status (current versus non-current smokers), years of cigarette smoking, number of cigarettes smoked per day, total energy intake (kjoules/day), body mass index (categories: < 20, 20–24.9, 25–29.9, and ≥ 30 kg/m^2), alcohol intake (grams/day), vegetable intake (grams/day), fruit intake (grams/day), levels of education (four categories), and non-occupational physical activity (four categories). For EAC, models are additionally adjusted for use of lower oesophageal sphincter relaxing medications
			ESCC, men Q1*	7	1	
			Q2*	15	2.53(0.94–6.77)	
			Q3*	12	2.05(0.7–6.01)	
			Q4*	9	1.73(0.6–4.98)	
			Q5*	16	3.47(1.21–9.94)	
			*Trend-test *p*-value: 0.04			
			Risk by quintile			
			EAC, men Q1*	24	1	
			Q2*	20	0.8(0.42–1.53)	
			Q3*	19	0.76(0.4–1.45)	
			Q4*	27	1.07(0.58–1.97)	
			Q5*	24	0.94(0.46–1.89)	
			*Trend-test *p*-value: 0.84			
			Risk by tertile			
			ESCC, women T1*	19	1	
			T2*	15	0.71(0.32–1.55)	
			T3*	14	0.63(0.28–1.44)	
			*Trend-test *p*-value: 0.31			

Table 2.8.2 Cohort studies: Processed meat and cancer of the oesophagus (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
			Risk by tertile			
			EAC, women T1*	11	1	
			T2*	13	1.11(0.46–2.7)	
			T3*	7	0.58(0.22–1.5)	
			*Trend-test *p*-value: 0.2			
Jakszyn et al. (2013) the European Prospective Investigation into Cancer and Nutrition (EPIC) 11 years	472 538 participants; A total of 521 457 subjects (153,447men), aged mostly 35–70 years in 23 centres from 10 European countries **Exposure assessment method:** Questionnaire; Models for the continuous variables of meat (unprocessed red and processed)(for 25 g/2,000 kcal)	Oesophageal adenocarcinoma	Processed red meat (25 g/200 kcal)			Sex, Smoking status (never, former, smoker and unknown), Time since quitting smoking (y), Total energy intake (kcal/day), Number of cigarettes (cig/d), Body mass index (BMI)(kg/m2), Fresh fruits (g/2,000 kcal), Vegetables intake (g/2,000 kcal), Educational levels
			Tertile 1	23	1	
			Tertile 2	52	1.65 (0.98–2.77)	
			Tertile 3	62	2.27 (1.33–3.89)	
			Trend-test p-value: 0.004			

References

Cross AJ, Freedman ND, Ren J, Ward MH, Hollenbeck AR, Schatzkin A, et al. (2011). Meat consumption and risk of esophageal and gastric cancer in a large prospective study. Am J Gastroenterol. 106(3):432–42. PMID:20978481 http://dx.doi.org/10.1038/ajg.2010.415

Jakszyn P, Luján-Barroso L, Agudo A, Bueno-de-Mesquita HB, Molina E, Sánchez MJ, et al. (2013). Meat and heme iron intake and esophageal adenocarcinoma in the European Prospective Investigation into Cancer and Nutrition study. Int J Cancer. 133(11):2744–50. PMID:23728954

Keszei AP, Schouten LJ, Goldbohm RA, van den Brandt PA (2012). Red and processed meat consumption and the risk of esophageal and gastric cancer subtypes in The Netherlands Cohort Study. Ann Oncol. 23(9):2319–26. PMID:22351741 http://dx.doi.org/10.1093/annonc/mdr615