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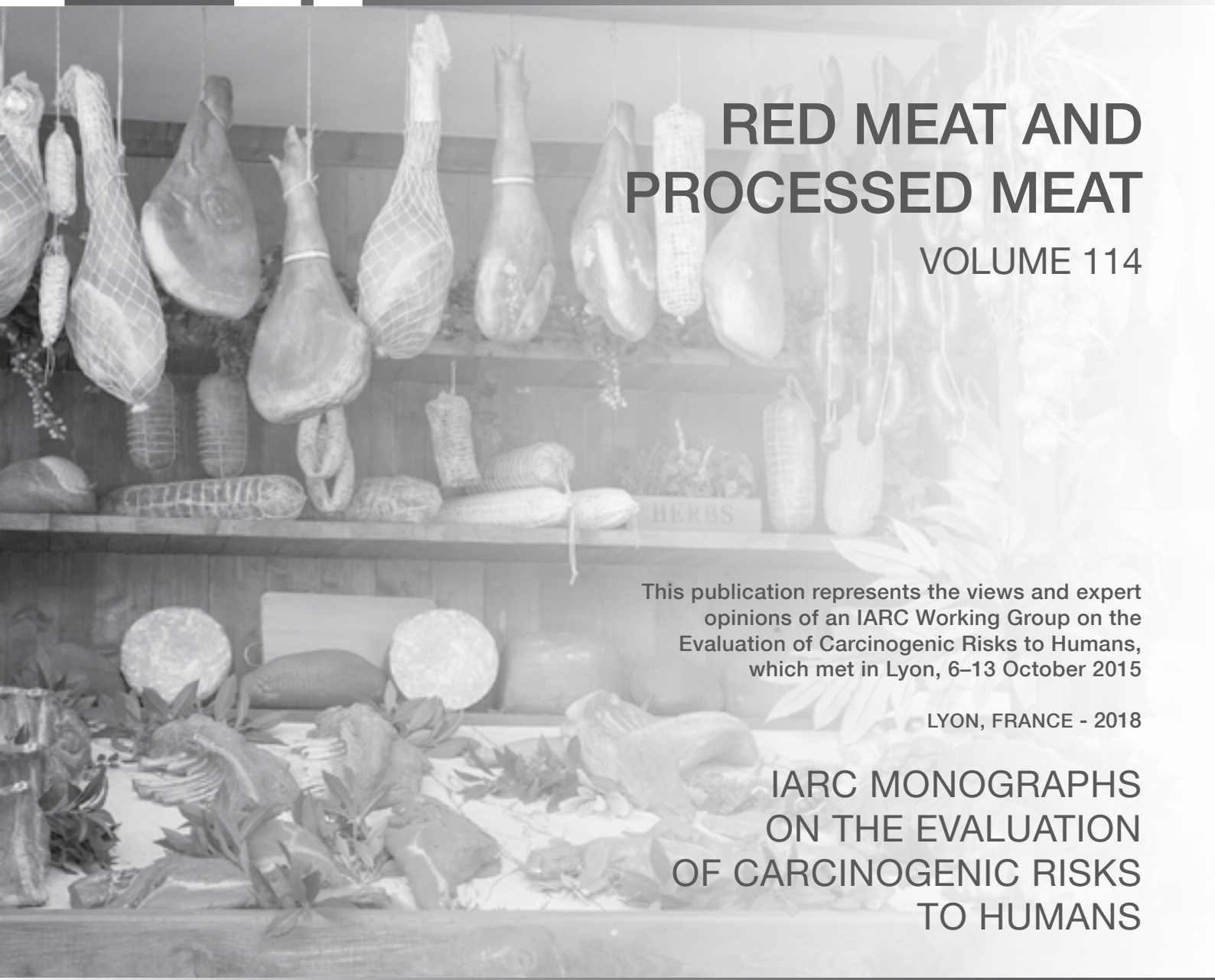

RED MEAT AND PROCESSED MEAT

VOLUME 114

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

LYON, FRANCE - 2018

IARC MONOGRAPHS ON THE EVALUATION OF CARCINOGENIC RISKS TO HUMANS

International Agency for Research on Cancer

World Health Organization

Table 2.3.1 Cohort studies: Red meat and cancer of the stomach (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
Ngoan et al. (2002) Japan (Fukuoka prefecture) 1986–1999 Cohort	13 250; male and female aged over 15. **Exposure assessment method:** Questionnaire	Stomach: 151(ICD-9)	Risk by frequency			Age, sex, smoking, processed meat, cooking or salad oil, suimono, and pickled food.
			Liver, low (seldom or never)	49	1	
			Medium (2–4times/moth)	42	0.7 (0.4–1.2)	
			High (2–4 time or more/wk)	13	0.6 (0.2–1.8)	
González et al. (2006) 10 European countries: Denmark (Aarhus, Copenhagen), France, Germany (Heidelberg, Potsdam), Greece, Italy (Florence, Turin, Varese, Naples, Ragusa), the Netherlands (Bilthoven, Utrecht), Norway, Spain (Granada, Murcia, Asturias, Navarra, San Sebastian), Sweden (Malmo, Umeå), and the United Kingdom (Norfolk, Oxford). 1992–1999/2002(depending on the study centre) Cohort	521 457; 35–70 years old, usually from the general population **Exposure assessment method:** Questionnaire; FFQ	Stomach: ICD-10rev	Risk by tertiles			Center and age at EPIC study entry and adjusted by sex, height, weight, education level, tobacco smoking, cigarette smoking intensity, work and leisure physical activity, alcohol intake, energy intake, vegetable intake, citrus fruit intake, and non-citrus fruit intake. Red meat, poultry, and processed meat intakes were mutually adjusted.
			ALL; red meat Q1(M0–26, F0–17 g/d)	NR	1	
			Q2(M26–52, F17–36 g/d)	NR	1.22 (0.87–1.71)	
			Q3(M52–84, F36–61)	NR	1.27 (0.89–1.82)	
			Q4(M84–1087, F61–584)	NR	1.5 (1.02–2.22)	
			Continuous; observed	330	1.14 (0.97–1.33)	
			Continuous; calibrated	330	1.31 (0.89–1.94)	
			CARDIA;red meat Q1	NR	1	
			Q2	NR	1.56 (0.8–3.02)	
			Q3	NR	1.48 (0.73–3.02)	
			Q4	NR	1.17 (0.53–2.6)	
			Continuous; observed	94	1.04 (0.79–1.38)	
			Continuous; calibrated	94	1.09 (0.46–2.59)	
			NONCARDIA;red meat Q1	NR	1	
			Q2	NR	0.9 (0.56–1.44)	
			Q3	NR	1.29 (0.79–2.1)	
			Q4	NR	1.65 (0.97–2.82)	
			Continuous; observed	159	1.3 (1.04–1.63)	
			Continuous; calibrated	159	1.73 (1.03–2.88)	

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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
			Intestinal; red meat Q1	NR	1	
			Q2	NR	1.29 (0.73–2.3)	
			Q3	NR	1.52 (0.83–2.78)	
			Q4	NR	1.23 (0.61–2.51)	
			Continuous; observed	109	1.03 (0.76–1.4)	
			Continuous; calibrated	109	1.1 (0.5–2.44)	
			Diffuse; red meat Q1	NR	1	
			Q2	NR	1.11 (0.65–1.91)	
			Q3	NR	0.95 (0.51–1.75)	
			Q4	NR	1.74 (0.93–3.24)	
			Continuous; observed	116	1.13 (0.84–1.51)	
			Continuous; calibrated	116	1.1 (0.54–2.23)	
			Trend-test p-value: 0.002			
		Stomach: (ICD-10rev)	Risk by 50 g			Same as above
			Nested case control sample ALL; red meat; HP negative	40	1.78 (0.27–11.7)	
			Positive	201	1.26 (0.69–2.32)	
			Cardia; Hp negative	22	1.55 (0.1–24.5)	
			Hp positive	47	0.56 (0.16–2)	
			Non cardia; Hp negative	12	1.22 (0.01–237)	
			Hp positive	113	1.93 (0.9–4.12)	
			Trend-test p-value: 0.002			

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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
Larsson et al. (2006) Sweden (Uppsala and Vastmanland counties in central Sweden) recruitment (1987–90) – end of follow up (2004) Cohort	61 433; Women born in 1914 and 1948 **Exposure assessment method:** Questionnaire; FFQ, age-specific portion size (mean of weighed and recorded food data of 213 random samples: unpublished data)	Stomach: (ICD9th rev)	Red meat by servings per week			Age, education, BMI, energy, alcohol, fruits, and vegetables.
			< 2.0	56	1	
			2.0–3.4	60	1.07 (0.73–1.57)	
			≥ 3.5	40	1.07 (0.69–1.66)	
			Trend-test p-value: 0.76			
Iso et al. (2007) Japan 1988–2003 Cohort	For beef, 42 513 men and 57 777 women; 40–79 yrs old **Exposure assessment method:** Questionnaire; FFQ	Stomach	Risk per frequency			Age, area
			Men, Beef; < 1/w	525	1	
			1–2/w	124	0.92 (0.73–1.14)	
			3–4 ≤ /w	51	1.19 (0.88–1.62)	
			Pork; < 1/w	341	1	
			1–2/w	232	1.15 (0.93–1.42)	
			3–4 ≤ /w	123	1.28 (1–1.64)	
			Liver; < 1/w	533	1	
			1–2/w	82	0.96 (0.75–1.24)	
			3–4 ≤ w	33	1.2 (0.84–1.73)	
			Women, Beef; < 1/w	243	1	
			1–2/w	65	1.09 (0.79–1.5)	
			3–4 ≤ /w	21	1.03 (0.64–1.66)	
			Pork; < 1/w	174	1	
			1–2/w	104	0.99 (0.74–1.32)	
			3–4 ≤ /w	48	1.01 (0.71–1.45)	
			Liver; < 1/w	252	1	
			1–2/w	40	1.16 (0.8–1.67)	
			3–4 ≤ /w	18	1.53 (0.94–2.5)	

Table 2.3.1 Cohort studies: Red meat and cancer of the stomach (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 Cohort	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. "Red Meat" = all types of beef, pork and lamb, including bacon, beef, cold cuts, ham, hamburger, hotdogs, liver, pork, sausage and steak. Meat added to complex food mixtures, such as pizza, chili, lasagna, and stew, contributed to the relevant meat type.	Stomach: Cardia (ICD-O-3 C16.0) – Adenocarcinomas	Red 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 (10.0)	57	1	
			Q2 (21.9)	90	1.29 (0.92–1.81)	
			Q3 (32.2)	90	1.12 (0.79–1.59)	
			Q4 (44.1)	104	1.13 (0.79–1.61)	
			Q5 (64.8)	113	1.04 (0.72–1.51)	
			All – Red Meat – Continuous (per 10 g/1000kcals)	NR	1 (0.95–1.04)	
			Trend-test p-value: 0.589			
		Stomach: Non Cardia (ICD-O-3 C16.1-C16.9) – Adenocarcinomas	Red meat, Quintile median (µg/1000kcals)			Same as above
			Q1 (10.0)	110	1	
			Q2 (21.9)	95	0.81 (0.61–1.08)	
			Q3 (32.2)	88	0.72 (0.53–0.97)	
			Q4 (44.1)	105	0.83 (0.61–1.11)	
			Q5 (64.8)	103	0.77 (0.56–1.06)	
			All – Red Meat – Continuous (per 10 g/1000kcals)	NR	0.99 (0.94–1.04)	
			Trend-test p-value: 0.261			

Table 2.3.1 Cohort studies: Red meat and cancer of the stomach (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 factor questionnaire sent to a subcohort of 303 156 persons six months later elicited detailed information on meat intake and cooking preferences. Using the information collected on meat cooking methods (grilled/barbecued, pan-fried, microwaved, boiled) and doneness levels (well done and medium-rare) with the CHARRED database, intake of several heterocyclic amines were estimated: DiMeIQx: 2-amino-3,4,8-trimethylimidazo[4,5-f]quinoxaline,MeIQx: 2-amino-3,8-dimethylimidazo[4,5-f]quinoxaline,PhIP: 2-amino-1-methyl-6-phenylimidazo[4,5-b]pyridine,as well as a marker of polycyclic aromatic hydrocarbons:B[a]P: benzo[a]pyrene; Heme iron levels were estimated using the detailed meat questionnaire in conjunction with a database of measured values from meats cooked by different methods and to varying degrees of doneness.	Stomach: Cardia (ICD-O-3 C16.0) – Adenocarcinomas	Heme Iron, Quintile median (µg/1000kcals)			Same as above
			Q1 (48.8)	38	1	
			Q2 (102.9)	45	0.98 (0.63–1.52)	
			Q3 (154.2)	58	1.1 (0.72–1.68)	
			Q4 (218.7)	56	0.94 (0.6–1.45)	
			Q5 (347.7)	58	0.83 (0.53–1.3)	
			All – Heme Iron – Continuous (per 100 µg/1000kcals)	NR	0.95 (0.86–1.05)	
			Trend-test p-value: 0.256			
		Stomach: Non Cardia (ICD-O-3 C16.1-C16.9) – Adenocarcinomas	Heme Iron, Quintile median (µg/1000kcals)			Same as above
			Q1 (48.8)	63	1	
			Q2 (102.9)	49	0.71 (0.49–1.04)	
			Q3 (154.2)	39	0.54 (0.36–0.82)	
			Q4 (218.7)	69	0.92 (0.64–1.33)	
			Q5 (347.7)	57	0.72 (0.48–1.08)	
			All – Heme Iron – Continuous (per 100 µg/1000kcals)	NR	0.96 (0.87–1.06)	
			Trend-test p-value: 0.531			

Table 2.3.1 Cohort studies: Red meat and cancer of the stomach (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) Netherland 1986–2002 Cohort	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; validated FFQ. Red meat = beef, pork, minced meat (both beef and pork), liver, and other non-poultry meat (e.g. horsemeat and lamb).	Stomach: cardia adenocarcinomas (C16.0) and non-cardia adenocarcinomas C16.1–C16.9, including overlapping (C16.8) and not otherwise specified (C16.9) tumours.	Risk by quintile			Adjusted for age (years), smoking status (current versus non-current smoker), 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/m2), 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.
			GCA, men, Q1	27	1	
			Q2	24	0.9 (0.5–1.59)	
			Q3	32	1.16 (0.67–2.01)	
			Q4	27	1.01 (0.56–1.8)	
			Q5	29	1 (0.56–1.78)	
			Trend-test p-value: 0.92			
		Stomach: cardia adenocarcinomas (C16.0) and non-cardia adenocarcinomas C16.1–C16.9, including overlapping (C16.8) and not otherwise specified (C16.9) tumours.	Risk by quintile			
			GNCA, men, Q1	59	1	
			Q2	70	1.16 (0.79–1.72)	
			Q3	54	0.9 (0.6–1.37)	
			Q4	75	1.32 (0.9–1.94)	
			Q5	71	1.15 (0.77–1.71)	
			Trend-test p-value: 0.4			
		Stomach: cardia adenocarcinomas (C16.0) and non-cardia adenocarcinomas C16.1–C16.9, including overlapping (C16.8) and not otherwise specified (C16.9) tumours.	Risk by tertile			
			GCA, women, T1	11	1	
			T2	7	0.61 (0.24–1.56)	
			T3	6	0.45 (0.17–1.19)	
			Trend-test p-value: 0.11			
		Stomach: cardia adenocarcinomas (C16.0) and non-cardia adenocarcinomas C16.1–C16.9, including	Risk by tertile			
			GNCA, women, T1	59	1	
			T2	47	0.75 (0.5–1.12)	
			T3	54	0.85 (0.57–1.26)	

Table 2.3.1 Cohort studies: Red meat and cancer of the stomach (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
		overlapping (C16.8) and not otherwise specified (C16.9) tumours.	Trend-test p-value: 0.45			
Epplein et al. (2014) China (Shanghai) 2002–2006(recruitment) – 2009 (follow up) Nested Case-Control	**Cases:** 226; Permanent residents of urban Shanghai. Incident cases. **Controls:** 451; Permanent residents of urban Shanghai **Exposure assessment method:** Questionnaire; FFQ	Stomach: (ICD-O 161–166, 168, 169)	Risk per Tertile			Age, smoking, history of gastritis, regular aspirin use, total energy intake, and high-risk *H. pylori* infection.
			All T1 (≤ 36.0 g/d)	70	1	
			T2 (36.1–66.5)	64	1.02 (0.66–1.56)	
			T3 (66.5–)	92	1.45 (0.93–2.28)	
			Low-risk (0–4 H.p positive) T1	34	1	
			T2	19	0.56 (0.29–1.09)	
			T3	33	1.19 (0.6–2.36)	
			High-risk (5–6 H.p positive) T1	36	1	
			T2	45	1.68 (0.94–3.01)	
			T3	59	1.85 (1.01–3.4)	
		Stomach: (ICD-O 161–166, 168, 169)	Risk per Tertile			Same as above
			Heme iron; All T1 (≤ 2.2 g/d)	66	1	
			T2 (2.3–3.3)	63	1.01 (0.65–1.58)	
			T3 (3.3–)	97	1.66 (1.05–2.28)	
			Low-risk (0–4 H.p positive) T1	28	1	
			T2	22	0.88 (0.45–1.72)	
			T3	36	1.69 (0.84–3.38)	

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			High-risk (5–6 H.p positive) T1	38	1	
			T2	41	1.27 (0.72–2.24)	
			T3	61	1.95 (1.06–3.57)	
		Stomach: (ICD-O 161–166, 168, 169)	Risk per Tertile			Same as above
			All T1 (≤ 36.0 g/d)	70	1	
			T2 (36.1–66.5)	64	1.02 (0.66–1.56)	
			T3 (66.5–)	92	1.45 (0.93–2.28)	
			Low-risk (0–4 H.p positive) T1	34	1	
			T2	19	0.56 (0.29–1.09)	
			T3	33	1.19 (0.6–2.36)	
			High-risk (5–6 H.p positive) T1	36	1	
			T2	45	1.68 (0.94–3.01)	
			T3	59	1.85 (1.01–3.4)	

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