

5.

Cancers attributable to dietary factors in the UK in 2010

II. Meat consumption

DM Parkin^{*,1}¹Centre for Cancer Prevention, Wolfson Institute of Preventive Medicine, Queen Mary University of London, Charterhouse Square, London EC1M 6BQ, UKBritish Journal of Cancer (2011) 105, S24–S26; doi:10.1038/bjc.2011.478 www.bjcancer.com
© 2011 Cancer Research UK

The current consensus based on several published meta-analyses is that consumption of red meat (all fresh, minced, and frozen beef, veal, pork and lamb), especially processed meat (any meat preserved by methods other than freezing, including marinating, smoking, salting, air-drying or heating (includes ham, bacon, sausages, pate and tinned meat)), is associated with an increased risk of bowel cancer (Department of Health, 1998; WHO/FAO, 2003; WCRF, 2007). Sandhu *et al* (2001) observed significant positive associations with all meat and red meat (an increased risk of around 15% per 100 g per day intake of red meat), and a stronger increase for processed meat (49% risk increase for a 25-g per day serving). Norat *et al* (2002) found a significant increase in risk for colorectal cancer with higher consumption of red meat (1.24 per 120 g per day) and processed meat (1.36 per 30 g per day). Larsson and Wolk (2006) considered 15 prospective studies, and found a relative risk of 1.28 for an increase of 120 g per day intake of red meat and 1.09 for an increase of 30 g per day intake of processed meat. Consumption of red meat and processed meat was positively associated with the risk of both colon and rectal cancer, although the association with red meat appeared to be stronger for rectal cancer.

There are no dietary guidelines concerning recommended levels of consumption of red and processed meat; as for alcohol, it is assumed that 'less is better' and that there is no threshold below which consumption presents no risk. In this section, we assume that the optimum (or target) is zero consumption. Currently, about 10% of the adult population are vegetarian, or consume only fish and poultry products (DEFRA, 2007).

METHODS

The relative risk of meat consumption for colorectal cancer is taken from the WCRF report (2007), and is based on the effect of red meat in a meta-analysis of three prospective studies (1.29 per 100 g red meat per day). Under the assumption that the increase in risk is a logarithmic function of intake of meat, the risk is increased by 0.0025 for each gram of meat consumed. The effect of processed meat, based on five studies, was 1.21 per 50 g per day (the excess risk corresponds to 0.0038 per gram).

The latent period, or interval between 'exposure' to meat and the increased risk of colorectal cancer, is not known. In the cohort studies included in the meta-analyses by WCRF (2007), the mean duration of follow-up was 8.9 years. In studies contributing to the meta-analysis by Larsson and Wolk (2006), the mean duration of follow-up (when this was given) was 8.7 years. We chose to assume a mean latency of 10 years, and estimate the effects on cancers occurring in 2010 from meat consumption in 2000.

Information on consumption of meat in the UK is available for 2000–2001 from the National Diet and Nutrition Survey (Food Standards Agency, 2002) as mean consumption, in grams of different types of meat per week, by age group and sex. The relevant data are shown in Table 1.

The population distribution of protein consumption, in grams per day, by age group and sex, is available from the National Diet and Nutrition Survey (Volume 2, Table 3.1; Food Standards Agency, 2003). This was converted to grams of meat per day, based on the average intake of meat (Table 1) and protein (NDNS Volume 2, Table 3.4) in each age–sex group.

The estimate for 2000 is shown in Table 2 (as the percentage of the population in different age–sex groups consuming specified amounts of red and processed meat), and in Figure 1 as the cumulative frequency (percentage) of the population in each age–sex group at different consumption levels.

The relative risk of meat consumption for each of the x consumption categories shown in Table 2 was calculated according to the following formula:

$$RR_x = \exp(R_g \times G_x)$$

where R_g is the increase in risk of colon cancer per gram of meat (0.0025) and G_x is the consumption of meat in gram per day in category x .

Population-attributable fractions (PAFs) were calculated for each sex–age group according to the following formula:

$$PAF = \frac{\sum(p_x \times ERR_x)}{1 + \sum(p_x \times ERR_x)}$$

where p_x is the proportion of population in consumption category x and ERR_x the excess relative risk ($RR_x - 1$) in consumption category x .

*Correspondence: Professor DM Parkin; E-mail: d.m.parkin@qmul.ac.uk

Table 1 Total quantities of meat consumed by age of respondent, including non-consumers (Great Britain, 2000–2001)

Meat	Grams per day consumed, by age (years)									
	Men					Women				
	19–24	25–34	35–49	50–64	All men	19–24	25–34	35–49	50–64	All women
Red meat ^a (including liver)	63	72	74	77	73	45	37	50	52	47
Processed meat ^b	63	50	43	35	45	32	24	21	19	23
Red (including processed)	125	122	118	111	118	77	62	71	71	69
All meat products ^a	144	142	137	133	138	86	70	81	80	78

^aExcludes poultry. ^bBacon, ham, sausages, burgers, kebabs.

Table 2 Distribution of meat (red and processed) consumption by age group and sex, grams

Consumption category	Consumption of red and processed meat by age group (years)									
	19–24		25–34		35–49		50–64		All ages	
	grams per day	%	grams per day	%	grams per day	%	grams per day	%	grams per day	%
<i>Men</i>										
1	0	6	0	0	0	2	0	3	0	2
2	79	6	66	2	64	4	62	3	66	4
3	88	0	74	3	71	1	68	1	73	1
4	97	11	81	14	79	6	76	7	81	9
5	113	22	95	14	91	9	88	14	94	14
6	129	19	108	16	105	19	100	19	107	18
7	145	19	122	21	118	23	113	13	120	19
8	161	9	135	13	131	14	125	16	134	13
9	177	7	149	8	144	8	138	8	147	9
10	193	1	162	3	157	6	151	10	161	5
11	217	0	182	6	176	8	169	6	181	6
Mean gram per day	125		122		118		111		118	
<i>Women</i>										
1	0	7	0	7	0	4	0	2	0	4
2	52	9	42	13	44	6	42	6	44	9
3	59	4	48	1	50	2	49	1	50	1
4	66	17	54	22	56	15	54	11	55	16
5	77	28	63	26	65	21	63	25	65	24
6	90	19	74	17	76	26	74	25	76	23
7	103	9	84	9	87	16	84	16	87	13
8	116	6	95	3	98	6	95	10	98	7
9	129	1	105	1	109	3	106	4	109	2
10	148	0	121	1	125	1	121	0	125	1
Mean gram per day	77		62		71		71		69	

RESULTS

Table 3 shows PAFs of colorectal cancer resulting from meat consumption in 2000–2001, and the estimated number of cases ‘caused’ in 2010. The final three columns show the excess numbers of cases of colorectal cancer caused by meat consumption expressed as a fraction of the total burden of (incident) cancer. The estimate is 3.5% cancers in men and 1.9% in women, or 2.7% of cancers overall.

DISCUSSION

The association between consumption of red and processed meat and the risk of cancer of the colon and rectum is now well established. Although the risk for processed meat products (such as ham, bacon, sausages, pate and tinned meat) is greater than that for fresh meat, in this analysis we have considered both together,

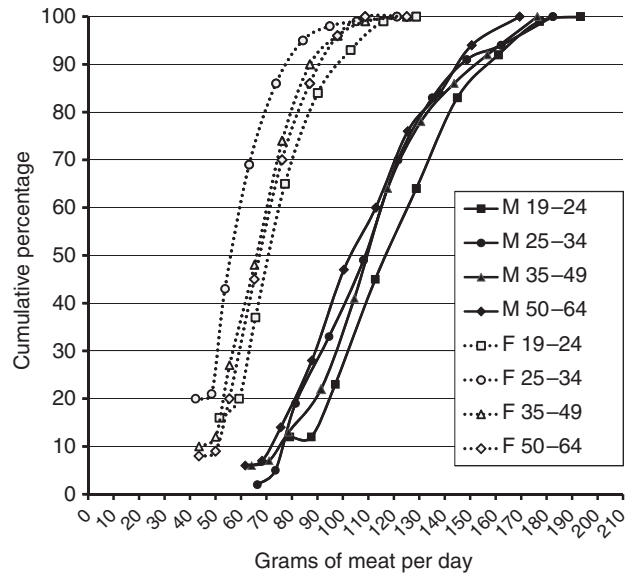


Figure 1 Estimated consumption of red and processed meat, by age group and sex, expressed as grams per day.

partly because separate estimates of intake (by age group and sex) would be difficult, and partly because it would not affect the overall estimate, which is concerned with the proportion of colorectal cancer related to any meat consumption (i.e., over and above a diet including poultry and fish, as sources of animal protein).

The estimation of attributable fraction is against a baseline of a diet that would contain no red meat, and is based on the relative risks of consumption of red meat, according to the review by WCRF (2007). The values for red meat consumption (1.29 per 100 g per day) are rather higher than those in the more recent meta-analysis of Larsson and Wolk (1.29 per 120 g per day, when adjusted for BMI, physical activity, smoking, energy intake and so on). These values would have given a total of 18% of colon cancers due to consumption of red meat (rather than 21.1%, as in Table 3).

Norat *et al* (2002) estimated the proportion of colorectal cancer risk attributable to current (1995) red meat consumption in North and Central Europe as 7.8% in men and 5.8% in women, much lower than the estimated percentages in the UK, but estimated per caput red meat consumption of this population (47.3 g per day in men and 35 g per day in women) was around one-half of that in the UK in 2000 (Table 1). WCRF (2009), based on the relative risks from the EPIC study (Norat *et al*, 2005; 1.49 per 100 g red meat, 1.70 per 100 g processed meat), estimated that 15% of colorectal cancer in the UK in 2002 was due to consumption in excess of 10 g per day of red meat and 10 g per day of processed meat.

Several other cancers have been linked to consumption of red or processed meat. However, at the time of the review by WCRF

Table 3 Colorectal cancer diagnosed in 2010, attributable to meat consumption in 2000–2001

Age (years)		Colon–rectum				All cancers ^a		
At exposure	At outcome	PAF	Observed cases	Excess attributable cases	PAF (%)	Observed cases	Excess attributable cases	PAF (%)
<i>Men</i>								
19–24	29–34	0.27	92	24.8	26.9	1333	24.8	1.9
25–34	35–44	0.26	397	102.5	25.8	4124	102.5	2.5
35–49	45–59	0.26	2921	756.7	25.9	22 388	756.7	3.4
50–64	≥60	0.25	18 643	4611.3	24.7	128 192	4611.3	3.6
All ages			22 127	5495.3	24.8	158 667	5495.3	3.5
<i>Women</i>								
19–24	29–34	0.17	97	16.9	17.5	2248	16.9	0.8
25–34	35–44	0.14	402	57.0	14.2	8619	57.0	0.7
35–49	45–59	0.16	2292	376.0	16.4	31 631	376.0	1.2
50–64	≥60	0.17	14 926	2465.6	16.5	110 403	2465.6	2.2
All ages			17 787	2915.5	16.4	155 584	2915.5	1.9
<i>Persons</i>								
19–24	29–34		189	42	22.1	3582	42	1.2
25–34	35–44		799	160	20.0	12 743	160	1.3
35–49	45–59		5213	1133	21.7	54 019	1133	2.1
50–64	≥60		33 569	7077	21.1	238 595	7077	3.0
All ages			39 914	8411	21.1	314 251	8411	2.7

Abbreviations: PAF = population-attributable fraction. ^aExcluding non-melanoma skin cancer.

(2007), the evidence with respect to cancers of the oesophagus, lung, pancreas, endometrium, stomach and prostate was considered to be 'limited'. Only the associations between consumption of red and processed meat with an increased risk of colorectal cancer were considered to be 'convincing'.

REFERENCES

- Department for Environment, Food and Rural Affairs (DEFRA) (Environment Statistics and Indicators Division) (2007) *Report, Questionnaire and Data Tables Following Survey of Public Attitudes and Behaviours toward the Environment: Table 210, p 481*. <http://www.defra.gov.uk/environment/statistics/pubatt/>
- Department of Health (1998) *Nutritional Aspects of the Development of Cancer. Report of the Working Group on Diet and Cancer. Committee on Medical Aspects of Food Nutrition Policy*. The Stationery Office: London
- Food Standards Agency (2002) *National Diet and Nutrition Survey: Adults Aged 19 to 64, Vol. 1. Types and Quantities of Foods Consumed*. <http://www.food.gov.uk/multimedia/pdfs/ndnsprintedreport.pdf>
- Food Standards Agency (2003) *National Diet and Nutrition Survey: Adults Aged 19 to 64, Vol. 2. Energy, Protein, Carbohydrate, Fat and Alcohol Intake*. <http://www.food.gov.uk/multimedia/pdfs/ndns2.pdf>
- Larsson SC, Wolk A (2006) Meat consumption and risk of colorectal cancer: a meta-analysis of prospective studies. *Int J Cancer* **119**: 2657–2664
- Norat T, Bingham S, Ferrari P, Slimani N, Jenab M, Mazuir M, Overvad K, Olsen A, Tjønneland A, Clavel F, Boutron-Ruault MC, Kesse E, Boeing H, Bergmann MM, Nieters A, Linseisen J, Trichopoulou A, Trichopoulos D, Tountas Y, Berrino F, Palli D, Panico S, Tumino R, Vineis P, Bueno-de-Mesquita HB, Peeters PH, Engeset D, Lund E, Skeie G, Ardanaz E, González C, Navarro C, Quirós JR, Sanchez MJ, Berglund G, Mattisson I, Hallmans G, Palmqvist R, Day NE, Khaw KT, Key TJ, San Joaquin M, Hémond B, Saracci R, Kaaks R, Riboli E (2005) Meat, fish, and colorectal

See acknowledgements on page Si.

Conflict of interest

The author declares no conflict of interest.

- cancer risk: the European Prospective Investigation into cancer and nutrition. *J Natl Cancer Inst* **97**: 906–916
- Norat T, Lukanova A, Ferrari P, Riboli E (2002) Meat consumption and colorectal cancer risk: dose-response meta-analysis of epidemiological studies. *Int J Cancer* **98**: 241–256
- Sandhu MS, White IR, McPherson K (2001) Systematic review of the prospective cohort studies on meat consumption and colorectal cancer risk: a meta-analytical approach. *Cancer Epidemiol Biomarkers Prev* **10**: 439–446
- World Cancer Research Fund (WCRF)/American Institute for Cancer Research (AICR) (2009) *Policy and Action for Cancer Prevention – Food, Nutrition and Physical Activity: A Global Perspective*. American Institute for Cancer Research: Washington, DC
- World Cancer Research Fund (WCRF) Panel (2007) *Food, Nutrition, Physical Activity, and the Prevention of Cancer: A Global Perspective*. World Cancer Research Fund: Washington, DC
- World Health Organization (WHO)/Food and Agriculture Organization (FAO) (2003) *Diet, Nutrition and The Prevention of Chronic Diseases: Report of a Joint WHO/FAO Expert Consultation*. WHO Technical Report Series 916. WHO: Geneva



This work is licensed under the Creative Commons Attribution-NonCommercial-Share Alike 3.0 Unported License. To view a copy of this license, visit <http://creativecommons.org/licenses/by-nc-sa/3.0/>