The Summer Meeting of the Nutrition Society was held at the University of Surrey on 29 June–2 July 1998

Meat or wheat for the next millennium? A Debate
Pro meat

Meat and colo-rectal cancer

Michael J. Hill
Lady Sobell Gastrointestinal Unit, Wexham Park Hospital, Slough SL2 4HL, UK

In early epidemiological studies of diet and cancer the stress was on the search for causal factors. Population (ecological) studies tended to show a strong correlation between meat intake, particularly red meat, and the risk of colo-rectal cancer. They also tended to show meat to be strongly inversely correlated with cancers of the stomach and oesophagus and liver. Early case–control studies tended to support the postulated role for red meat in colo-rectal carcinogenesis, although more recent case–control studies, particularly those from Europe, have tended to show no relationship. The cohort studies in general failed to detect any relationship between meat intake and colo-rectal cancer risk. The available evidence points to the intake of protective factors such as vegetables and whole-grain cereals being the main determinants of colo-rectal cancer risk, with meat intake only coincidentally related.

Colo-rectal cancer: Meat intake: Epidemiological studies

The study of the relationship between diet and cancer risk is not simple because the tools available are so imprecise. The major methods used are: (a) human epidemiology, (b) animal models, (c) *in vitro* model systems, (d) dietary intervention studies. Of these methods, only the last method yields evidence in which we can have confidence, because only by dietary intervention do we see the actual effect of a recommended action. However, there have been few such dietary intervention studies. The animal and *in vitro* model systems can be used to study aspects of the carcinogenesis process, and have been of great value in studies of the cell biology and histopathology of carcinogenesis, but they give us no reliable information on the aetiology of human cancer (Hill, 1995), and we are left therefore with the blunt instrument of human epidemiology.

Epidemiological studies take three main forms, i.e. (a) the comparison of populations (often called ecological studies, although they rarely study ecology), (b) case–control studies (often called analytical studies, although they usually involve no analyses), and (c) prospective, or cohort, studies. The strengths and weaknesses of these studies have been discussed elsewhere (Hill, 1995). Well-constructed cohort studies with a 10–20 year follow-up are the most reliable source of evidence, but they are very expensive, and so usually only follow after case–control and population studies. The results of epidemiological work are easily misinterpreted, and so it is only when the results of all three types of study give mutually consistent results that any confidence can be attached to the conclusions. Recently, for example, the European Cancer Prevention Consensus Group (1997) concluded that the evidence concerning cereal fibre and colo-rectal cancer was sufficiently consistent between the three types of study to allow them to conclude that cereal fibre protects against colo-rectal cancer.

The World Cancer Research Fund (1997) published its ‘global report’ on diet and cancer; the most widely publicized of its conclusions was that ‘if eaten at all, limit intake of red meat to less than 80 g (3 ounces) per day’. Can this conclusion be justified on the basis of the available evidence? Is there, in fact, the same consistency in the evidence on meat that can be seen for cereal fibre, or for fruit and vegetables?

***Corresponding author:** Dr Michael J. Hill, fax +44 (0)1256 880416

Population studies of meat and cancer

There have been many population studies of meat and colo-rectal cancer, and these have been reviewed elsewhere (Hill, 1986). They all tend to give similar results because they all use broadly the same database. In general they show a strong correlation between intake of meat, particularly of red meat, and colo-rectal cancer incidence and mortality. They also tend to show a strong inverse relationship between red meat intake and risk of cancers of the stomach, oesophagus and liver. In any 'global perspective' these latter cancers are far more significant than the relationship with colo-rectal cancer.

Case–control studies

Inevitably, because they all use independent databases, the case–control studies are much less unanimous in their conclusions. Furthermore, because of the inherent weaknesses in the case–control approach (Hill, 1995), they tend to show only weak, if any, correlation between meat intake and colo-rectal cancer risk. In the Department of Health (1998) report twenty-five case–control studies are summarized; in nine studies the odds ratios between the highest and the lowest red meat intake was > 1·2, and in one study the relationship was statistically significant (and with no error bars shown for six of the nine studies). In eight studies the odds ratios were < 1 (one of which was statistically significant) and in eight studies they were marginally > 1. The evidence from Europe of a role for meat in colo-rectal carcinogenesis is particularly unconvincing. Two recent case–control studies from Europe (Faivre *et al*. 1997; Franceschi *et al*. 1997) found no evidence of any relationship between meat intake and colo-rectal cancer risk. A similar lack of relationship was seen in two further case–control studies from southern Europe (Macquart-Moulin *et al*. 1986; Benito *et al*. 1990) and in the Belgian study by Tuyns *et al*. (1987). Thus, the evidence from case–control studies is far from overwhelming.

Cohort studies

The evidence from cohort studies of a causal role for red meat is even less persuasive than that from the case–control studies. Studies of white meat almost all show either no relationship or slight protection against colo-rectal carcinogenesis (Department of Health, 1998) and so the distinction between red and white meat is very important. Only one cohort study (Willett *et al*. 1990) showed a statistically significant dose–response relationship with red meat intake, whilst another cohort study (Giovannucci *et al*. 1994) showed an elevated risk only at the highest intake (129 g/d); a further seven studies showed no relationship (Table 1). The report of the Committee on Medical Aspects of Food Policy (Department of Health, 1998) summarized and highlighted the lack of relationship (both from case–control and from cohort studies) between the number of servings of red meat per week (a reasonable measure of red meat intake) and the risk of colo-rectal cancer.

In summary, the cohort studies and the case–control studies do not even support a conclusion of a relationship between red meat intake and colo-rectal cancer risk. They certainly give no support for an upper limit of 80 g/d!

Other data

During the last 30 years the intake of red meat in the UK has fallen steadily (Hill, 1997) to 75 % of its 1965 value (Table 2). During that same period of time the incidence of colo-rectal cancer, far from falling by 25 % as would be expected from the World Cancer Research Fund (1997) recommendation, has actually increased by more than 50 %. Within the EU the UK has the lowest intake of red meat (Table 3). All Mediterranean populations eat more red meat than the British, but they have lower incidences of colo-rectal cancer. So what is the explanation? It comes from looking at what else happened to the British diet during the last 30 years. During that time, the red meat intake decreased markedly, the intake of (harmless) white meat

Table 1. Cohort studies of the relationship between the intake of red meat and colo-rectal cancer risk

	Quintile of red meat intake				
Study	1	2	3	4	5
Willett *et al.* (1990): Odds ratio	1·0	1·2	1·3	1·1	1·8
Meat intake (g) by quintile	< 59	59–83	83–105	105–133	> 134
Giovannucci *et al.* (1994): Odds ratio	1·0	1·0	1·0	1·2	1·7
Meat intake (g) by quintile	19	43	64	89	130
Thun *et al.* (1992): Odds ratio	1·0	1·0	1·1	1·0	1·1
Bostick *et al.* (1994): Odds ratio	1·0	1·1	1·2	0·9	1·0
Servings per week	< 4	4–6	7–8	9–11	> 11
Phillips & Snowdon (1985): Odds ratio	1·0		1·4		0·9
Meat intake (g)	< 20		20–80		> 80
Goldbohm *et al.* (1994): Odds ratio	1·0	0·9	1·2	1·0	0·8
Mean meat intake (g)	54	84	101	123	158
Gaard *et al.* (1996): Odds ratio	1·0	0·9	1·0	0·8	
Servings fried and/or roast meat per week	< 1	1–2	3–4	> 5	
Knekt *et al.* (1994): Odds ratio	1·0		0·7		1·0
Intake fried meat (g) per week	17		27		41
HALS Study (M Whichelow, personal communication)	No relationship between meat intake and cancer risk				

HALS, Health and Lifestyle Study.

https://doi.org/10.1017/S002966519900035X Published online by Cambridge University Press

Table 2. Temporal changes in intake of red meat in the UK 1965–95 (data from FAOSTAT website; http://apps.fac.org/lim500/nph-wrap-pl?G) and colo-rectal cancer incidence per 100 000 population per year

Year	Red meat intake (kg per person per year)	Colo-rectal cancer incidence (per 100 000 population per year)
1965	61·0	34·4
1970	60·8	37·1
1980	56·1	46·4
1985	53·4	48·4
1990	51·8	53·3
1995	45·9	?

Table 3. Red meat intake (kg per person per year, data from the FAOSTAT website; http://apps.fao.org/lim500/nph-wrap-pl?G), and colo-rectal cancer mortality (per 100 000 population per year; data from Levi *et al.* 1993) in the countries of the EU

Country	Red meat intake (kg per person per year)	Colo-rectal cancer incidence (per 100 000 population per year)
Ireland	62·0	24·9
Denmark	84·2	23·8
Germany	69·7	23·0
France	69·2	22·6
England and Wales	45·9	21·5
The Netherlands	65·9	20·9
Italy	61·4	19·3
Portugal	56·1	16·1
Spain	71·6	13·2
Greece	52·0	7·9

Table 4. Changes in the mean consumption (oz/week) of some key foods in the British diet, 1970–88 (Data from National Household Food Surveys; Ministry of Agriculture, Fisheries and Food, 1971, 1981, 1989)

	Mean consumption of food item (oz/week)			
Food item	1970	1980	1988	Change in consumption 1970–88 (%)
Beef and veal	7·80	8·10	6·30	–19·2
Poultry	4·80	6·70	8·10	67·4
Fresh green vegetables	14·50	12·40	10·40	–28·0
Bread	38·10	31·10	30·30	–20·5
Sugar and jams	19·50	13·20	8·80	–54·9
Colo-rectal cancer incidence	37·1	46·4	53·3	43·7

Table 5. Changes in mortality from lung cancer (per 100 000 per year) in men aged 50–59 years and at all ages in the UK and in Finland, 1975–95 (Data from Peto *et al.* 1994)

	UK		Finland	
Year	50–59 years	All ages	50–59 years	All ages
1975	146·9	108·4	122·2	68·7
1985	118·3	107·1	112·2	74·1
1990	88·7	95·7	64·9	66·1
1995	68·1	82·9	42·9	59·2

increased, and the intake of (protective) cereals (European Cancer Prevention Consensus Group, 1997) and vegetables (Block *et al*. 1992) decreased (Table 4). The changes in risk of colo-rectal cancer could be predicted from the changes in intake of the protective factors, but were unrelated to meat intake. A similar pattern emerges from the European data. The risk of colo-rectal cancer in the UK compared with that in the Mediterranean countries was related to the intake of the (protective) vegetables and cereals, and not at all to the intake of red meat.

Conclusions

The conclusion from this analysis of the data must be that the World Cancer Research Fund (1997) made a serious error of judgement in its recommendation that intake of red meat should be limited to 80 g/d, if consumed at all. This is not a minor matter. Table 5 shows the change in lung cancer rates in the UK and in Finland following the successful anti-smoking campaigns. This is a triumph for cancer prevention, and showed that people will listen to advice and will benefit from it. However, it was only achieved because all health professionals gave a common message backed by solid evidence. There was never any need to retract anything from the anti-smoking message! People will listen if the message is a good one. They will not listen when we constantly change the message, and when we suddenly produce new findings that later have to be retracted.

Until recently we were all giving the same message:

avoid overweight by taking physical exercise and controlling energy intake;
eat a diet rich in vegetables and fresh fruits (at least five servings per d);
eat a diet rich in high-fibre cereals;
enjoy your food.

The addition of meat to the list, and the subsequent discussions, has confused the public, and has seriously set back the healthy eating campaigns. It will take us a time to recover the lost ground, and that is why the publicity for the anti-meat message at the launch of the World Cancer Research Fund (1997) report matters.

Most people in the UK eat meat; they do so because they like it. If they don't like meat then they can easily do without it; if they object to animal husbandry methods then this, too, is a legitimate reason for avoiding meat. However, the claimed risk of colo-rectal cancer is not a reason for avoiding meat. Red meat intake has fallen for the last 30 years without any decrease in colo-rectal cancer incidence, and there is no reason to assume that further decreases will

https://doi.org/10.1017/S002966519900035X Published online by Cambridge University Press

suddenly achieve the desired effect. The Mediterranean populations eat more meat than we do, but have less colo-rectal cancer. They achieve that by eating more of the vegetables and cereals that protect against cancer. That is what we should do too; we could then eat more meat (as they do) if we wanted to.

References

Benito E, Obrador A, Stiggelbout A, Bosch FX, Millet M & Munoz N (1990) A population based case control study of colorectal cancer in Majorca. 1. Dietary factors. *International Journal of Cancer* **45**, 69–76.

Block G, Patterson B & Subar A (1992) Fruit, vegetables and cancer prevention: a review of the epidemiological evidence. *Nutrition and Cancer* **18**, 1–29.

Bostick RM, Potter JD, Kushi LH, Sellars TA, Steinmetz KA, McKenzie DA, Gapstur SM & Folsom AR (1994) Sugar, meat and fat intake and non-dietary risk factors for colon cancer incidence in Iowa women (US). *Cancer Causes and Control* **5**, 38–52.

Department of Health (1998) *Nutritional Aspects of the Development of Cancer. Report on Health and Social Subjects* no. 48. London: The Stationery Office.

European Cancer Prevention Consensus Group (1997) Consensus meeting on cereals, fibre and colorectal and breast cancer. *European Journal of Cancer Prevention* **6**, 512–514.

Faivre J, Couillault C, Kronborg O, Rath U, Giacosa A, De Oliviera H, Obrador T, O'Morain C & the IECP Colon Group (1997) Chemoprevention of metachronous adenomas of the large bowel: design and interim results of a randomised trial of calcium and fibre. *European Journal of Cancer Prevention* **6**, 132–138.

Franceschi S, Favero A, La Vecchia C, Negri E, Conti E, Montella M, Giacosa A, Nanni O & De Carli A (1997) Food groups and risk of colorectal cancer in Italy. *International Journal of Cancer* **72**, 56–61.

Gaard M, Tretli S & Luken EB (1996) Dietary factors and risk of colon cancer: a prospective study of 50535 young Norwegian men and women. *European Journal of Cancer Prevention* **5**, 445–454.

Giovannucci E, Stampfer MJ, Colditz G, Rimm EB & Willett WC (1994) Intake of fat, meat and fiber in relation to the risk of colon cancer in men. *Cancer Research* **54**, 2390–2397.

Goldbohm RA, Van den Brandt PA, Van't Veer P, Brants HA, Dorant E & Hermus RJ (1994) A prospective cohort study on the relation between meat consumption and the risk of colon cancer. *Cancer Research* **54**, 718–723.

Hill MJ (1986) *Microbes and Human Cancer*. London: Edward Arnold.

Hill MJ (1995) Diet and cancer: A review of the scientific evidence. *European Journal of Cancer Prevention* **4**, Suppl. 2, 3–42.

Hill MJ (1997) Meat and colorectal cancer: what does the evidence show? *European Journal of Cancer Prevention* **6**, 415–417.

Knekt P, Steineck G, Jarvinen R, Hakulinen T & Aromaa A (1994) Intake of fried meat and risk of cancer. A follow-up study in Finland. *International Journal of Cancer* **59**, 756–760.

Levi F, La Vecchia C, Lucchini F & Boyle P (1993) Cancer incidence and mortality in Europe 1983–7. *Society for Preventive Medicine* **38**, Suppl. 3, s155–s229.

Macquart-Moulin G, Riboli E, Cornee J, Charnay B, Berthezene P & Day N (1986) Case-control study on colorectal cancer and diet in Marseilles. *International Journal of Cancer* **38**, 182–191.

Ministry of Agriculture, Fisheries and Food (1971) *Household Food Consumption and Expenditure, 1970. Annual Report of the National Food Survey Committee*. London: H.M. Stationery Office.

Ministry of Agriculture, Fisheries and Food (1981) *Household Food Consumption and Expenditure, 1980. Annual Report of the National Food Survey Committee*. London: H.M. Stationery Office.

Ministry of Agriculture, Fisheries and Food (1989) *Household Food Consumption and Expenditure, 1988. Annual Report of the National Food Survey Committee*. London: H.M. Stationery Office.

Peto R, Lopez AD, Boreham J, Thun M & Heath C (1994) *Mortality from Smoking in Developed Countries 1950–2000*. Oxford: Oxford University Press.

Phillips RL & Snowdon DA (1985) Dietary relationships with fatal colorectal cancer among Seventh Day Adventists. *Journal of the National Cancer Institute* **74**, 307–317.

Thun MJ, Calle EE, Namboodiri MM, Flanders WD, Coates RJ, Byers T, Boffetta P, Garfinkel L & Heath CW (1992) Risk factors for fatal colon cancer in a large prospective study. *Journal of the National Cancer Institute* **84**, 1491–1500.

Tuyns AJ, Halterman M & Kaaks R (1987) Colorectal cancer and the intake of nutrients; oligosaccharides are a risk factor, fats are not. *Nutrition and Cancer* **10**, 181–196.

Willett WC, Stampfer MJ, Colditz GA, Rosner BA & Speizer FE (1990) Relation of meat, fat and fiber intake to the risk of colon cancer in a prospective study among women. *New England Journal of Medicine* **323**, 1664–1672.

World Cancer Research Fund (1997) *Food, Nutrition and the Prevention of Cancer: a Global Perspective*. Washington, DC: AICR.