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REVIEW

Foodstuffs and colorectal cancer risk: A review

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Summary
Background and aims: To assess the relationships between food intake and colorectal cancer risk.
Methods: Systematic review of available prospective studies on dietary intake and colorectal cancer.
Results: Twelve out of 15 studies found no significant relationship between vegetable intake and colorectal cancer risk; also, 11 out of 14 studies found no relationship with fruit consumption. Conversely, the combined consumption of vegetables and fruit reduced colorectal cancer risk in three out of six studies, although the relationship was somewhat inconsistent between genders and anatomical localizations. Most studies found no relationship between cancer risk and red meat (15 in 20) or processed meat (seven out of 11) consumption; still, most of the reported relative risks were above unity, suggesting that high consumption of red or processed meat might increase colorectal cancer risk. The consumption of white meat, fish/seafood, dairy products, coffee or tea was mostly unrelated to colorectal cancer risk, although the consumption of smoked or salted fish actually increased risk.
Conclusions: The relationships between dietary intake and colorectal cancer risk might be less important than previously reported. The combined consumption of vegetables and fruit might be protective, whereas excessive consumption of meat or smoked/salted/processed food appears to be deleterious.

Contents

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Introduction

Worldwide, colorectal cancer is one of the most prevalent, accounting for 7.3% and 8.5% of all cancers in men and women, respectively.[1] In Portugal, in 1999, it was responsible for 8.7% and 11.7% of all cancer deaths in men and women, respectively,[2] a percentage which remained rather stable in 2001, 9.4% and 11.1%.[3]

Relationships between nutrition and colorectal cancer have been early hypothesized;[4] recently, it has been estimated that a third to half of colon cancers may possibly be avoided if several lifestyle risk factors, namely obesity, high alcohol and red meat intake, were controlled for.[5,6] It has indeed been shown that adherence to healthy nutrition-related behaviours lessen colorectal cancer risk,[7–9] and dietary recommendations have been issued accordingly.[10] However, the particular effect of the consumption of each type of food on colorectal cancer risk remains questionable. Furthermore, more precise comprehensive dietary surveys have enabled the assessment of new foodstuffs, and some authors have also suggested that the impact of diet might differ according to the cancer location, i.e. colon or rectum.[11,12]

In order to appraise potential relationships between dietary intake and colorectal cancer, data from different epidemiological studies can be used.[13] Briefly, case-control studies assess past dietary intake in patients versus healthy individuals; though usually cheaper and easier to perform, the main drawback of this type of study relates to recall bias, as subjecs may have difficulties in accurately remembering past dietary intake.[14] Conversely, although prospective studies tend to be expensive and time-consuming, current dietary intake is in general more reliable and can be related to future events. Results of prospective studies are expressed as relative risks, defined as the ratio of the rates of appearance of a given outcome (cancer) for different categories of exposure (dietary intake);[13] a relative risk above unity indicates that the exposure increases risk, whereas a relative risk below unity indicates that the exposure is protective, i.e. decreases risk. For instance, in Giovannucci et al.'s study, high consumers of processed meat have a relative risk of 1.51, i.e. their risk of developing colon cancer is increased by 51% comparative to nonconsumers.[15] Furthermore, prospective studies are usually considered more reliable than case-control studies to estimate the relations between dietary intake and cancer risk,[13] but so far their data have not yet been analysed comprehensively. This paper therefore conveys the results from a systematic review of all published prospective studies that assessed relationships of foodstuffs with colorectal cancer risk; those studies were collected by a Medline search using "prospective", "colorectal cancer" or "cohort study" as keywords, and the bibliography of each article was thoroughly screened in order to find other prospective data. Whenever doable, the effects of foodstuffs on different cancer locations (proximal or distal colon, rectum) are highlighted; finally, and based on the collected data, a few remarks regarding the effect of foodstuffs in colorectal cancer prevention will be presented.

Cereals, nuts and seeds

Cereals

Seven studies reported on the effect of cereal intake on colorectal cancer risk[12,16–21] (Table 1). In

Table 1 Consumption of cereals, nuts, and seeds, and colorectal cancer risk.

Reference	Cohort size	Follow-up (years)	Gender	Age at inclusion	Location	RR (95% CI)	Comparison method	Adjustment
Cereals								
[12]	61,433	14.8	Women	40–75	Colon, rectum	Colorectal: 0.80 (0.60–1.06) Colon: 0.67 (0.47–0.94) Rectal: 1.11 (0.67–1.83)	4.5 vs. <1.5 servings/day	Age; BMI; education; energy, saturated fat, calcium, red meat, fruit and vegetable intake
[16]	265,118	17	Men and women	⩾40	Colon	Rice/wheat: Sigmoid: 0.44 (0.26–0.73) Proximal: 0.96 (0.72–1.28)	Daily/occasional vs. infrequent or none	Age
[17]	337,505 426,838	6	Men Women	⩾30	Colon	Grain: Men: 0.72 (0.52–0.99) Women: no relationship	Highest vs. lowest quintile	BMI; physical activity; family history; aspirin use; total fat intake
[18]	17,633	20	Men	NR	Colon, rectum	Bread: Colon: 0.8 (0.4–1.5) Colorectal: 0.8 (0.5–1.4)	⩾176.3 vs. < 88 times / month	Age; smoking; total energy and alcohol intake
[20]	45,181 62,643	9.9	Men Women	40–79	Colon, rectum	Men: Colon: 0.81 (0.49–1.33) Rectum: 0.59 (0.34–1.03) Women: Colon: 0.91 (0.47–1.78) Rectum: 2.06 (0.88–4.84)	⩾5 vs. 0–2/day	Age; family history; BMI; smoking; physical activity; education; alcohol intake; region
[21]	10,998	17	Men and women	Median 33	Colon, rectum	Brown bread: 0.90 (0.59–1.38) White bread: 2.11 (1.17–3.81) Breakfast cereals: 1.24 (0.76–2.03)	⩾55 vs. <15 slices/wk ⩾5 vs. 0 times/week	Age; gender; smoking; alcohol intake
Nuts and seeds								
[22]	478,040	4.8	Men and women	35–70	Colon, rectum	Colorectal: 0.91 (0.75–1.11) Colon: 0.81 (0.63–1.04) Rectal: 1.04 (0.77–1.42)	⩾6.2 g/d. vs. none	Age; gender; smoking; height; weight; physical activity; energy, fibre and fruit intake

BMI: body mass index; NR, not reported.

two studies no effect of cereal or bread consumption was found,[18,19] whereas in another study breakfast cereals or brown bread had no effect, but a deleterious effect of white bread was established.[21] A Japanese study found that increased rice or wheat consumption had no effect on proximal colon cancer, but significantly decreased the risk of sigmoid cancer;[16] conversely, in another Japanese study no relationship was found between rice intake and colorectal cancer risk in both genders.[20] Another study reported that the combined consumption of grains and vegetables could reduce colon cancer mortality in both genders.[17] Finally, in Sweden a study of circa 60,000 women showed that a high consumption of whole grains was associated with a lower risk of colon cancer, but not of rectal cancer.[12] Overall, from the available prospective data, no precise relationship between cereal consumption and colorectal cancer risk can be drawn; such findings are perhaps due to the diversity of cereals and cereal products presented and also to differences in food processing or fortification.

Nuts and seeds

Only one prospective study assessed the relationship between nut and seed intake[22] (Table 1). The cohort included 10 European countries: there was no association between higher intake of nuts and seeds and the risk of colorectal, colon or rectal cancer, although in women a significant inverse association with colon cancer risk was observed for the highest intake (RR = 0.69; 95% confidence interval, 0.50–0.95). Still, the authors indicate that the site-specific associations require further confirmation before any recommendations can be made regarding nuts and seeds intake.

Vegetables, legumes and fruit

Vegetables and legumes

Eighteen studies assessed the relationship between vegetables and colorectal cancer risk[15–21,23–33]; analyses included either total vegetable intake alone or in association with fruit, or the consumption of selected species of vegetables or legumes, while several reported data for different combinations[15,18,25,26] (Tables 2–4).

Fifteen studies assessed the relationship between total vegetable consumption and colorectal cancer risk[15,17–19,21,24,25,27–34] (Table 2); 12 failed to find any significant linkage,[15,18,19,21,24,25,27,28,30,31,33,34] two studies though found an inverse relationship[29,32] to be confirmed in another only in women but not in men.[17] A study did not identify any effect of vegetables, yet legumes (beans, peas, lentils) seemed to reduce colorectal cancer risk,[29] findings disputed by another study.[25]

Eleven studies assessed the relationship between selected species of vegetables or legumes[15,16,18–20,23–26,28,31] (Table 3). In both genders, no effect on the incidence of colorectal cancer was found for leek or onion[26] or green salad,[23] whereas a significant inverse relationship between *brassica* vegetables and colon cancer risk was reported for women.[31] The overall findings concerning the protective/deleterious effect of the consumption of selected vegetables/legumes are rather conflicting: the consumption of green-yellow vegetables had no effect on proximal colon cancer, yet were protective for sigmoid colon cancer,[16] results not reproduced in other studies;[20,24] likewise, cruciferous vegetables consumption had a deleterious effect in a Finnish cohort,[19] unproven in three other studies.[18,20,25] Furthermore, another Japanese survey found no relationship between colon or rectal cancer risk and the intake of carrots, tomato, mushrooms or tofu.[20] Finally, one survey found an inverse relationship between garlic consumption and colon cancer risk,[25] whereas no relationship was found in others[15,28] and a meta-analysis of all the available data between 1 January 1966 and 15 August 1999 concluded towards a protective effect of garlic consumption.[35]

Fruit

Fourteen studies reported data on fruit consumption and colorectal cancer risk[15,18–21,24,25,27,28,30–34] (Table 4); no significant relationship was found in 11 studies,[15,18,19,21,25,27,28,30,31,33,34] two reported an inverse relationship in women,[24,32] whereas another showed a positive association in women but none in men,[20] although this study lacked statistical power due to small sample size and measurement error in the food-frequency questionnaire. Again, and as for vegetable consumption, the available data indicate that increased fruit consumption per se may only slightly reduce the risk of colorectal cancer.

Vegetables and fruit

Six studies assessed the effect of the combined consumption of vegetables and fruit[17,24,25,30–32] (Table 5). Three studies on colon or rectal cancer risk found little or no effect of the individual consumption of vegetable or fruit, whereas the

Table 2 Vegetable consumption and colorectal cancer risk.

Reference	Cohort size	Follow-up (years)	Gender	Age at inclusion	Location	RR (95% CI)	Comparison method	Adjustment
[15]	47,949	6	Men	40–75	Colon	1.02 (0.64–1.63)	⩾5 vs. ⩽2 servings/day	Age; total energy intake
[17]	337,505 426,838	6	Men Women	⩾30	Colon	Men: no relationship Women: 0.63 (0.45–0.89)	Highest vs. lowest quintile	BMI; physical activity; family history; aspirin use; total fat intake
[18]	17,633	20	Men	⩾35	Colon, rectum	1.3 (0.8–2.4)	⩾4.5 vs. <1.2 times/month	Age; smoking; total energy and alcohol intake
[19]	27,111	8	Men	50–69	Colon, rectum	1.2 (0.8–1.9)	Highest vs. lowest quartile	Age; BMI; smoking; physical activity; education; alcohol and calcium intake
[21]	10,998	17	Men and women	Median 33	Colon, rectum	0.86 (0.54–1.38)	Highest vs. lowest tertile	Age; gender; smoking; alcohol intake
[25]	41,837	5	Women	55–69	Colon	0.73 (0.47–1.13)	Highest vs. lowest quartile	Age; total energy intake
[27]	14,727	7.1	Women	34–65	Colon, rectum	1.63 (0.92–2.89)	Highest vs. lowest quartile	Age; education; geographical area; total energy intake
[28]	35,216	10	Women	55–69	Colon	No family history: 1.1 (0.7–1.6) Family history: 2.0 (1.0–4.2)	⩾27 vs. ⩽18 servings/week	Age; family history of polyps; total energy intake
[29]	32,051	6	Men and women	⩾25	Colon	0.53 (0.33–0.86)	⩾2 vs. <1/week	Age; gender; BMI; smoking; physical activity; family history; aspirin use; alcohol consumption
[30]	47,325 88,764	8.8 10.9	Men Women	30–55	Colon, rectum	Men: Colon: 1.01 (0.90–1.14) Rectum: 1.01 (0.80–1.27) Women: Colon: 1.03 (0.97–1.10) Rectum: 1.03 (0.91–1.17)	+1 serving/day	Age; BMI; height; smoking; physical activity; family history; aspirin and vitamin supplement use; total calorie, alcohol and red meat intake
[31]	58,279 62,573	6.3	Men Women	55–69	Colon, rectum	Men: Colon: 0.85 (0.57–1.27) Rectum: 0.88 (0.55–1.41) Women: Colon: 0.83 (0.54–1.26) Rectum: 1.17 (0.94–3.38)	Highest vs. lowest quintile	Age; family history; alcohol intake
[32]	61,463	9.6	Women	40–74	Colon, rectum	Colorectal: 0.84 (0.65–1.09) Colon: 0.90 (0.66–1.24) Rectum: 0.71 (0.45–1.12)	⩾2 vs. <1 servings/day	Age, BMI; education; energy, alcohol, red meat, total fat, folic acid, vitamins C and D and calcium intake
[33]	45,490	8.7	Women	Mean 61	Colon, rectum	0.95 (0.71–1.26)	Highest vs. lowest quintile	BMI; height; smoking; physical activity; education; multivitamin supplement use; use of NSAID; energy, grain foods, red meat, calcium, vitamin D, alcohol and fruit intake
[34]	88,658	9	Men and women	40–69	Colon, rectum	Colorectal: 1.00 (0.79–1.27) Colon: 1.08 (0.80–1.45) Rectum: 0.87 (0.58–1.31)	Highest vs. lowest quartile	Age; gender; BMI; smoking; physical activity; multivitamin supplement use; geographical area; energy, cereals, meat, fish and alcohol consumption

BMI: body mass index; NSAID, nonsteroid anti-inflammatory drugs.

Table 3 Consumption of selected vegetables and colorectal cancer risk.

Reference	Cohort size	Follow-up (years)	Gender	Age at inclusion	Location	RR (95% CI)	Comparison method	Adjustment
Cruciferous vegetables								
[18]	17,633	20	Men	⩾35	Colon, rectum	1.4 (0.9–2.2)	⩾67 vs. <29.3 times/month	Age; smoking; total energy and alcohol intake
[19]	27,111	8	Men	50–69	Colon, rectum	1.6 (1.0–2.3)	Highest vs.lowest quartile	Age; BMI; smoking; physical activity; education; alcohol and calcium intake
[20]	45,181 62,643	9.9	Men Women	40–79	Colon, rectum	Men: Colon: 1.19 (0.73–1.94) Rectum: 1.22 (0.73–2.05) Women: Colon: 1.21 (0.78–1.87) Rectum: 1.08 (0.55–2.25)	Daily vs. 0–2/week	Age; family history; BMI; smoking; physical activity; education; alcohol intake and region
[25]	41,837	5	Women	55–69	Colon	1.12 (0.74–1.70)	Highest vs. lowest quartile	Age; total energy intake
Onions								
[26]	120,852	3.3	Men and women	55–69	Colon, rectum	Men: Colon: 0.87 (0.48–1.65) Rectum: 0.66 (0.28–1.52) Women: Colon: 1.49 (0.79–2.81) Rectum: 1.34 (0.55–3.31)	⩾5 vs. 0/day	Age; BMI; smoking; education; family history; alcohol, vitamin C and β-carotene intake
Green-yellow vegetables								
[16]	265,118	17	Men and women	⩾40	Colon	Sigmoid: 0.36 (0.14–0.92) Proximal: 1.42 (0.62–3.24)	Daily/occasional vs. infrequent or none	Age
Dark green vegetables								
[24]	11,580	8	Men Women	Mean 75 Mean 74	Colon	Men: 2.28 (1.33–3.91) Women: 1.04 (0.63–1.73)	Highest vs. lowest tertile	Age; smoking
Yellow vegetables								
[24]	11,580	8	Men Women	Mean 75 Mean 74	Colon	Men: 1.09 (0.65–1.84) Women: 0.83 (0.52–1.32)	Highest vs. lowest tertile	Age; smoking

Table 3 (*continued*)

Reference	Cohort size	Follow-up (years)	Gender	Age at inclusion	Location	RR (95% CI)	Comparison method	Adjustment
Leek								
[26]	120,852	3.3	Men and women	55–69	Colon, rectum	Men: Colon: 1.10 (0.71–1.70) Rectum: 0.72 (0.40–1.30) Women: Colon: 1.18 (0.73–1.89) Rectum: 1.31 (0.60–2.85)	⩾5 vs. 0/day	Age; BMI; smoking; education; family history; alcohol, vitamin C and β-carotene intake
Green salad								
[23]	25,493	21	Men and women	⩾40	Colon, rectum	0.9 (0.6–1.3)	⩾7 vs. <4/week	Age; gender
Garlic								
[15]	47,949	6	Men	40–75	Colon	0.77 (0.51–1.16)	⩾ 2 vs. 0 servings/week	Age; total energy intake
[25]	41,837	5	Women	55–69	Colon	0.68 (0.46–1.02)	Highest vs. lowest consumption	Age; total energy intake
[28]	35,216	10	Women	55–69	Colon	No family history: 1.2 (0.8–1.9) Family history: 1.0 (0.4–2.5)	⩾1 vs. 0 servings/week	Age; family history of polyps; total energy intake
Brassica vegetables								
[31]	58,279 62,573	6.3	Men Women	55–69	Colon, rectum	Men: Colon: 0765 (0.51–1.13) Rectum: 0.88 (0.54–1.44) Women: Colon: 0.62 (0.40–0.96) Rectum: 1.16 (0.65–2.07)	Highest vs. lowest quintile	Age; family history; alcohol intake

BMI: body mass index.

Table 4 Fruit consumption and colorectal cancer risk.

Reference	Cohort size	Follow-up (years)	Gender	Age at inclusion	Location	RR (95% CI)	Comparison method	Adjustment
[15]	47,949	6	Men	40–75	Colon	0.98 (0.54–1.77)	⩾4 vs. <1 serving/day	Age; total energy intake
[18]	17,633	20	Men	NR	Colon, rectum	1.6 (0.9–2.8)	⩾67 vs.<29.3 times/month	Age; smoking; total energy and alcohol intake
[19]	27,111	8	Men	50–69	Colon, rectum	1.1 (0.8–1.7)	Highest vs. lowest quartile	Age; BMI; smoking; physical activity; education; alcohol and calcium intake
[20]	45,181 62,643	9.9	Men Women	40–79	Colon, rectum	Men: Colon: 1.06 (0.64–1.75) Rectum: 0.80 (0.46–1.41) Women: Colon: 1.62 (1.02–2.57) Rectum: 0.53 (0.22–1.26)	Daily vs. 0-2/week	Age; family history; BMI; smoking; physical activity; education; alcohol intake and region
[21]	10,998	17	Men and women	Median 33	Colon, rectum	0.60 (0.35–1.02)	⩾10 vs. <5/week	Age; gender, smoking; alcohol
[24]	11,580	8	Men Women	Mean 75 Mean 74	Colon	Men: 1.12 (0.69–1.81) Women: 0.50 (0.31–0.80)	Highest vs. lowest tertile	Age; smoking
[25]	41,837	5	Women	55–69	Colon	0.86 (0.58–1.29)	Highest vs. lowest quartile	Age; total energy intake
[27]	14,727	7.1	Women	34–65	Colon, rectum	1.49 (0.82–2.70)	Highest vs. lowest quartile	Age; education; geographical area; total energy intake
[28]	35,216	10	Women	55–69	Colon	No family history: 0.9 (0.6–1.2) Family history: 1.4 (0.7–2.8)	⩾20 vs. ⩽13 servings/week	Age; family history of polyps; total energy intake
[30]	47,325 88,764	8.8 10.9	Men Women	30–55	Colon, rectum	Men: Colon: 1.08 (1.00–1.16) Rectum: 1.09 (0.94–1.26)	+1 serving/day	Age; BMI; height; smoking; physical activity; family history; aspirin and

Table 4 (*continued*)

Reference	Cohort size	Follow-up (years)	Gender	Age at inclusion	Location	RR (95% CI)	Comparison method	Adjustment
						Women: Colon: 0.96 (0.89–1.03) Rectum: 0.96 (0.83–1.11)		vitamin supplement use; total calorie, alcohol and red meat intake
[31]	58,279 62,573	6.3	Men Women	55–69	Colon, rectum	Men: Colon: 1.33 (0.90–1.97) Rectum: 0.85 (0.55–1.32) Women: Colon: 0.73 (0.48–1.11) Rectum: 0.67 (0.34–1.33)	Highest vs. lowest quintile	Age; family history; alcohol intake
[32]	61,463	9.6	Women	40–74	Colon, rectum	Colorectal: 0.68 (0.52–0.89) Colon: 0.76 (0.55–1.06) Rectum: 0.54 (0.33–0.89)	$\geqslant$2 vs. $<$1 serving/day	Age, BMI; education; energy, alcohol, red meat, total fat, folic acid, vitamins C and D and calcium intake
[33]	45,490	8.7	Women	Mean 61	Colon, rectum	1.15 (0.86–1.53)	Highest vs. lowest quintile	BMI; height; smoking; physical activity; education; multivitamin supplement use; use of NSAID; energy, grain foods, red meat, calcium, vitamin D, alcohol and vegetable intake
[34]	88,658	9	Men and women	40–69	Colon, rectum	Colorectal: 0.92 (0.70–1.19) Colon: 0.92 (0.66–1.28) Rectum: 0.91 (0.59–1.40)	Highest vs. lowest quartile	Age; gender; BMI; smoking; physical activity; multivitamin supplement use; geographical area; energy, cereals, meat, fish and alcohol consumption

BMI: body mass index; NSAID, nonsteroid anti-inflammatory drugs.

Table 5 Combined consumption of fruit and vegetables and colorectal cancer risk.

Age at inclusion	Location	RR (95% CI)			Reference Comparison method	Cohort size Adjustment	Follow-up (years)	Gender
[17]	337,505 426,838	6	Men Women	⩾30	Colon	Men: 0.76 (0.57–1.02) Women: 0.62 (0.45–0.86)	Highest vs. lowest quintile	BMI; physical activity; family history; aspirin use; total fat intake
[24]	11,580	8	Men Women	Mean 75 Mean 74	Colon	Men: 1.50 (0.91–2.46) Women: 0.63 (0.40–1.00)	Highest vs. lowest tertile	Age; smoking
[25]	41,837	5	Women	55–69	Colon	0.89 (0.57–1.40)	Highest vs. lowest quartile	Age; total energy intake
[30]	47,325	8.8	Men	30–55	Colon, rectum	Colon: 1.02 (0.98–1.05)	+1 serving/day	Age; BMI; height; smoking; physical activity; family history; aspirin and vitamin supplement usage; total calorie, alcohol and red meat intake
	88,764	10.9	Women			Rectum: 1.02 (0.95–1.09)		
[31]	58,279 62,573	6.3	Men Women	55–69	Colon, rectum	Men: Colon: 0.95 (0.64–1.41) Rectum: 0.88 (0.56–1.37) Women: Colon: 0.66 (0.44–1.01) Rectum: 1.17 (0.63–2.17)	Highest vs. lowest quintile	Age; family history; alcohol intake
[32]	61,463	9.6	Women	40–74	Colon, rectum	Colorectal: 0.73 (0.56–0.96) Colon: 0.81 (0.59–1.13) Rectum: 0.60 (0.38–0.96)	⩾5 vs. <2.5 servings/day	Age; BMI; education; energy, alcohol, red meat, total fat, folic acid, vitamins C and D and calcium intake

BMI: body mass index.

combined consumption decreased colon cancer risk[31] or mortality,[17] specifically in women but not in men.[24] Another study reported that the combined consumption of vegetables and fruit decreased rectal but not colon cancer risk,[32] a relationship not reproduced.[31] Finally, two studies did not find any benefit related to the combined consumption of vegetables and fruit.[25,30]

Taken together, those findings suggest that the relationship between vegetable consumption and colorectal cancer risk is relatively low. Conversely, the combined consumption of vegetable and fruit might be of interest.

Meat

Red meat

Twenty studies assessed the relationships between red meat consumption and colorectal cancer risk,[11,15–21,23,27–29,36–43] (Table 6). Fifteen of those did not found any significant relationship,[16–21,23,27,28,36–40,43] two reported an increase in colorectal cancer risk,[15,29] two found an increase of colon but not of rectal cancer risk[11,41] and one reported a deleterious effect for distal colon but not for proximal colon or rectum.[42] Still, most of the reported relative risks were above unity, suggesting that high consumption of red meat might increase colorectal cancer risk. Although the precise mechanism for this relationship remains unclear, the most likely hypothesis is carcinogen production during meat cooking.[44,45]

Processed meat

The effect of processed meat on colorectal cancer risk was assessed in 11 studies[11,15,19,20,27,36–38,41–43] (Table 7); most (seven) studies found no relationship.[15,19,20,27,36,42,43] Conversely, one study found a positive relationship with both colorectal and rectal, but not with colon cancer risk;[11] three reported a significant relationship with colon cancer risk[37,38,41] whereas the relationship with rectal cancer risk was nonsignificant.[41] Again, and as for red meat intake, most of the relative risks were greater than unity, indicating that high consumption of processed meat might increase the risk for colorectal cancer.

Poultry/white meat

Eleven studies reported on the effect of poultry/white meat consumption and colorectal cancer risk[15,19,20,27,29,36,37,39,42] (Table 8). Nine of them found no significant relationship,[11,15,18–20,27,36,37,42] whereas two studies found a positive relationship with colon[29,39] but not with rectal cancer risk.[39] Overall, those results suggest no association between poultry or white meat consumption and colorectal cancer risk.

Fish and seafood

Twelve studies assessed the relationships between fish and seafood consumption and colorectal cancer risk[16,18–21,27,37,38,42,43,46] (Table 9). A negative association was reported in one study,[27] the majority though found no relationship between fish and seafood consumption and the incidence of colorectal cancer.[16,18–21,37,38,42] Conversely, the consumption of smoked and salted fish was associated with a significant increase in colorectal cancer, probably due to an increased intake of N-nitroso compounds,[43] whereas an unexpected protective effect of the consumption of fish rich in organochlorine compounds was reported.[46] Overall, the data indicate that fish or seafood consumption is unrelated to colorectal cancer risk, although smoked or salted fish might actually increase the risk.

Eggs

Five studies reported data on egg consumption and colorectal cancer risk[18,20,21,23,39] (Table 10); in agreement with a previously published review,[47] two showed a positive relationship,[20,23] but the other three failed to confirm those results.[18,21,39] Overall, the available data suggest that high (almost daily) consumption of eggs might increase colorectal cancer risk; since raw eggs are seldom consumed, the effect of the varied cooking procedures requires further assessment.

Dairy products

The relationship with the consumption of dairy products (total consumption or selected products) was analysed in 12 studies[18–21,23,27,38,48–52] (Table 11); nine did not show any significant relationship between milk consumption and colorectal cancer risk[18,20,21,23,38,48–50,52]; two studies reported a protective effect towards colorectal[27] and colon [19] cancer, whereas no protective effect was seen for dairy products regarding rectal cancer.[51] Furthermore, five studies found no relationship

Table 6 Meat/red meat consumption and colorectal cancer risk.

Reference	Cohort size	Follow-up (years)	Gender	Age at inclusion	Location	RR (95% CI)	Comparison method	Adjustment
[11]	37,112	9	Men and women	27–75	Colon, rectum	Colorectal: 1.4 (1.0–1.9) Colon: 1.1 (0.7–1.6) Rectum: 2.3 (1.2–4.2)	Highest vs. lowest quartile	Age; gender; country of birth; energy, fat, and cereal products intake
[15]	47,949	6	Men	40–75	Colon	1.71 (1.15–2.55)	Highest vs. lowest quintile	Age; total energy intake
[16]	265,118	17	Men and women	⩾40	Colon	Sigmoid: 1.79 (0.87–3.66) Proximal: 1.04 (0.79–1.37)	Daily/occasional vs. infrequent or none	Age
[17]	337,505 426,838	6	Men Women	⩾30	Colon	Men: 1.21 (NS) Women: 1.05 (NS)	Highest vs. lowest quintile	No adjustment
[18]	17,633	20	Men	NR	Colon, rectum	Colorectal: 1.9 (0.9–4.3) Colon: 1.8 (0.8–4.4)	⩾60 vs. <15 times/month	Age; smoking; total energy and alcohol intake
[19]	27,111	8	Men	50–69	Colon, rectum	1.1 (0.7–1.7)	Highest vs. lowest quartile	Age; BMI; smoking; physical activity; education; alcohol and calcium intake
[20]	45,181 62,643	9.9	Men Women	40–79	Colon, rectum	Men: Colon: 1.46 (0.74–2.86) Rectum: 1.38 (0.68–2.78) Women: Colon: 1.11 (0.57–2.14) Rectum: 0.37 (0.05–2.84)	3–7 vs. 0–2/week	Age; family history; BMI; smoking; physical activity; education; alcohol intake and region
[21]	10,998	17	Men and women	Median 33	Colon, rectum	1.14 (0.67–1.93)	Daily vs. none	Age; gender; smoking; alcohol
[23]	25,493	21	Men and women	⩾40	Colon, rectum	Men: 1.1 (NS) Women: 1.0 (NS)	⩾4 vs. <1/week	Age; gender
[27]	14,727	7.1	Women	34–65	Colon, rectum	1.23 (0.68–2.22)	Highest vs. lowest quartile	Age; education; geographical area; total energy intake
[28]	35,216	10	Women	55–69	Colon	No family history: 1.3 (0.8–2.0) Family history: 1.0 (0.5–2.1)	⩾7 vs. ⩽3.5 servings/week	Age; family history of polyps; total energy intake

Table 6 (*continued*)

Reference	Cohort size	Follow-up (years)	Gender	Age at inclusion	Location	RR (95% CI)	Comparison method	Adjustment
[29]	32,051	6	Men and women	⩾25	Colon	1.90 (1.16–3.11)	⩾1/week vs. none	Age; gender; BMI; smoking; physical activity; family history; aspirin use; alcohol consumption
[36]	35,215	4.8	Women	55–69	Colon	1.15 (0.75–1.77)	<184 vs. ⩾391 g/day	Age; height; parity; vitamin E intake; vitamin A supplement intake
[37]	120,852	3.3	Men and women	55–69	Colon	Men: 0.87 (0.43–1.77) Women: 0.88 (0.45–1.69)	Highest vs. lowest quintile	Age; gender; total energy intake
[38]	50,535	11.4	Men and women	20–54	Colon	Men: 0.80 (0.35–1.86) Women: 1.87 (0.77–4.86)	⩾5 vs. <3/week	Age
[39]	9959	27	Men and women	⩾15	Colon, rectum	Colon: 1.34 (0.57–3.15) Rectum: 1.82 (0.60–5.52)	Highest vs. lowest quartile	Age; gender; BMI; smoking; occupation; geographical area; total energy, vegetables, fruit and cereal intake
[40]	45,490	8.5	Women	Mean 61	Colon, rectum	1.10 (0.83–1.45)	Highest vs. lowest quintile	Nutrient density*; fat intake
[41]	46,632 87,733	14 20	Men Women	40–75 30–55	Colon, rectum	Colon: 1.43 (1.00–2.05) Rectum: 0.90 (0.47–1.75)	⩾5 /week vs. none	Age; gender; BMI; height; smoking; physical activity; family history; history of endoscopy; processed meat, alcohol, calcium and folate intake
[42]	61,433	13.9	Women	40–75	Colon, rectum	Distal colon: 2.22 (1.34–3.68) Proximal: 1.03 (0.67–1.60) Rectum: 1.28 (0.83–1.98)	⩾94 vs. <50 g/day	Age; BMI; education; total energy, alcohol, saturated fat, calcium, folate, fruits, vegetables and whole grain intake
[43]	9985	24	Men and women	15–99	Colon, rectum	1.19 (0.51–2.76)	Highest vs. lowest quartile	Age; gender; municipality; smoking and energy intake

BMI: body mass index. For [23] and [17], no confidence intervals were provided.

*Grams of meat per 1000 kcal per day or percentage of total energy from fat, both with total energy also in the model.

Table 7 Processed meat consumption and colorectal cancer risk.

Reference	Cohort size	Follow-up (years)	Gender	Age at inclusion	Location	RR (95% CI)	Comparison method	Adjustment
[11]	37,112	9	Men and women	27–75	Colon, rectum	Colorectal: 1.5 (1.1–2.0) Colon: 1.3 (0.9–1.9) Rectum: 2.0 (1.1–3.4)	Highest vs. lowest quartile	Age; gender; country of birth; energy, fat, and cereal products intake
[15]	47,949	6	Men	40–75	Colon	1.16 (0.44–3.04)	>4 vs. 0 servings/week	Age; total energy intake
[19]	27,111	8	Men	50–69	Colon, rectum	1.2 (0.7–1.8)	Highest vs. lowest quartile	Age; BMI; smoking; physical activity; education; alcohol and calcium intake
[20]	45,181 62,643	9.9	Men Women	40–79	Colon, rectum	Men: Colon: 1.44 (0.90–2.31) Rectum: 1.00 (0.68–1.78) Women: Colon: 0.94 (0.53–1.66) Rectum: 1.56 (0.69–3.53)	3–7/week vs. 0–2/month	Age; family history; BMI; smoking; physical activity; education; alcohol intake and region
[27]	14,727	7.1	Women	34–65	Colon, rectum	1.09 (0.59–2.02)	Highest vs. lowest quartile	Age; education; geographical area; total energy intake
[36]	35,215	4.8	Women	55–69	Colon	1.51 (0.72–3.17)	>3 vs. 0/week	Age; height; parity; vitamin E or vitamin A supplement intake
[37]	120,852	3.3	Men and women	55–69	Colon	1.72 (1.03–2.87)	>20 vs. 0 g/day	Age; gender; total energy intake
[38]	50,535	11.4	Men and women	20–54	Colon	Men: 1.98 (0.70–5.58) Women: 3.50 (1.02–11.9)	⩾5 vs. <1/month	Age
[41]	46,632 87,733	14 20	Men Women	40–75 30–55	Colon, rectum	Colon: 1.33 (1.04–1.70) Rectum: 0.90 (0.52–1.57)	⩾5/week vs. none	Age; gender; BMI; height; smoking; physical activity; family history; previous colonoscopy; beef, pork or lamb as a main dish, alcohol, calcium and folate intake
[42]	61,433	13.9	Women	40–75	Colon, rectum	Colorectal: 1.07 (0.85–1.33) Rectum: 0.90 (0.60–1.34)	⩾32 vs. <12 g/day	Age; BMI; education; total energy, alcohol, saturated fat, calcium, folate, fruits, vegetables and whole grain intake
[43]	9985	24	Men and women	15–99	Colon, rectum	Cured meat: 1.84 (0.98–3.47)	Highest vs. lowest quartile	Age; gender; municipality; smoking and energy intake

BMI: body mass index.

Table 8 Poultry/white meat consumption and colorectal cancer risk.

Reference	Cohort size	Follow-up (years)	Gender	Age at inclusion	Location	RR (95% CI)	Comparison method	Adjustment
[11]	37,112	9	Men and women	27–75	Colon, rectum	Colorectal: 0.7 (0.6–1.0) Colon: 0.7 (0.5–1.1) Rectum: 0.7 (0.5–1.2)	Highest vs. lowest quartile	Age; gender; country of birth; energy, fat, and cereal products intake
[15]	47,949	6	Men	40–75	Colon	0.82 (0.54–1.24)	Highest vs. lowest quintile	Age; total energy intake
[18]	17,633	20	Men	⩾35	Colon, rectum	1.1 (0.5–2.2)	⩾4 vs. <0.5 times/month	Age; smoking; total energy and alcohol intake
[19]	27,111	8	Men	50–69	Colon, rectum	1.2 (0.8–1.8)	Highest vs. lowest quartile	Age; BMI; smoking; physical activity; education; alcohol and calcium intake
[20]	45,181 62,643	9.9	Men Women	40–79	Colon, rectum	Men: Colon: 1.55 (0.90–2.66) Rectum: 0.80 (0.44–1.45) Women: Colon: 0.68 (0.38–1.21) Rectum: 0.71 (0.22–2.32)	3–7/week vs. 0–2/month	Age; family history; BMI; smoking; physical activity; education; alcohol intake and region
[27]	14,727	7.1	Women	34–65	Colon, rectum	0.79 (0.46–1.34)	Highest vs. lowest quartile	Age; education; geographical area; total energy intake
[29]	32,051	6	Men and women	⩾25	Colon	3.29 (1.60–6.75)	⩾1/week vs. none	Age; gender; BMI; smoking; physical activity; family history; aspirin usage; alcohol consumption
[36]	35,215	4.8	Women	55–69	Colon	With skin: 1.52 (0.98–2.36) Without skin: 1.15 (0.80–1.67)	⩾1 vs. 0/week	Age; height; parity; vitamin E or vitamin A supplement intake
[37]	120,852	3.3	Men and women	55–69	Colon	1.03 (0.90–1.17)	Increment 15 g/day	Age; gender; total energy intake
[39]	9959	27	Men and women	⩾15	Colon, rectum	Colon: 1.93 (1.12–3.35) Rectum: 1.20 (0.60–2.37)	Yes vs. no	Age; gender; BMI; smoking; occupation; geographical area; total energy, vegetables, fruit and cereal intake
[42]	61,433	13.9	Women	40–75	Colon, rectum	Colorectal: 0.75 (0.55–1.02) Rectum: 0.62 (0.34–1.13)	⩾0.5 vs. 0 servings/week	Age, BMI, education, total energy, alcohol, saturated fat, calcium, folate, fruits, vegetables and whole grain food

BMI: body mass index.

Table 9 Consumption of fish and seafoods and colorectal cancer risk.

Reference	Cohort size	Follow-up (years)	Gender	Age at inclusion	Location	RR (95% CI)	Comparison method	Adjustment
[11]	37,112	9	Men and women	27–75	Colon, rectum	Colorectal: 0.9 (0.7–1.2) Colon: 1.0 (0.7–1.4) Rectum: 0.9 (0.6–1.4)	Highest vs. lowest quartile	Age; gender; country of birth; energy, fat, and cereal products intake
[15]	47,949	6	Men	40–75	Colon	1.06 (0.70–1.60)	Highest vs. lowest quintile	Age; total energy intake
[18]	17,633	20	Men	⩾35	Colon, rectum	1.5 (0.9–2.6)	>4 vs. <0.8 times/month	Age; smoking; total energy and alcohol intake
[19]	27,111	8	Men	50–69	Colon, rectum	0.9 (0.6–1.4)	Highest vs. lowest quartile	Age; BMI; smoking; physical activity; education; alcohol and calcium intake
[20]	45,181 62,643	9.9	Men Women	40–79	Colon, rectum	Men: Colon: 1.04 (0.65–1.66) Rectum:0.95 (0.60 –1.51) Women: Colon: 0.97 (0.62–1.50) Rectum: 0.90 (0.44 –1.84)	Daily vs. 0–2/week	Age; family history; BMI; smoking; physical activity; education; alcohol intake and region
[21]	10,998	17	Men and women	Median 33	Colon, rectum	1.17 (0.71–1.92)	⩾1/week vs. none	Age; gender; smoking; alcohol intake
[27]	14,727	7.1	Women	34–65	Colon, rectum	0.49 (0.27–0.89)	Highest vs. lowest quartile	Age; education; geographical area; total energy intake
[36]	35,215	4.8	Women	55–69	Colon	0.76 (0.49–1.19)	Highest vs. lowest quintile	Age; height; parity; vitamin E intake; vitamin A supplement intake
[37]	120,852	3.3	Men and women	55–69	Colon	0.81 (0.56–1.17)	>20 vs. 0 g/day	Age; gender; energy intake
[38]	50,535	11.4	Men and women	20–54	Colon	Men: 0.46 (0.19–1.11) Women: 0.81 (0.30–1.94)	⩾5 vs. <1/month	Age
[42]	61,433	13.9	Women	40–75	Colon, rectum	Colorectal: 1.08 (0.81–1.43) Rectum: 1.08 (0.63–1.86)	⩾2 vs. <0.5 servings/week	Age; BMI; education; total energy, alcohol, saturated fat, calcium, folate, fruits, whole grain food and vegetables
[43]	9985	24	Men and women	15–99	Colon, rectum	Smoked and salted: 2.58 (1.21–5.51) Other: 1.11 (0.55–2.28)	Highest vs. lowest quartile	Age; gender; municipality; smoking and energy intake

BMI: body mass index.

Table 10 Consumption of eggs and colorectal cancer risk.

Age at inclusion	Location	RR (95% CI)			Reference Comparison method	Cohort size Adjustment	Follow-up (years)	Gender
[18]	17,633	20	Men	⩾35	Colon, rectum	1.3 (0.7–2.4)	>21 vs. <4 times/month	Age; smoking; total energy and alcohol intake
[20]	45,181 62,643	9.9	Men Women	40–79	Colon, rectum	Men: Colon: 1.54 (0.99–2.42) Rectum:0.82 (0.54–1.26) Women: Colon: 1.17 (0.79–1.75) Rectum: 0.75 (0.39 –1.46)	Daily vs. 0–2/week	Age; family history; BMI; smoking; physical activity; education; alcohol intake and region
[21]	10,998	17	Men and women	Median 33	Colon, rectum	1.29 (0.66–2.52)	⩾6 vs. <1/week	Age; gender; smoking; alcohol
[23]	25,493	21	Men and women	⩾40	Colon, rectum	1.5 (1.0–2.3)	⩾5 vs. <2/week	Age; gender
[39]	9959	27	Men and women	⩾15	Colon, rectum	Colon: 1.02 (0.48–2.14) Rectum: 1.54 (0.66–3.64)	Highest vs. lowest quartile	Age; gender; BMI; smoking; total energy, vegetables, fruit and cereal intake; occupation; geographical area

BMI: body mass index.

between the different types of dairy products (milk, fermented milk, yogurt, cheese and butter) and colorectal cancer,[20,21,23,49,51] although one found, in women, a borderline positive relationship between cheese intake and rectal cancer.[20] Finally, in women without a family history of colon cancer, total dairy intake was inversely associated with disease risk, whereas no protective effect was shown in women with a positive family history.[28] Overall, the consumption of dairy products appears to exert no significant effect on colorectal cancer risk.

Beverages

Coffee

Five studies provided data on coffee consumption and colorectal cancer risk[23,53–56] (Table 12); there was no relationship in three,[54–56] one reported an increased risk among heavy consumers,[23] and another study found an inverse association between coffee consumption and colorectal cancer risk in subjects aged less than 65 years.[53] Thus, the available prospective data do not support a relationship with coffee consumption.

Tea

The issue of tea consumption and colorectal cancer risk were reported in eight studies[55,57–63] (Table 12). In women, no significant effect was found in three,[57,62,63] although a different study reported that catechins (namely from tea) were inversely related to rectal, but not colon cancer.[64] In men, a significant inverse relationship was found in one study,[63] whereas another one conducted in men of Japanese ancestry found no effect on colon cancer risk, and even an increased rectal cancer risk among tea drinkers (RR = 4.2).[58] Conversely, opposite results (deleterious effect on colon, no effect on rectum cancer) were found in a Finnish study.[55] Finally, no relationships between colorectal cancer risk and black[59,60] or green [61] tea consumption were found. Overall, and as for coffee, the available data do not indicate a relationship between tea consumption and colorectal cancer risk.

Other

Finally, a single study suggested that the exposure to chlorination by-products in drinking water was associated with increased risk of colon cancer,[65] but those findings need further assessment (Table 12).

Conclusions

One of the major difficulties in analysing and drawing messages from the prospective studies' data is related to the heterogeneity between studies in what concerns: subject's characteristics, collected data and the substantial differences among groups. For instance, processed meat consumption could be expressed either in number of servings per week,[15] grams per day[37] or quartiles of consumption.[19,27] Furthermore, not providing the exact intake might be misleading, since the highest quintile of consumption might differ widely between countries.[66] Indeed, in order to facilitate between-studies, it would be interesting to provide risk estimators either for standardized portions (e.g. one serving or one glass) or for a given amount of food consumed (e.g. 100 g). Also, for each study, relative risks are adjusted on several covariates, whose number differs considerably between studies; again, it would be more valuable if relative risks were adjusted for a limited number of covariates, in order to allow an efficient pooling of the available data. Finally, it must be stressed that nearly every study has been conducted in the USA, in Japan or in Northern European countries; hence, the results may not be directly applicable to other populations, namely South European.

In summary, the available prospective data does not help to clarify the relationships between food intake and colorectal cancer risk; still, the following conclusions can be drawn:

- The consumption of cereals, vegetables and fruit appears to exert little effect on risk, although the combined consumption of fruit and vegetables might actually decrease risk.
- Cruciferous vegetables might be related to an increased risk, whereas other types of vegetables per se appear to exert little if no effect.
- Red meat, processed meat and egg consumption might increase risk, whereas the consumption of poultry and fish/seafood appears to be neutral.
- The consumption of dairy products appears unrelated to colon cancer risk, although a deleterious effect on rectal cancer risk cannot be excluded.
- The consumption of coffee or tea do not seem to exert any effect, whereas the risk associated to chlorinated water consumption should be further assessed.

Table 11 Consumption of dairy products and colorectal cancer risk.

Reference	Cohort size	Follow-up (years)	Gender	Age at inclusion	Location	RR (95% CI)	Comparison method	Adjustment
[18]	17,633	20	Men	⩾35	Colon, rectum	0.6 (0.3–1.2)	>85 vs. <26 times/month	Age; smoking; total energy and alcohol intake
[20]	45,181 62,643	9.9	MenWomen	40–79	Colon, rectum	Milk: Men: Colon: 1.22 (0.74–2.02) Rectum: 1.05 (0.64–1.71) Women: Colon: 1.16 (0.71–1.90) Rectum: 1.64 (0.70–3.82) Cheese: Men: Colon: 1.17 (0.68–2.01) Rectum:1.19 (0.70–2.02) Women: Colon: 1.01 (0.61–1.69) Rectum: 2.52 (1.11–5.72)	Daily vs. Seldom 1–7/week vs. seldom	Age; family history; BMI; smoking; physical activity; education; alcohol intake and region
[21]	10,998	17	Men Women	Median 33	Colon, rectum	Milk: 1.10 (0.65–1.87) Cheese: 0.98 (0.48–2.03)	>0.5 vs. <0.5 pints/day ⩾10 vs. <5/week	Age; gender; smoking; alcohol intake
[23]	25,493	21	Men and women	⩾40	Colon, rectum	Milk: 0.7 (0.4–1.2) Cheese: 1.1 (0.8–1.6)	⩾3 vs.<1 /day ⩾3 vs.<1/week	Age; gender
[27]	14,727	7.1	Women	34–65	Colon, rectum	0.69 (0.40–1.20)	Highest vs. lowest quartile	Age; education; geographical area; total energy intake
[28]	35,216	10	Women	55–69	Colon	No family history: 0.7 (0.4–1.0) Family history: 0.7 (0.4–1.4)	>20 vs. ⩽10 servings/week	Age; family history of polyps; total energy intake
[38]	50,535	11.4	Men and women	20–54	Colon	Men: 0.72 (0.25–2.07) Women: 1.24 (0.35–4.40)	⩾4 vs.<1 glass of milk/day	Age

[48]	35,215	4.8	Women	55–69	Colon	0.72 (0.38–1.36)	Highest vs. lowest quintile	Age; height; parity; total energy, vitamin E and low-fat meat intake
[49]	120,852	3.3	Men and women	55–69	Colon, rectum	Fermented milk: 0.89 (0.60–1.33) Unfermented milk: 0.86 (0.57–1.29) Cheese: 0.88 (0.59–1.33)	Highest vs. lowest consumption group	Age; gender; BMI; family history; gallbladder surgery; total energy, fat, and fibre intake
[50]	47,935	16	Men	40–75	Colon	1.09 (0.69–1.72)	Milk consumption >2/day vs. <1/month	Age; smoking; BMI; physical activity; family history; aspirin usage; previous polyp; total energy, alcohol, red meat, saturated fat and fibre intake
[51]	9959	24	Men	$\geqslant 15$	Colon, rectum	Total milk products: Colon: 0.37 (0.12–1.39) Rectum: 2.52 (0.80–7.90) Milk: Colon: 0.46 (0.14–1.46) Rectum: 1.13 (0.39–3.31) Fermented milk: Colon: 0.79 (0.34–1.79) Rectum: 2.67 (0.91–7.80) Cheese: Colon: 2.42 (0.91–6.43) Rectum: 1.12 (0.43–2.91)	Highest vs. lowest quartile	Age; gender; BMI; smoking; occupation; geographical area; energy intake
[52]	60,866 66,883	4	Men Women	50–74	Colon, rectum	Men: 0.96 (0.67–1.38) Women: 1.11 (0.68–1.83)	Highest vs. lowest quintile	Age; smoking; BMI; physical activity; education; family history; vitamin use; energy, saturated fat, fruit, vegetables intake

BMI: body mass index.

Table 12 Consumption of coffee or tea and colorectal cancer risk.

Reference	Cohort size	Follow-up (years)	Gender	Age at inclusion	Location	RR (95% CI)	Comparison method	Adjustment
Coffee								
[23]	25,493	21	Men and women	⩾40	Colon, rectum	1.5 (1.0–2.2)	⩾2 vs. <1/day	Age; gender
[53]	13,664 2891	11.5	Men Women	⩾18	Colon	<65 years: 0.22 (NS) ⩾65 years: 1.96 (NS)	⩾7 vs. ⩽2 cups/day	Gender; residence
[54]	11,888	4.5	Men and women	NR	Colon, rectum	Men: 1.54 (0.6–3.7) Women: 1.17 (0.4–3.1)	⩾4 vs. <2 cups/day	Age
[55]	27,111	8.0	Men	50–69	Colon, rectum	Colon: 0.84 (0.50–1.40) Rectum: 0.74 (0.40–1.36)	>6 vs. ⩽4 cups/day	Age; BMI; physical activity; intervention group; calcium and tea intake
[56]	61,463	9.6	Women	40–74	Colon, rectum	Colorectal: 1.04 (0.70–1.54) Colon: 1.06 (0.65–1.72) Rectum: 1.06 (0.54–2.10)	⩾4 cup/day vs. never	Age; BMI; education; total energy, red meat, total fat, fibre, calcium, folic acid, vitamin C and D intake
Tea								
[55]	27,111	8.0	Men	50–69	Colon, rectum	Colon: 2.09 (1.34–3.26) Rectum: 0.87 (0.47–1.60)	⩾1 vs. 0 cups/day	Age; BMI; physical activity; intervention group; serum cholesterol; calcium intake
[57]	35,369	8	Women	55–69	Colon, rectum	Colon: 0.71 (0.45–1.11) Rectum: 0.70 (0.34–1.46)	⩾2 cups/day vs. never	Age; WHR; smoking; physical activity; education; family history; fruit and vegetable intake
[58]	7833	17	Men	45–68	Colon, rectum	Colon: not reported Rectum: 4.2	⩾1 cup/day vs. never	Age; alcohol intake
[59]	14,085	19	Men	45–60	Colon, rectum	Colon: 0.67 ($p = 0.07$) Rectum: 0.50 (NS)	⩾10 vs. 0–3 cups/day	No adjustment
[60]	58,279 62,573	4.3	Men Women	55–69	Colon, rectum	0.94 (0.66–1.34)	⩾5 cups/day vs. never	Age; gender; smoking; education; family history; coffee and vitamin C intake
[61]	14,873 23,667	13	Men Women	Mean 53 Mean 57	Colon, rectum	Colon: 1.00 (0.76–1.40) Rectum: 1.30 (0.77–2.10)	⩾5 vs. ⩽1 times/day	Age; gender; BMI; education; city; radiation exposure; alcohol intake
[62]	61.463	9.6	Women	40–74	Colon, rectum	0.98 (0.64–1.51)	⩾2 vs. <1 cup/day	Age; BMI; education; total energy, red meat, coffee, alcohol, total fat, fruit fibre, vegetable fibre, cereal fibre, calcium, folic acid, vitamin C and D intake
[63]	10,220	10	Men and women	25–74	Colon	Men: 0.40 (0.25–0.63) Women: 0.69 (0.46–1.04)	Drinkers vs. non-drinkers	Age; race; BMI; physical activity; family history; aspirin and vitamin/mineral supplement use; energy, fat, fibre and calcium intake
Other								
[65]	28,237	8	Women	55–69	Colon, rectum	Colon: 1.68 (1.11–2.53) Rectum: 1.07 (0.60–1.93)	14-287 μg/L of chloroform vs. below detection limits	Age; BMI; WHR; smoking; physical activity; education; total energy, fruit and vegetable intake

BMI: body mass index; WHR, waist-hip ratio. For[53,58] and[59] no confidence intervals were provided.

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