RESEARCH COMMUNICATION

Dietary Patterns and Risk of Colorectal Cancer: a Factor Analysis in Uruguay

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Abstract

In the time period 1996-2004, a case-control study of colorectal cancer was conducted in Montevideo, Uruguay. The study included 610 cases and 1,220 controls, frequency matched for age, sex, and residence. All cases were newly diagnosed and microscopically confirmed and controls were drawn from the same hospitals. Controls were submitted to factor analysis (principal components method) and 4 dietary patterns for men (prudent, traditional, Western, drinker) and 3 for women (prudent, Western, drinker) were retained. These were rotated and normalized by the Kaiser method. Scores were applied to all participants (cases and controls) and odds ratios were estimated by logistic regression and polynomial regression. The Western pattern showed an OR of 2.62 (95 % CI 1.36-5.08) for colon cancer among men, and women displayed a similar increase in risk. However, rectal cancer was not associated with this diet, rather being inversely associated with the prudent and traditional patterns among men (OR 0.49, 95 % CI 0.28-0.57 for the traditional pattern). In conclusion, whereas the Western pattern was directly associated with colon cancer, the prudent pattern was strongly protective for rectal cancer.

Keywords: Colorectal cancer - dietary patterns - factor analysis - principal components

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Introduction

Colorectal cancer is the third malignancy among males (ASR 34.1 per 100,000) and second among females (ASR 25.2 per 100,000) in the Uruguayan population (Barrios et al, 2010). According to a recent monograph (World Cancer Research Fund, 2007) red meat, processed meat, alcohol drinking, obesity, and adult attained height are convincing risk factors for cancers of the colon and rectum.

Several factor analyses have studied colorectal cancer with rewarding results. This method has the purpose of reducing a large number of variables to a smaller number of factors for modeling purposes (Gorsuch, 2008). Since the initial study by Randall et al (1992), at least 12 studies have used factor analysis for exploratory purposes (Slattery et al, 1998; Terry et al, 2001; Fung et al, 2003; Dixon et al, 2004; Kim et al, 2005; Kesse et al, 2006; Butler et al, 2008; Flood et al, 2008; Williams et al, 2009; Miller et al, 2010; Bravi et al, 2010).

Only one of the studies introduced nutrients into the model (Bravi, 2010), and the remaining 11 studies included foods. All the studies were conducted in developed countries, mainly in Western Europe and United States. In our opinion, it could be convenient to conduct studies on factor analysis and colorectal cancer in developing countries. In this sense, Uruguay appears to be an appropriate country with high incidence of this malignancy. Moreover Uruguay is a major producer and consumer of beef in the World (Matos et al, 2002).

Given the fact that in Uruguay is a developing country in which this disease has a high incidence and mortality, together with the fact that the population is characterized by a diet rich in red meat, we decided to conduct a factor analysis among the Uruguayan population. In short, colorectal cancer is a diet-dependent malignancy and its study in a country like Uruguay could be profitable.

Materials and Methods

In time period 1996-2004 all cases of colorectal cancer, newly diagnosed and microscopically confirmed as adenocarcinomas, were considered eligible for the study. The patients were drawn from the four major public health hospitals of Montevideo, Uruguay. From an initial number of 626 cases, 16 patients refused the interview, leaving a final total number of 610 cases (response rate

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97.3 %). These cases were distributed by sex as follows: males (360 patients, 59.0 %) and females (250 females, 41.0 %). There was a greater number of patients with colon cancer (320 patients, 52.5 %) and 290 (47.5 %) patients presented lesions located in the rectum.

In the same time period and in the same hospitals, 2,032 hospitalized controls who presented conditions not related to smoking or drinking and without recent changes in their diets were considered eligible for the study. Fifty patients refused the interview, leaving a final total of 1,981 patients (response rate 95.5 %). From this pool of controls, 1,220 patients were frequency matched to cases on age, sex, and residence according a matching ratio of 2:1. These patients presented the following diseases: eye disorders (350 patients, 28.7 %), abdominal hernia (246, 20.2 %), diseases of the skin (92, 7.5 %), injuries (89, 7.3 %), varicose veins (88, 7.2 %), acute appendicitis (84, 6.9 %), urinary stones (72, 5.9), bone diseases (62, 5.1 %), hydatid cyst (59, 4.8 %), blood disorders (58, 4.8 %), and prostate hypertrophy (20, 1.6 %).

A structured questionnaire was administered to both types of participants (cases and controls) by two trained social workers, shortly after admittance. No proxy interviews were accepted. The questionnaire presented the following sections: sociodemographics (age, sex, residence, education, income), a complete occupational history based on the last four jobs and their duration, self reported height and weight five years before the date of the interview, a family history of cancer on first-degree relatives, a complete history of smoking (age of start, age of quit, number of cigarettes smoked per day, type of tobacco, type of cigarette, inhalation practices), a complete history of alcohol drinking (age of start, age of quit, number of glasses drunk per day/week, type of alcoholic beverages), a complete history of non-alcoholic beverages (mate, coffee, white coffee, tea, tea with milk, soft drinks), menstrual and reproductive events, and a food frequency questionnaire (FFQ) on 64 items. This FFQ allowed the calculation of total energy intake and it was representative of the typical Uruguayan diet. It was tested for reproducibility with good results (Ronco et al, 2006).

The following food groups and beverages were included in the model: red meat (beef, lamb), white meat (poultry, fish), processed meat (bacon, sausage, blood pudding, mortadella, salami, saucisson, hot dog, ham, salted meat), dairy foods (cheese, butter, whole milk, white coffee, tea with milk), eggs (boiled eggs, fried eggs, mayonnaise), desserts (caramel, rice pudding, custard, marmalade, ice cream, cake), total grains (rice, maize, oat, polenta, pasta, white bread, croissant), raw vegetables (carrot, tomato, lettuce, onion), cooked vegetables (garlic, swiss chard, spinach, winter squash, cabbage, cauliflower, beetroot, zucchini, red pepper), all tubers (potato, sweet potato), legumes (chick peas, kidney bean, lentil), total fruits (orange, tangerine, apple, pear, grape, peach, plum, banana, figs, fruit cocktail), beer, wine, and hard liquor.

Statistical methods

Factor analysis was performed separately among men and women controls. We decided to employ the principal components method (Harman, 1976; Kline, 2002; Kim and Mueller, 1978; Gorsuch, 2008). The model for men extracted four factors, whereas the same model for women extracted three factors. The sampling adequacy was of 0.76 when tested by Cronbach alpha. The factors were rotated by the orthogonal varimax procedure and the normalized by Kaiser's method (Kaiser, 1974). Then we calculated the scores by the regression method (Thomson, 1951). The scores were applied to all participants.

Relative risks for men, women, colon, and rectum, were approximated by the odds ratios (Breslow and Day, 1980; Rothman et al, 2007). The p-value for trend was estimated entering into the model categorical variables as continuous and p-value for heterogeneity was estimated using likelihood-ratio test. All calculations were performed using the software STATA, release 10 (StatCorp, 2007).

Results

Distribution of cases and controls by sociodemographics are shown in Table 1. As expected from the matched design, age, sex, and residence were very similar among cases and controls. Cases were less educated compared with controls but monthly income was similar among both groups of participants. Cases were slightly leaner than controls but the differences were not significant. Finally, cases showed a much higher number of first-degree relatives with family history of colorectal cancer than controls (global p-value <0.0001).

The factor-loading matrix among male controls is shown in Table 2. The factor analysis retained four factors. Factor 1 showed high loadings for white meat, dairy foods, raw vegetables, and total fruits. This factor was labeled as the prudent pattern, explaining 10.6 % of the variance. Factor 2 displayed high loadings for desserts, cooked

Table 1. Distribution of Cases and Controls for Sociodemographic Variables

Variable	Category	Cases		Controls		p-value
Age (years)	30-39	12	2.0	24	2.0	
	40-49	53	8.7	106	8.7	
	50-59	99	16.2	198	16.2	
	60-69	194	31.8	388	31.8	
	70-79	208	34.1	416	34.1	
	80-89	44	7.2	88	7.2	1.00
Sex	Males	360	59.0	720	59.0	
	Females	250	41.0	500	41.0	1.00
Residence	Montevideo	299	49.0	598	49.0	
	Urban	206	33.8	412	33.8	
	Rural	105	17.2	210	17.2	1.00
Education (yrs)	0-2	151	24.7	334	27.4	
	3-5	256	42.0	437	35.8	
	6+	203	33.3	449	36.8	0.06
Income (US$)	≤140	259	42.5	492	40.3	
	141+	237	38.8	496	40.7	
	Unknown	114	18.7	232	19.0	0.67
BMI	≤23.0	151	21.7	306	25.1	
	23.1-25.3	164	26.9	306	25.1	
	25.4-28.0	156	25.6	303	24.8	
	28.1+	139	22.8	305	25.0	0.70
Family history of CRC	No	565	92.6	1201	98.4	
	Yes	45	7.4	19	1.6	<0.001
No participants		610	100.0	1220	100.0	

Table 2. Factor-loading Matrix among Male Controls

Food Groups	Prudent Factor 1	Traditional Factor 2	Western Factor 3	Drinker Factor 4
Red meat	-0.07	-0.00	**0.66**	-0.03
White meat	**0.57**	0.15	-0.33	0.10
Processed meat	0.13	-0.12	**0.61**	0.27
Dairy foods	**0.46**	0.09	0.37	-0.11
Eggs	0.01	0.17	**0.43**	0.04
Desserts	0.28	**0.46**	0.22	-0.03
Total grains	-0.09	0.28	0.35	0.09
Raw vegetables	**0.62**	-0.11	-0.01	0.09
Cooked vegetables	0.13	**0.68**	-0.07	0.01
All tubers	-0.36	**0.65**	0.11	0.03
Legumes	0.16	**0.42**	0.05	0.15
Total fruits	**0.62**	0.27	0.05	-0.13
Beer	0.03	0.15	0.04	**0.63**
Wine	-0.07	-0.02	0.15	**0.68**
Hard liquor	0.03	0.02	0.08	**0.65**
Variance[1] (%)	10.60	10.30	9.70	9.70

Loadings higher than 0.39 are typed in bold; [1]Total variance (including error variance) 40.4 %.

Table 3. Factor-loading Matrix among Female Controls

Food groups	Prudent Factor 1	Western Factor 2	Drinker Factor 3
Red meat	-0.05	**0.56**	0.10
White meat	**0.41**	**-0.43**	-0.01
Processed meat	0.25	0.30	0.34
Dairy foods	**0.48**	0.05	0.06
Eggs	0.38	0.26	0.11
Desserts	**0.52**	-0.00	0.19
Total grains	0.07	**0.59**	-0.05
Raw vegetables	**0.50**	-0.31	0.06
Cooked vegetables	**0.54**	0.22	-0.07
All tubers	0.19	**0.68**	-0.02
Legumes	0.33	0.24	0.35
Total fruits	**0.46**	-0.03	0.29
Beer	-0.04	0.01	**0.66**
Wine	0.04	-0.02	**0.74**
Hard liquor	0.03	-0.03	**0.53**
Variance[1] (%)	11.90	11.30	11.20

Loadings higher than 0.39 are typed in bold; [1]Total variance (including error variance): 34.3 %.

vegetables, all tubers, and legumes. It was labeled as the traditional pattern and explained 10.3 % of the variance. Factor 3 presented high loadings for red meat, processed meat and total eggs and was labeled as the Western pattern. This pattern explained 9.7 % of the variance. Factor 4 was characterized by high loadings of beer, red wine, and hard liquor and was labeled as the drinker pattern. This factor explained 9.7 % of the variance. The model explained 40.4 % of the variance. All the patterns showed 4 or more zero loadings, following the requirements of simple structure solution.

The results of factor-loadings matrix among females controls are shown in Table 3. The model extracted three factors. Factor 1 showed high loadings for white meat, dairy foods, desserts, total vegetables, and total fruits and was labeled as the prudent pattern, explaining 11.9 % of the variance. Factor 2 displayed high loadings for red meat, total grains, and all tubers. Processed meat showed moderately high positive loadings (0.30). On the other hand, this pattern showed high negative loadings on white meat and raw vegetables. This pattern was labeled the Western diet and explained 11.3 % of the variance. It is to note that this pattern shared some features of the traditional pattern observed in men. Finally, the factor 3 loaded positively on beer, red wine, and hard liquor and was labeled the drinker pattern. This factor explained 11.2 % of the variance.

Table 4. Correlations between Dietary Patterns and Selected Variables among Male Controls

Variables	Prudent	Traditional	Western	Drinker
Age	0.07	0.07	-0.07	-0.16
Residence	-0.05	0.14	0.13	-0.12
Education	0.09	-0.11	-0.13	0.09
BMI	0.11	-0.04	-0.06	-0.02
Smoking intensity	-0.07	0.01	0.04	**0.23**
Smoking duration	-0.04	0.05	0.08	**0.21**
Total energy	0.11	**0.41**	**0.56**	0.03
Protein	0.13	0.29	**0.58**	0.03
Carbohydrates	0.07	**0.54**	**0.31**	0.01
Fat	0.07	0.08	**0.70**	-0.00
Cholesterol	0.05	0.08	**0.60**	0.01
Beta-carotene	-0.06	**0.61**	0.05	-0.05
Vitamin C	**0.30**	**0.49**	0.11	-0.03
Vitamin E	**0.37**	**0.47**	0.25	-0.01
Folate	0.29	**0.54**	0.26	-0.05
Thiamine	-0.07	**0.43**	**0.43**	0.11
Calcium	**0.38**	0.28	**0.30**	-0.05

Significant correlations are typed in bold

Table 5. Correlations between Dietary Patterns and Selected Variables among Female Controls

Variables	Prudent	Western	Drinker
Age	0.16	-0.04	-0.06
Residence	-0.08	0.07	-0.12
Education	-0.02	-0.19	-0.03
BMI	0.04	0.04	0.05
Smoking intensity	-0.08	0.01	0.10
Smoking duration	-0.09	0.00	0.16
Total energy	0.38	**0.59**	0.09
Protein	0.31	**0.50**	0.10
Carbohydrates	0.38	**0.47**	0.00
Fat	0.15	**0.49**	0.13
Cholesterol	0.14	**0.40**	0.13
Beta-carotene	**0.44**	0.32	-0.08
Vitamin C	**0.55**	0.17	-0.04
Vitamin E	**0.57**	0.18	-0.01
Folate	**0.67**	0.27	-0.04
Thiamine	0.25	**0.65**	-0.03
Calcium	0.39	0.28	0.04

Significant correlations are typed in bold

The associations between selected variables and the dietary patterns in males are shown in Table 4. The prudent pattern was characterized by a predominance of men with high positive correlations for high BMI, vitamin C, vitamin E, folate, and calcium. The traditional pattern was characterized by the predominance of poorly educated men who lived outside Montevideo, mostly in rural areas. They were highly associated with intake of energy, protein, carbohydrates, beta-carotene, vitamin C, vitamin E, folate, and calcium. The drinker pattern showed

Table 6. Odds Ratios of Colorectal cancer for Dietary Patterns among Men, Stratified by the Tumor Site

Cases/	Colon		Rectum		Both sites	
Controls	OR	95 % CI	OR	95 % CI	OR	95 % CI
Prudent						
104/180	1.00	reference	1.0	reference	1.0	reference
94/180	0.60	0.36-1.01	1.09	0.69-1.71	0.84	0.58-1.21
94/180	0.88	0.53-1.45	0.71	0.44-1.15	0.79	0.55-1.15
68/180	0.51	0.29-0.89	0.61	0.37-1.01	0.56	0.37-0.84
p-value*	0.08		0.02		0.009	
Traditional						
99/180	1.0	reference	1.0	reference	1.0	reference
100/180	1.03	0.62-1.69	0.86	0.54-1.37	0.93	0.64-1.36
97/180	0.99	0.59-1.68	0.86	0.53-1.39	0.91	0.61-1.34
64/180	0.76	0.42-1.37	0.49	0.28-0.57	0.60	0.38-0.93
p-value*	0.34		0.04		0.04	
Western						
66/180	1.0	reference	1.0	reference	1.0	reference
93/180	2.02	1.15-3.54	0.99	0.59-1.66	1.37	0.91-2.07
103/180	2.17	1.20-3.95	1.14	0.65-1.99	1.52	0.98-2.37
98/180	2.62	1.36-5.08	0.79	0.43-1.48	1.39	0.85-2.26
p-value*	0.009		0.70	0.18		
Drinker						
76/180	1.0	reference	1.0	reference	1.0	reference
84/180	1.57	0.92-2.67	0.67	0.40-1.13	1.03	0.69-1.53
96/180	1.28	0.73-2.23	1.00	0.61-1.64	1.12	0.75-1.67
104/180	1.69	0.97-2.94	1.25	0.76-2.04	1.41	0.94-2.11
p-value*	0.09		0.19		0.06	

*Trend, adjusted for age, residence, education, family history of colorectal cancer among first-degree relatives, body mass index, smoking index, total energy intake, and all dietary patterns

a predominance of heavy smokers and younger men which lacked significant association with nutrients. The Western pattern was highly positively associated with total fat and cholesterol intakes.

Correlations between female controls and the same variables are shown in Table 5. The prudent pattern was directly associated with beta-carotene, vitamin C, vitamin E, folate, and calcium intakes. The Western pattern was directly associated with total energy, protein, fat, cholesterol, and thiamine intakes. Finally, the drinker pattern was directly correlated with smoking intensity, years smoked, total fat and cholesterol consumption.

Odds ratios for colorectal cancer for dietary patterns among men and stratified by tumor site are shown in Table 6. Colon cancer was positively associated with the Western pattern (OR 2.62, 95 % CI 1.36-5.08, p-value for linear trend=0.009) and with the drinker pattern (OR 1.69, 95 % 0.97-2.94, p-value for trend=0.09). On the other hand colon cancer was inversely associated with the prudent and traditional patterns but without dose-response. Conversely, rectal carcinoma was not associated with the Western pattern (p-value for heterogeneity=0.01). In fact only the prudent and the traditional patterns were inversely associated with risk of the rectal cancer (OR for the prudent pattern 0.61, 95 % CI 0.37-1.01, p-value for linear trend=0.02). When colorectal cancer (both colon and rectal cancer) was analyzed, the prudent pattern was significantly protective (OR 0.56, 95 % CI 0.37-0.84, p-value for linear trend=0.009). The traditional pattern was also inversely associated with colorectal cancer (OR 0.60, 95 % CI 0.38-0.93, p-value for linear trend=0.04). The Western pattern was not associated with colorectal cancer (CRC), suggesting that the high effect for colon cancer and the null association for rectal cancer cancelled the effects of this diet. Finally, CRC was directly associated with the drinker pattern and the dose-response was marginally significant (OR 1.41, 95 % CI 0.94-2.11, p-value for trend=0.06).

Table 7. Odds Ratios of Colorectal cancer for Dietary Patterns among Women, Stratified by the Tumor Site

Cases/	Colon		Rectum		Both sites	
Controls	OR	95 % CI	OR	95 % CI	OR	95 % CI
Prudent						
77/125	1.0	reference	1.0	reference	1.0	reference
63/125	0.81	0.48-1.39	0.69	0.36-1.33	0.77	0.49-1.20
63/125	0.84	0.48-1.49	0.65	0.33-1.28	0.78	0.49-1.24
47/125	0.45	0.24-0.84	0.66	0.33-1.34	0.53	0.32-0.89
p-value*	0.04		0.24		0.03	
Western						
47/125	1.0	reference	1.0	reference	1.0	reference
52/125	1.10	0.60-2.03	0.90	0.43-1.88	1.01	0.61-1.67
71/125	1.82	0.99-3.34	0.93	0.43-2.02	1.41	0.85-2.35
80/125	1.95	1.00-3.78	0.94	0.37-2.40	1.48	0.83-2.64
p-value*	0.01		0.97		0.07	
Drinker						
57/125	1.0	reference	1.0	reference	1.0	reference
68/125	1.52	0.88-2.62	0.86	0.45-1.64	1.19	0.76-1.87
62/125	1.31	0.74-2.34	0.86	0.43-1.73	1.09	0.67-1.76
63/125	1.38	0.80-2.38	0.70	0.37-1.34	1.04	0.66-1.64
p-value*	0.37		0.31		0.97	

*Trend, adjusted for age, residence, education, family history of colorectal cancer among first-degree relatives, body mass index, smoking index, total energy intake, and all dietary patterns

Odds ratios for colon cancer, rectal cancer, and of both sites together (CRC) among women for dietary patterns are shown in Table 7. Colon cancer was directly associated with the Western pattern (OR for the highest quartile versus the lowest quartile 1.95, 95 % CI 1.00-3.78, p-value for linear trend=0.01). On the other hand, this anatomic site was inversely associated with prudent pattern (OR 0.45, 95 % CI 0.24-0.84, p-value for linear trend=0.04). The drinker pattern showed a moderate increase in risk for colon cancer but without dose-response. Rectal cancer was not associated with any of the dietary patterns. Finally, CRC was inversely associated with the prudent pattern (OR 0.53, 95 % CI 0.32-0.89). There was a lack of association for the Western and drinker patterns.

Discussion

According to our results, colon cancer was directly associated with the Western pattern, but rectal cancer and colorectal cancer were not. Perhaps this discrepancy is the major tentative conclusion in this study (p-value for heterogeneity=0.01).

In the study conducted by Slattery et al (1998), the Western pattern was associated with risk of colon cancer, with a higher risk on proximal colon cancer among men. On the contrary, the study by Terry et al (2001) the Western pattern was not associated with colon, rectal, and colorectal cancer. Fung et al (2003) in studying the Nurses

Health prospective study, showed that the Western pattern increases the risk of colon cancer, whereas rectal cancer was not associated with the retained dietary patterns. Furthermore, these authors suggested that the possible influence of insulin as a mediator of colorectal neoplasia development (Giovannucci, 1995). In the study by Fung et al (2003) the Western pattern might be acting through fasting insulin and C-peptide levels (Fung et al, 2001). Another mechanism for colorectal cancer, which could explain the deleterious effect of the Western pattern, could be related to the presence of heterocyclic amines in well-done red meat. According to Sinha et al (2002) heterocyclic amines are powerful multiorgan carcinogens and act as initiators of colon cancer. Weisburger (2002) has suggested that saturated fat could promote the initial steps of heterocyclic amines in colorectal carcinogenesis. This postulated mechanism, which is biologically plausible, is of utmost importance in Uruguay, combining high consumption of barbecued meat with elevated incidence rates of colon cancer (De Stefani et al, 1998).

In the study by Kim et al (2005) the Western pattern was positively associated with female colon cancer, mainly with distal female colon cancer. The authors suggest that the adoption of the Western pattern could explain the increasing rate of colorectal cancer in Japan. In a French study (Kesse et al, 2006) the sequence adenoma-carcinoma was carefully examined. The Western pattern was directly associated with adenomas but not with carcinomas in French women. The authors also identified a pattern labelled meat-eaters. In fact, it is rather difficult to differentiate both meat-eaters pattern from the Western pattern, since in this study the Western diet showed rather low loadings of processed meat and red meat. Finally, two recent studies (Flood et at, 2008; Miller et al, 2010) extracted a pattern labeled as pork, processed meat and potato (PPP pattern), which was rather similar to the Western pattern. This PPP pattern was positively associated with proximal colon and rectal cancer.

Our results showed an inverse association with the prudent pattern, replicating at least 4 studies, of which 3 were prospective (Slattery et al, 1998; Flood et al, 2008; Williams et al, 2008, Miller et al, 2010). This inverse association also applies to colorectal cancer as well as to males and females. This pattern presented high loadings for white meat, raw vegetables, and total fruits. On the other hand, four prospective studies (Terry et al, 2001; Fung et al, 2003; Kim et al, 2005; Kesse et al, 2006) reported no association with colorectal cancer. Thus, the results observed with the prudent pattern are conflicting. It is important to note that no elevation in risk was associated with this pattern in the last studies. Although white meat, vegetables and fruits were constituents of the so-called prudent (or healthy) pattern, the relevance of fruits and vegetables in colorectal carcinogenesis is questionable (Michels, 2000). Rather recently, Koushik et al (2007) studied a pooled analysis of 14 cohorts and found that distal colon cancer was inversely associated with plant foods, although this effect was not present in proximal and total colon cancer. Nevertheless, plant foods are a source of vitamins, like ascorbic acid, folate, pyridoxine, beta-carotene, and other carotenoids. Also these foods are a rich source of flavonoids and phytosterols, so it is possible that plant foods could be protective against the development of large bowel adenocarcinoma. Recently, an experimental study in rats showed that quercetin, the major component of flavonoids, suppressed early colon carcinogenesis through inhibition of inflammatory mediators (Turner et al, 2009).

In our study, the drinker pattern was associated with colon cancer and with CRC, but not with rectal cancer in males although the dose-response for males was marginally significant. The lack of association was observed among women. In previous studies adenomas of the large bowel were significantly associated with risk of drinker pattern in the French cohort (Kesse et al, 2006). The studies by Slattery et al (1998) and Terry et al (2001) showed lack of association with CRC. According to the recent monograph of the World Cancer Research Fund (2007), there is evidence that alcoholic drinks are a cause of CRC in men. A total of 13 cohort studies and 41 case-control studies investigated alcohol intake and CRC. Reactive metabolites of alcohol, such as acetaldehyde may be carcinogenic. Additionally, the effects of alcohol may be mediated through the production of prostaglandins, lipid peroxidation and the generation of free radical oxygen species. Alcohol also acts as a solvent, enhancing the penetration of carcinogens into the cells (IARC, 2010; Baan et al, 2007). Also diets high in alcohol and low in folate have been suspected as carcinogenic for large bowel cancer (IARC, 2010). In a pooled study involving cohort studies the relative risk of drinkers of >45 grams, compared with never drinkers, showed an increase in 40 %, very similar to the OR of 1.41 in the present study for CRC among men.

In the present study, the traditional pattern was observed only among men. This pattern was inversely associated with rectal cancer and for both sites together, but not for colon cancer. This pattern was characterized by high loadings for cooked vegetables, tubers, and legumes, suggesting the composition of stew, a staple diet frequent in Uruguay. In fact, as suggested by Balder et al (2003) country-specific dietary patterns are actually population-specific in certain countries. This appears to be the case of the traditional pattern in Uruguay. Besides, cooked vegetables, sweet potatoes, and legumes are a rich source of vitamins or provitamins like beta-carotene.

As suggested by Slattery (2008), an important question is related to the relative importance of isolated foods versus broad eating patterns. While it is assumed that dietary patterns may be more important than single foods in the etiology of cancer and other chronic diseases, few studies have made any exploratory analyses to test whether single foods account for the associations found with dietary patterns or if the associations for dietary patterns are independent of the effect of single foods. Individual foods are characterized by their high collinearity which is an important drawback. As aptly stated (Jacobs et al, 2003; Hu, 2002) it is likely that there are additive or more than additive influences of foods and food constituents on health and disease. Recently, Stattery (2008) strongly suggested that the sum (that is dietary patterns) is greater than its parts (individual foods).

Like other case-control studies, the present study has limitations and strengths. Selection bias is an important drawback. We tried to minimize this bias by frequency matching cases and controls by age, sex, and residence. Also, participants were distributed similarly by hospital. Recall bias is perhaps the major problem. Unlike prospective studies, case-control studies are especially prone to this bias. Recall bias could lead to non-differential misclassification (similar faulty recall for cases and controls) or to differential misclassification (faulty recall among cases or among controls independently). The latter could seriously distort the results of the study, whereas the former could lead to results close to the null, attenuating the differences between cases and controls. Since the role of diet in colon cancer is mainly unknown among the Uruguayan population, it is possible that recall bias affected both groups of participants. Further, we cannot exclude the possibility of residual confounding by unknown or unmeasured factors like physical activity. Among the strengths of the study, the high response rate of cases and controls should be mentioned. Also, cases were microscopically diagnosed by pathologists with considerable expertise in colon cancer.

In conclusion, our findings provide further evidence that the Western pattern increases the risk of colon cancer, whereas the prudent pattern decreases the risk of rectal cancer. Reducing the main constituents of the Western pattern, like red meat, processed meat, and eggs intake may be an important modifiable measure in the prevention of colon cancer.

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