

# Comparison between hypopharyngeal and laryngeal cancers: II-the role of foods and nutrients

## Research Article

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**Abbreviations:** monounsaturated fat, (MUFA); odds ratios, (OR's); polyunsaturated fat, (PUFA)

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## Summary

A case-control study involving 320 cases with hypopharyngeal/laryngeal cancer and 640 controls with non-neoplastic diseases was conducted in Montevideo, Uruguay. This study was designed in order to compare the effects of tobacco, alcohol and diet in both tumor sites. In this second report, the role of food groups and nutrients will be examined in detail. Significant heterogeneity between tumors of the hypopharynx and larynx was found for high-fat foods and total grains. Whereas laryngeal carcinomas displayed a much higher risk for fatty foods compared with hypopharyngeal lesions, the last mentioned cancers displayed an elevated odds ratio (OR=2.2) for total grains, compared with a null effect in laryngeal cancers. When nutrients were examined by tumor site, fats (particularly saturated fat) displayed an OR of 2.7 for laryngeal carcinomas, whereas hypopharyngeal cancers were not associated with fat intake. These findings strongly suggest that hypopharyngeal and laryngeal carcinomas could be different epidemiological entities.

## I. Introduction

Hypopharyngeal and laryngeal cancers were strongly associated with increasing exposure to tobacco smoking and alcohol drinking (see companion report). This article examined the role of food and nutrients in these malignancies. Previous reports on diet and hypopharyngeal/laryngeal cancers (La Vecchia et al, 1990; Freudenheim et al, 1992; Graham et al, 1992; Cattaruzza et al, 1996; Estève et al, 1996; Riboli et al, 1996; World Cancer Research Fund, 1997) suggested a protective effect of vegetable and fruit consumption.

In the present report, we presented a detailed analysis of the effect of foods and nutrients in hypopharyngeal and laryngeal carcinomas.

## II. Materials and methods

Selection of cases, controls, details of the interviews, structure of the questionnaire and statistical analysis employed were presented in detail in the companion report.

## A. Definition of food groups

The following food groups were created: red meat (beef, lamb), white meat (poultry, fish), processed meat (bacon, sausage, blood pudding, mortadella, salami, saucisson, hot dog, ham, salted meat), total meat (red meat, white meat, processed meat, liver), dairy foods (cheese, butter, whole milk, ice cream), eggs (boiled eggs, fried eggs, mayonnaise), desserts (milk with sugar, rice pudding, custard, marmalade, cake), high-fat foods (red meat, processed meat, dairy foods, eggs, desserts), total grains (white rice, maize, polenta, pasta, white bread), raw vegetables (carrot, tomato, lettuce, onion), cooked vegetables (garlic, swiss chard, spinach, winter squash, cabbage, cauliflower, beetroot, zucchini, red pepper), total vegetables (raw vegetables, cooked vegetables), citrus fruits (orange, tangerine), other fruits (apple, pear, grape, peach, banana, fig, plum, fruit cocktail), total fruits (citrus fruits, other fruits), total vegetables and fruits (total vegetables, total fruits), all tubers (potato, sweet potato), pulses (chickpea, kidney bean, lentil) and total plant foods (total vegetables, total fruits, all tubers, pulses). All foods and food groups were recorded in units representing frequency of

consumption in servings per year. Food groups were distributed in approximated tertiles, following the controls distribution.

## B. Nutrients

Nutrients were calculated in units per day (grams, miligrams or micrograms). The values for nutrients were estimated by a local table of chemical composition of foods (Mazzei et al, 1995). The following nutrients were included in the analysis: protein, carbohydrates, total fat, saturated fat, monounsaturated fat (MUFA), polyunsaturated fat (PUFA), linoleic acid, alpha-linolenic acid, cholesterol, total vitamin A, beta-carotene, alpha-carotene, lutein, lycopene, beta-cryptoxanthin, vitamin C, vitamin E, fiber, total phytosterols and total flavonols. All nutrients (macro- and micronutrients) were energy-adjusted by the residuals method of Willett and Stampfer (Willett and Stampfer, 1986).

## C. Statistical analysis

Odds ratios for food groups were estimated after fitting a model which included the following terms: age (categorical), residence, urban/rural status, education (categorical), body mass index (categorical), tobacco smoking (categorical), alcohol drinking (categorical) and total energy intake (continuous). Similarly, OR's for nutrients were estimated after fitting the same model. Both food groups and nutrients were introduced into the model one per time. Joint effects for red meat and vegetables, high-fat foods and raw vegetables and saturated fat and vitamin C were analyzed. All calculations were performed with the STATA software programme (Stata Reference Manual 1999).

## III. Results

Odds ratios of hypopharyngeal and laryngeal cancers combined for food groups are shown in **Table 1**. Only red meat and stewed meat consumptions were significantly and directly associated with risk (OR for high consumption of stewed meat 2.19, 95 % CI 1.45-3.32, p-value for trend=0.0002). On the other hand, consumption of raw vegetables, total vegetables, citrus fruits, total fruits, total vegetables and fruits, pulses and total plant foods displayed strong inverse associations with hypopharyngeal/laryngeal cancers risk. All these associations were statistically significant. The highest reductions in risk were observed for high intake of raw vegetables (OR 0.33, 95 % CI 0.22-0.50, p-value for trend <0.0001) and for high consumption of citrus fruits (OR 0.40, 95 % CI 0.27-0.61, p-value for trend <0.0001). White meat (poultry plus fish), processed meat, total meat, dairy foods, eggs, desserts, grains, cooked vegetables, non-citrus fruits and tubers were not associated with risk of hypopharyngeal/laryngeal carcinomas.

The comparison between hypopharyngeal and laryngeal cancers for food groups are shown in **Table 2**. Hypopharyngeal cancers displayed significant increases in risk for the following food groups: barbecued meat (OR 1.84, 95 % CI 1.01-3.36) and grains (OR 2.19, 95 % CI 1.14-4.18). Inverse associations were observed for raw vegetables (OR 0.35, 95 % CI 0.18-0.68), citrus fruits (OR 0.26, 95 % CI 0.13-0.53), total vegetables and fruits (OR 0.46, 95 % CI 0.23-0.92) and legumes (OR 0.32, 95 % CI 0.16-0.65).

**Table 1.** Odds ratios (and 95 % CI) of hypopharyngeal and laryngeal cancers for food groups. Both sites together (1).

Food groups	Tertiles				p-value for trend
	II		III		
	OR	95 % CI	OR	95 % CI	
Red meat	1.27	0.84-1.93	1.75	1.16-2.64	0.007
White meat	0.73	0.50-1.08	0.84	0.56-1.25	0.36
Processed meat	1.44	0.96-2.16	1.20	0.80-1.79	0.42
Stewed meat	1.51	0.99-2.32	2.19	1.45-3.32	0.0002
Total meat	0.90	0.60-1.36	1.21	0.81-1.80	0.31
Dairy foods	1.31	0.90-1.92	1.03	0.67-1.58	0.76
Eggs	0.67	0.46-0.99	0.86	0.58-1.27	0.38
Desserts	1.21	0.83-1.78	1.24	0.83-1.87	0.28
Fat-rich foods	1.64	1.10-2.43	1.43	0.95-2.16	0.09
Grains	1.34	0.91-1.99	1.15	0.76-1.73	0.49
Raw vegetables	0.48	0.32-0.71	0.33	0.22-0.50	<0.0001
Cooked vegetables	0.89	0.61-1.31	0.86	0.57-1.29	0.46
Total vegetables	0.78	0.54-1.14	0.51	0.34-0.77	0.002
Citrus fruits	0.60	0.41-0.87	0.40	0.27-0.61	<0.0001
Other fruits	0.73	0.50-1.08	0.83	0.56-1.22	0.31
Total fruits	0.68	0.47-1.00	0.54	0.36-0.81	0.002
Total vegetables and fruits	0.64	0.44-0.93	0.46	0.31-0.70	0.0002
All tubers	1.19	0.81-1.76	1.07	0.71-1.62	0.71
Pulses	0.84	0.57-1.22	0.48	0.32-0.73	0.0006
Total plant foods	0.73	0.50-1.06	0.47	0.31-0.71	0.0003

1-Adjusted for age (categorical), residence, urban/rural status, education (categorical), body mass index (categorical), tobacco smoking (pack years, categorical), alcohol drinking (categorical) and total energy intake (continuous).

**Table 2.** Comparison between hypopharyngeal and laryngeal carcinomas for food groups (1,2).

Food groups	Hypopharynx		Larynx		p-value for heterogeneity
	OR	95 % CI	OR	95 % CI	
Red meat	1.11	0.59-2.08	2.02	1.28-3.18	0.07
White meat	0.81	0.44-1.52	0.84	0.54-1.29	0.92
Processed meat	0.86	0.45-1.63	1.34	0.86-2.08	0.19
Barbecued meat	1.84	1.01-3.36	1.18	0.77-1.80	0.11
Stewed meat	1.82	0.94-3.52	2.33	1.48-3.66	0.45
Total meat	0.86	0.46-1.61	1.33	0.86-2.05	0.15
Dairy foods	0.88	0.44-1.78	1.06	0.67-1.69	0.74
Eggs	1.11	0.62-2.02	0.77	0.50-1.19	0.25
Desserts	1.02	0.51-2.02	1.33	0.86-2.06	0.52
Fat-rich foods	0.56	0.28-1.13	1.93	1.22-3.04	0.001
Grains	2.19	1.14-4.18	0.90	0.57-1.42	0.01
Raw vegetables	0.35	0.18-0.68	0.32	0.20-0.50	0.68
Cooked vegetables	0.80	0.42-1.53	0.87	0.56-1.35	0.82
Total vegetables	0.54	0.28-1.03	0.50	0.32-0.79	0.84
Citrus fruits	0.26	0.13-0.53	0.45	0.29-0.71	0.15
Other fruits	0.99	0.54-1.80	0.78	0.51-1.19	0.46
Total fruits	0.63	0.34-1.17	0.51	0.33-0.79	0.53
Total vegetables and fruits	0.46	0.23-0.92	0.46	0.29-0.71	0.66
All tubers	1.38	0.71-2.69	1.00	0.64-1.56	0.37
Pulses	0.32	0.16-0.65	0.54	0.35-0.84	0.19
Total plant foods	0.54	0.28-1.07	0.45	0.29-0.70	0.41

1-Adjusted for age (categorical), residence, urban/rural status, education (categorical), body mass index (categorical), tobacco smoking (pack years, categorical), alcohol drinking (categorical) and total energy intake (continuous).

2-Each cell correspond the the upper tertile of consumption (reference category: lower tertile).

Total vegetables and total plant foods also displayed important reductions in risk which were marginally significant. On the other hand, laryngeal cancers showed significant positive associations for high intakes of red meat (OR 2.02, 95 % CI 1.28-3.18), stewed meat (OR 2.33, 95 % CI 1.28-3.18) and fat-rich foods (OR 1.93, 95 % CI 1.22-3.04). Raw vegetables, total vegetables, citrus fruits, total fruits, total vegetables and fruits, legumes and total plant foods were inversely associated with laryngeal carcinomas risk. All these negative associations were highly significant. Three food groups were significantly heterogeneous between hypopharyngeal and laryngeal tumors: red meat (p-value for heterogeneity=0.07), fat-rich foods (p-value for heterogeneity=0.001) and total grains (p-value for heterogeneity=0.01).

Odds ratios of both tumor sites combined for nutrient intake are shown in **Table 3**. Protein, total fat, saturated fat, monounsaturated fat and alpha-linolenic acid were positively associated with risk of hypopharyngeal/laryngeal carcinomas. All these nutrients were significant and saturated fat was associated with the higher risk (OR 2.08, 95 % CI 1.37-3.15, p-value for trend=0.0006). Total carbohydrates, alpha-carotene, lycopene, beta-cryptoxanthin, vitamin C, vitamin E, total phytosterols and flavonols were negatively associated with hypopharyngeal/laryngeal carcinomas risk. The strongest reduction in risk was observed for the higher tertile of consumption of beta-cryptoxanthin (OR 0.32, 95 % CI 0.21-0.49, p-value for trend <0.0001). Polyunsaturated

fat, linoleic acid, vitamin A, beta-carotene, lutein and fiber were not associated with risk.

Comparisons between hypopharyngeal and laryngeal cancers are shown in **Table 4**. No nutrients increased the risk of hypopharyngeal carcinomas. Alpha-carotene, lycopene, beta-cryptoxanthin, vitamin C and total phytosterols were inversely associated with risk of these lesions. The strongest reduction in risk was observed for the highest tertile of beta-cryptoxanthin (OR 0.21, 95 % CI 0.10-0.44), followed by total phytosterols (OR 0.28, 95 % CI 0.14-0.58). On the contrary, protein, total fat, saturated fat, monounsaturated fat, polyunsaturated fat and alpha-linolenic acid displayed significant positive associations with laryngeal cancers. The highest increase in risk was observed for high consumption of saturated fat (OR 2.67, 95 % CI 1.67-4.27). Total carbohydrates, alpha-carotene, lycopene, beta-cryptoxanthin, vitamin C, vitamin E, total phytosterols and flavonols were negatively associated with laryngeal cancers risk. The strongest reduction in risk was shown by lycopene (OR 0.34, 95 % CI 0.21-0.54). There was significant heterogeneity for the following nutrients: total carbohydrates, total fat, saturated fat, monounsaturated fat, alpha-linolenic acid and dietary fiber.

Joint effects of red meat and raw vegetables by tumor site are shown in **Table 5**. OR's of hypopharyngeal cancers displayed moderate elevations, with the exception of the last row (high consumption of red meat and low intake of raw vegetables) (OR 2.98, 95 % CI 1.05-8.52). On the other hand, laryngeal cancers displayed elevated

**Table 3.** Odds ratios (and 95 % CI) of hypopharyngeal/laryngeal carcinomas for nutrients (1).

Nutrient	Tertiles				p-value for trend
	II		III		
	OR	95 % CI	OR	95 % CI	
Protein	1.33	0.89-2.00	1.59	1.07-2.38	0.02
Carbohydrates	0.75	0.52-1.10	0.54	0.36-0.82	0.003
Total fat	1.06	0.70-1.63	1.99	1.31-3.00	0.0006
Saturated fat	1.55	1.02-2.36	2.08	1.37-3.15	0.0006
MUFA (2)	0.98	0.64-1.50	1.88	1.24-2.83	0.001
PUFA (3)	1.26	0.84-1.88	1.45	0.96-2.18	0.07
Linoleic acid	1.03	0.69-1.53	1.29	0.86-1.94	0.21
Alpha-linolenic acid	1.10	0.73-1.67	1.87	1.24-2.80	0.002
Cholesterol	0.91	0.61-1.35	1.08	0.73-1.60	0.70
Vitamin A	1.07	0.73-1.58	0.74	0.49-1.11	0.16
Beta-carotene	1.10	0.74-1.64	1.01	0.67-1.52	0.94
Alpha-carotene	0.56	0.38-0.82	0.36	0.24-0.55	<0.0001
Lycopene	0.60	0.41-0.88	0.35	0.23-0.54	<0.0001
Lutein	0.90	0.61-1.33	1.08	0.73-1.60	0.70
Beta-cryptoxanthin	0.54	0.38-0.80	0.32	0.21-0.49	<0.0001
Vitamin C	0.55	0.37-0.80	0.41	0.27-0.62	<0.0001
Vitamin E	0.61	0.41-0.89	0.52	0.35-0.78	0.0009
Dietary fiber	1.22	0.83-1.80	0.89	0.59-1.35	0.63
Total phytosterols	0.57	0.39-0.83	0.37	0.24-0.55	<0.0001
Flavonols	0.83	0.57-1.21	0.61	0.41-0.92	0.02

1-Adjusted for age (categorical), residence, urban/rural status, education (categorical), body mass index (categorical), tobacco smoking (pack years, categorical), alcohol drinking (categorical) and total energy intake (continuous).

2-Monounsaturated fat.

3-Polyunsaturated fat.

**Table 4.** Comparisons between hypopharyngeal and laryngeal cancers for nutrients (1,2,3,4).

Nutrient	Hypopharynx		Larynx		p-value for heterogeneity
	OR	95 % CI	OR	95 % CI	
Protein	1.44	0.79-2.62	1.65	1.06-2.55	0.71
Carbohydrates	0.92	0.47-1.78	0.47	0.30-0.73	0.02
Total fat	1.08	0.58-2.00	2.47	1.56-3.91	0.01
Saturated fat	1.08	0.58-2.01	2.67	1.67-4.27	0.01
MUFA (3)	1.00	0.54-1.85	2.36	1.49-3.73	0.01
PUFA (4)	1.06	0.57-1.99	1.62	1.04-2.54	0.21
Linoleic acid	1.07	0.58-1.96	1.38	0.88-2.16	0.43
Alpha-linolenic acid	1.13	0.61-2.11	2.19	1.40-3.43	0.04
Cholesterol	1.03	0.57-1.87	1.07	0.70-1.65	0.92
Vitamin A	0.72	0.38-1.38	0.75	0.48-1.17	0.90
Beta-carotene	1.36	0.70-2.63	0.94	0.60-1.45	0.29
Alpha-carotene	0.35	0.18-0.70	0.36	0.23-0.58	0.87
Lycopene	0.40	0.20-0.78	0.34	0.21-0.54	0.67
Lutein	1.04	0.55-1.99	1.08	0.71-1.65	0.93
Beta-cryptoxanthin	0.21	0.10-0.44	0.36	0.23-0.57	0.13
Vitamin C	0.53	0.28-0.98	0.37	0.23-0.58	0.33
Vitamin E	0.60	0.32-1.11	0.50	0.32-0.78	0.57
Dietary fiber	1.79	0.88-3.63	0.73	0.46-1.15	0.02
Total phytosterols	0.28	0.14-0.58	0.39	0.25-0.61	0.54
Flavonols	0.56	0.30-1.04	0.63	0.41-0.99	0.57

1-Adjusted for age (categorical), residence, urban/rural status, education (categorical), body mass index (categorical), tobacco smoking (pack years, categorical), alcohol drinking (categorical) and total energy intake (continuous).

2-Each cell correspond the the upper tertile of consumption (reference category: lower tertile).

3-Monounsaturated fat.

4-Polyunsaturated fat.

**Table 5.** Joint effects of red meat and raw vegetables by tumor site (1).

Meat	Vegetables	Hypopharynx		Larynx		p-value for heterogeneity
		OR	95 % CI	OR	95 % CI	
Low	High	1.0		1.0		-
Low	Medium	0.67	0.18-2.43	1.65	0.58-4.71	0.22
Low	Low	1.88	0.62-5.69	5.46	2.10-14.2	0.09
Medium	High	0.94	0.29-3.11	2.11	0.78-5.74	0.24
Medium	Medium	1.38	0.43-4.42	3.42	1.27-9.21	0.18
Medium	Low	1.32	0.46-3.82	4.53	1.83-11.2	0.04
High	High	0.20	0.04-1.08	2.78	1.07-7.25	0.004
High	Medium	1.35	0.44-4.16	3.63	1.36-9.67	0.13
High	Low	2.98	0.57-1.87	10.1	4.04-25.5	0.04

1-Adjusted for age (categorical), residence, urban/rural status, education (categorical), body mass index (categorical), tobacco smoking (pack years, categorical), alcohol drinking (categorical) and total energy intake (continuous).

risk in most combinations of the variables of study. There was a well-defined gradient for increased exposure of red meat and decreased exposure of raw vegetables and the last row (high consumption of red meat and low intake of vegetables) OR showed an of 10.1. Three rows showed significant heterogeneity between both tumor sites.

In **Table 6**, joint effects of high fat foods (red meat, processed meat, dairy foods, eggs and desserts) and raw vegetables are shown. Hypopharyngeal cancers displayed a somehow inconsistent trend of OR's, with several risks below the unity. The effect of high consumption of high fat foods and low intake of raw vegetables was associated with a risk of 0.78 (95 % CI 0.23-2.62). On the contrary, laryngeal carcinomas showed a fairly well-defined gradient associated with increased consumption of fatty foods and decreased intake of raw vegetables. The combination of high consumption of fat-rich foods and low intake of fresh vegetables was directly associated with a six-fold increase in risk. The differences between hypopharyngeal and laryngeal carcinomas were statistically significant (p-value for heterogeneity=0.002).

The interaction between saturated fat and vitamin C is shown in **Table 7**. Both nutrients displayed independent effects, after adjusting for each other and major confounders (results not shown). Also, the effect of saturated fat was much higher among laryngeal cancers compared with hypopharyngeal lesions (p-value for heterogeneity=0.02). Finally, the combined effect of high intake of saturated fat and low intake of vitamin C was associated with an increased risk of 15.4 for laryngeal carcinomas, whereas the OR's for hypopharyngeal cancers was of 3.23 (95 % CI 1.06-9.83, p-value for heterogeneity=0.02).

#### IV. Discussion

According our study red and boiled meat were directly associated with risk of hypopharyngeal/laryngeal cancers. On the other hand, raw vegetables, total vegetables, citrus fruits, total fruits, total vegetables and fruits, legumes and total plant foods. Previous studies reported similar findings, particularly concerning the protective effect of plant foods (De Stefani et al, 1987; Mackerras et al, 1988; La Vecchia et al, 1990;

Freudenheim et al, 1992; Graham et al, 1992; Cattaruzza et al, 1996; Estève et al, 1996; Riboli et al, 1996; World Cancer Research Fund, 1997). When both tumor sites were compared for food groups, fat-rich foods displayed significant higher risks for laryngeal cancer. On the contrary, grains were associated with increased risk for hypopharyngeal carcinomas, whereas there was no effect of this food group in the laryngeal cancers. To our knowledge, these results are new findings.

Grains could increase the risk of hypopharyngeal cancer by direct contact with the mucosa. This could result in injury of the epithelium, allowing the carcinogenic activity of tobacco and alcohol. The effect of high-fat foods in laryngeal mucosa is more difficult to explain. Further studies are needed in order to elucidate this effect.

Concerning nutrients, protein, total fat, saturated fat, monounsaturated fat and alpha-linolenic acid were directly associated with risk of hypopharyngeal/laryngeal carcinomas. On the other hand, alpha-carotene, lycopene, beta-cryptoxanthin, vitamin C, vitamin E, total phytosterols and flavonols were inversely associated with risk. These findings replicate those reported in previous studies (Freudenheim et al, 1992; Cattaruzza et al, 1996).

When both sites were compared by nutrient intake, protein, fats and alpha-linolenic acid displayed significantly higher risk among laryngeal carcinomas, compared with hypopharyngeal lesions. A previous study on laryngeal cancer (Freudenheim et al, 1992), reported similar findings. The mechanism of fat in laryngeal carcinogenesis is presently unknown. Franceschi et al, have suggested that heavy alcohol consumption is associated with lower intake of vegetables and fruits and high consumption of fat (Franceschi et al, 1994). This was also suggested by La Vecchia et al, (1992). Further studies on this complex relationship are needed.

Our study has limitations. Aside from selection bias, already discussed in the companion paper, recall bias could be a difficult problem. This bias usually result in non-differential misclassification bias. This bias result in null results. Thus, the risks observed in the study could have been even greater. Since both interviewers and patients were unaware of the role of diet in cancer of the upper aerodigestive cancers, it is unlikely that interviewer

**Table 6.** Joint effects of fatty foods and raw vegetables by tumor site (1).

Fatty	Vegetables	Hypopharynx		Larynx		p-value for heterogeneity
		OR	95 % CI	OR	95 % CI	
Low	High	1.0		1.0		-
Low	Medium	0.56	0.15-2.05	1.52	0.60-3.81	0.17
Low	Low	2.76	0.99-7.64	2.95	1.25-6.98	0.91
Medium	High	1.04	0.32-3.34	1.53	0.63-3.72	0.56
Medium	Medium	1.60	0.55-4.69	2.98	1.27-6.97	0.30
Medium	Low	2.67	0.99-7.19	4.95	2.24-10.9	0.26
High	High	0.24	0.04-1.26	2.05	0.84-5.02	0.01
High	Medium	1.59	0.50-5.04	1.74	0.67-4.55	0.88
High	Low	0.78	0.23-2.62	5.95	2.67-13.3	0.002

1-Adjusted for age (categorical), residence, urban/rural status, education (categorical), body mass index (categorical), tobacco smoking (pack years, categorical), alcohol drinking (categorical) and total energy intake (continuous).

**Table 7.** Joint effects of saturated fat and vitamin C by tumor site (1).

S.fat	Vitamin C	Hypopharynx		Larynx		p-value for heterogeneity
		OR	95 % CI	OR	95 % CI	
Low	High	1.0		1.0		-
Low	Medium	1.47	0.45-4.77	2.92	0.98-8.65	0.35
Low	Low	4.59	1.47-14.3	8.46	2.91-24.6	0.38
Medium	High	1.85	0.54-6.40	4.96	1.66-14.8	0.19
Medium	Medium	1.55	0.47-5.13	7.85	2.85-21.6	0.02
Medium	Low	1.32	0.38-4.53	6.49	2.36-17.8	0.03
High	High	1.68	0.51-5.54	6.07	2.13-17.2	0.07
High	Medium	1.45	0.43-4.89	5.60	1.99-15.8	0.06
High	Low	3.23	1.06-9.83	15.4	5.68-41.7	0.02

1-Adjusted for age (categorical), residence, urban/rural status, education (categorical), body mass index (categorical), tobacco smoking (pack years, categorical), alcohol drinking (categorical) and total energy intake (continuous).

bias could have existed. Our study also has strengths. Perhaps the major strength is the high response rate, both for cases and controls.

In summary, this study on diet and hypopharyngeal/laryngeal cancers showed interesting findings. In particular, the role of high-fat foods and saturated fat increased the the risk of laryngeal cancer. The only important risk factor for hypopharyngeal cancer was grain consumption. These dietary differences between both tumor sites, together with those differences for smoking and drinking (see companion report), further support the possibility that hypopharyngeal and laryngeal carcinomas could be different epidemiological entities.

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