Dietary Habits and Lung Cancer Risk Among Chinese Females in Hong Kong Who Never Smoked

Linda C. Koo

Abstract

This describes a retrospective study in which 88 lung cancer patients and 137 district-matched controls were interviewed concerning the effects of diet on lung cancer risk among Hong Kong Chinese women who never smoked tobacco. Those in the lowest tertile of consuming fresh fruit or fresh fish had statistically significant adjusted relative risks (RRs) of 2.4 and 2.8, respectively. The protective effects of diet, i.e., higher consumption of leafy green vegetables, carrots, tofu, fresh fruit, and fresh fish, were confined mostly to those with adenocarcinoma or large cell tumors. Only fresh fruit was found to positively, and smoked meats to negatively, affect the risk of squamous or small cell tumors. Foods high in vitamin C, retinol, and calcium seemed to exert larger effects. Subjects from larger households were shown to be more frequent consumers of fresh vegetables, fruit, and fish. Because the lifetime weighted household size could be used as a surrogate index of past dietary quality, when it was combined with current dietary intakes of fresh fruit, the RR increased as either factor decreased in a dose-response manner. The adjusted RR was 5.8 at the lowest level. Further testing of the validity of the lifetime weighted household size as an index of past dietary quality is needed.

(Nutr Cancer 11, 155–172, 1988)

Introduction

Lung cancer among females in Hong Kong is notable because the world age-adjusted incidence rate of 27.1 per 100,000 for 1982 (1) ranked it among the highest in the world and because 64% of the cases with lung cancer were not found to be attributable to a history of active smoking (2). Although lung cancer has been the major cause of cancer death among both men and women in Hong Kong since the mid-1970s, the world age-adjusted incidence rate for men of 63.6 per 100,000 (1) in 1982 was not unusual for an urban industrialized society, where 95% of the cases (2) were attributed to smoking. Thus, a case-control study of female lung cancer was conducted from 1981 to 1983 to explore possible environmental

L. C. Koo is affiliated with the Department of Community Medicine, University of Hong Kong, Hong Kong.

factors contributing to the high rates of this cancer among Chinese females in Hong Kong. These factors would probably be of recent introduction because the mortality rate for female lung cancer increased threefold from 1961 to 1980 (3).

In recent years, exposure to environmental tobacco smoke has been linked in some epidemiological studies to an increased risk for lung cancer among nonsmoking females (4–10). This possibility was studied in detail in our Hong Kong studies (3,11), and although early reports showed no statistically significant increased risks from such exposures, a more recent analysis of the data (12) suggested that such a link might exist among women with squamous cell tumors situated in the peripheral areas of the lung. However, less than 25% of females who never smoked but were lung cancer patients had these types of tumor characteristics, and the small numbers of cases for analyses left these findings very tentative.

One of the major criticisms of studies on passive smoking and lung cancer is that the association might really reflect the fact that wives with husbands who smoke(d) have different life-styles and past exposures than those whose husbands never smoked. This possibility was explored in an analysis of life history correlates of passive smoking among 136 Hong Kong Chinese wives who never smoked (13). Among the 97 quantifiable variables that were studied, data from dietary habits were among the clearest in showing a statistically significant difference in the dietary intakes of the wives based on their husbands' smoking habits. Wives with husbands who had never smoked more frequently consumed cruciferous vegetables, carrots, beans/legumes, and milk. In comparison, wives with husbands who had ever smoked during their marital life together were more frequent consumers of cured/smoked meats, fish (fresh and preserved), pickled vegetables, and chilies/chili sauces. According to the US National Research Council's 1982 report *Diet, Nutrition, and Cancer* (14) the foods more frequently consumed by the former group were identified as protective of cancer and that of the latter to be associated with higher risk for cancer. As a consequence, the direct role of diet in lung cancer risk among those who never smoked in Hong Kong needed further exploration.

It is well known that the human diet includes a large variety of carcinogens, promoters, and anticarcinogens that may be natural or added to food (15). Some, like *N*-methyl-*N*-formylhydrazine found in certain types of edible mushrooms need only be ingested in small amounts (e.g., 20 μg daily) to produce lung tumors in mice (15). Others, like vitamins A, C, and E, are micronutrients with anticarcinogenic activity; this is probably because they are antioxidants.

Epidemiological studies on diet and lung cancer have been relatively consistent in showing the protective effects of ingesting vegetables (16–18) or food sources of vitamin A (19–26). Most studies found these protective effects to be stronger among smokers (16,18,23,26) or exsmokers (17,19,21,24); no studies did separate analyses on subjects who never smoked, mostly because of inadequate sample sizes. Although some of the studies (16,18–24) made statistical adjustments for smoking (to reduce confounding effects) and found the effects to be statistically independent of smoking, it is still questionable as to whether these data are applicable for subjects who never smoked. This is because having a history of smoking may imply other life-style exposures/habits or irreparable damage/changes to the respiratory tract. Furthermore, because some studies (22,26) did not find these protective effects to be applicable to females, further studies seem warranted.

Subjects and Methods

Definition of Cases and Controls

From an initial retrospective case-control study conducted from 1981 to 1983 that covered 200 female lung cancer patients and 200 female district-matched controls, this analysis only includes 88 cases and 137 controls who reported no history of active smoking. Subjects who never smoked were defined as those who had smoked less than 20 cigarettes or pipes in the past. All lung cancer patients were interviewed at the hospital when they were receiving in- or out-patient care, and all controls were interviewed at their homes. The lung tumors were histologically typed according to the World Health Organization's histological classification of lung tumors (27). Further details concerning subject selection, lung cancer histological typing, and interview technique and content have been previously described (3,11–13).

The mean ages of the patients and controls were 57.8 (SD 10.8) and 59.3 years (SD 9.9), respectively. Among all the subjects, 66% were currently married (n = 149), 27% were widows (n = 60), 6% were separated or divorced (n = 13), and 1% had never married (n = 3). None of the women had remarried.

Demographic data collected during the interviews included a detailed listing of the number of household members living together for each residence since birth. A lifetime weighted household size index was calculated by a summation of the number of people residing in each address multipled by the number of years that they lived together at that residence then divided by the age of the subject.

Equation is as follows.

$$\frac{\Sigma \text{ (No. of people in each address} \times \text{ years at that address)}}{\text{Age of subject}}$$

It is a Σ, not simple addition.

Dietary Data

The dietary section of the interview inquired about the frequency of consumption of a list of food items or food groups. Cases were asked to report on their usual food habits one year before their diagnosis of cancer or the appearance of symptoms. Controls were asked to recall their current usual habits of eating. In the design of the study for all 200 cases and controls, each control was usually interviewed within six weeks of her matched case's interview to reduce the effects that seasonal availability might have on her recall of food consumption habits.

The Chinese style of eating makes it difficult to assess dietary quality, quantity, and frequency. It is common for one dish to be composed of small slices of meat(s) and various mixtures of fresh and pickled/preserved vegetables. When two or more persons are eating together, the dishes are put at the center of the table and one picks up a chopstick full of food each time. Thus, except for the bowl of rice, which is individually portioned, it is extremely difficult to recall the amounts and items of food one has eaten over the meal.

Realizing these difficulties, data gathering concentrated on eliciting consumption patterns of broad groups or types of food: cruciferous vegetables, fresh leafy green vegetables, beans/legumes, tofu/soy products, fresh fruit, fresh fish, dried/salted fish, smoked/cured meat/poultry, fermented fish/shrimp sauces, fermented beans/sauces, chilies/chili sauces, and pickled vegetables. The other advantage of categorizing the food into similar groups is that the large variety of dishes in Chinese cooking is based on working with these categories. For example, one can substitute sliced beef for sliced pork or one type of vegetable for another in a mixed dish composed of many ingredients. Thus, the substitutions occur in set patterns based on these broad food groups, and this eliminated the problem of asking about the hundreds of ingredients that make up the inventory of food items in the local diet. The subjects were also asked about consumption of carrots, the addition of monosodium glutamate in home cooking, and milk drinking patterns, because these items were of specific interest.

The original interview also covered beverages. Specific questions on the types of tea that the subject preferred drinking revealed about seven common types of black (fermented) or green (unfermented) teas. In this analysis, only those subjects who preferred to drink plain boiled water will be compared with those who preferred any type of tea. The question on milk consumption was modified to take into account that the adult population of this age group rarely drink just milk alone. Instead, milk could be added to tea, coffee, cocoa, or malted milk mixtures. Thus, the subjects were asked about the period of time when the equivalent of one cup of fresh milk would be consumed.

All subjects were asked about their alcoholic drinking patterns from a list of Chinese and western alcoholic drinks that included liquor, wines, and Chinese tonic wines (tinctures made of medicinal herbs). Because most Chinese women (70–80%) do not drink alcohol, all the alcoholic drinks were combined and subjects were classified as to whether they drank any type of alcohol one or more times a week (yes/no); this distinguished the regular drinkers from the infrequent social drinkers.

Subjects were asked to classify their frequency of eating each food item into one of the following categories: a) never, b) <1/month, c) 1–3/month, d) 1–4/week, e) 5–7/week, and f) ≥2/day. In the analysis of the average number of times these foods would be consumed per month, the conversion was done by giving each of the above categories the following weights, respectively: 0, 1, 2, 11, 26, and 61.

Statistical Analysis

The cases and controls were grouped into tertile levels of consumption (low, medium, and high) for statistical calculations of relative risk (RR). For ease of interpretation, the baseline value of 1.00 for protective items in the diet was set at the high levels of consumption, and the reverse was done for food items with detrimental effects. To conserve space in the tables, the definition of each tertile grouping in terms of the baseline value, the first level, and the second level were coded using the frequency categories given in the paragraph above (a to f), in the following manner: (A) = a+b, c, d+e+f; (B) = a+b+c+d, e, f; (C) = a+b+c, d, e+f; (D) = a, b+c, d+e+f; (E) = f+e+d, c, b+a; (F) = a, b, c+d+e+f; and (G) = f+e+d+c, b, a. In the analysis of nutrient levels, where the values for each food item were converted to the times per month, the definition of the tertile groupings per month were as follows: (H) ≤7.6, 7.7–16.25, >16.25; (I) ≤7.4, 7.5–18.0, >18.0; (J) ≤9.0, 9.1–13.0, >13.0; (K) ≤13.3, 13.4–20.8, >20.8; and (L) ≤10.2, 10.3–14.7, >14.7.

Relative risk calculations included the crude unadjusted (RR1) or adjusted (RR2) odds ratios (28). The latter were estimated by the use of a conditional logistic regression package, PECAN (29), of N:M matching by strata defined by district (n = 34) and housing type (public or private). This type of matched analysis was done to control for the effects of socioeconomic status. We had previously studied the effect of all variables in the data set to see their individual effects on lung cancer risk. From this, the following variables were identified as important possible confounders and the adjusted odds ratios took into account age (<50, 50–69, 70+ years), any formal schooling (yes/no), and the number of live births. Although the effects of alcohol were tested in the design of the model, adjustments for alcohol did not affect the relative risks in an additive or interactive way. Similarly, since 11.4% of the cases and 10.9% of the controls reported previous consumption of vitamins, with an average of 6.4 and 3.6 years of consumption, respectively, adjustments for vitamin consumption did not improve the logistic model.

In recognition of the fact that the original study of all 200 cases and controls was based on 1:1 matching by district and housing type, the 95% confidence intervals for the crude odds ratios were estimated from the N:M matched analysis with the value for each variable considered as its exact value. Similarly, this was done for the Mantel-Haenszel trend test for the unadjusted odds ratios. To conserve space in the tables, only the 95% confidence intervals of RR with P values ≤0.10 will be given.

Results

Table 1 shows that a more frequent consumption of fresh fruit or fresh fish conferred protection against lung cancer. Those at the lowest tertiles of consumption had adjusted RR of 2.4 for fresh fruit or 2.8 for fresh fish, and these results and the trend P values were statistically significant. Consumers of alcohol had adjusted RR of 1.85 (95% CI = 0.93–3.70), and the adjusted trend was of borderline significance ($p = 0.08$).

In Table 2, cases were analyzed by histological type. Those with squamous or small cell cancers, and those with adenocarcinoma or large cell cancers were combined because the former group were more closely associated with active smoking than the latter (2). In general, the protective effects of diet were more apparent among those with adenocarcinoma or large cell lung tumors. Among them, the adjusted RR of those who most infrequently consumed the following were: fresh leafy green vegetables 3.09, carrots 6.69, tofu or soy bean products 3.51, fresh fruit 1.55, and fresh fish 3.61. The finding that fermented seafood sauces like shrimp or fish sauces were protective in higher amounts may have been due to the fact that these condiments are frequently added to cooked vegetable dishes.

By contrast, only the consumption of fresh fruit showed a protective trend among those with squamous or small cell tumors, and less frequent consumption of smoked meat/poultry was of borderline significance.

As a heuristic exercise to understand the effects of foods which have in common certain nutrients that have been cited in the literature as being protective of cancer, the data were analyzed (Table 3) by four nutrient indexes: β-carotene, retinol, calcium, and vitamin C. Because data on quantities of food eaten per meal were not collected, and because the Chinese style of eating mixed vegetables and meat/poultry in one dish would not be conducive to assigning a standardized "portion" as in western foods, individual weights of the nutrient to each food type were not done to avoid giving a false sense of precision. The monthly frequencies of consumption of each food item per person were summed and then divided by the total number of items to obtain the average frequency per month for each subject. A dietary variable, "Good Diet," was developed which combined the monthly consumption frequencies of fruits, vegetables, soy products, soup, milk, and fresh fish. This was the diet recommended by the US National Research Council (14) as being protective of cancer and heart disease.

The analysis of all subjects showed that sources of vitamin C (e.g., fresh vegetables and fruit) seemed to confer the most protection against cancer, with the RR around 2 and the *P* values for trend 0.01. Also, sources of retinol (e.g., fish and milk) were associated with an RR of 2.1–2.4 at the lowest tertile of consumption.

In all the analyses in Table 3, none of the RR or trends for squamous or small cell tumors were statistically significant at the $p \leq 0.05$ level. By comparison, the oppsosite was true for the adenocarcinoma or large cell tumors. All the trend values for each nutrient index were significant or nearly significant, and the RR values were especially elevated for foods high in vitamin C or retinol.

The combined variable Good Diet had the most consistent dose-response model for all subjects, especially those with adenocarcinoma or large cell tumors. The highly significant RR values had a range of 2.1–2.3 for all subjects, and 3.2–3.6 for those with adenocarcinoma or large cell tumors; the *P* values for trend ranged from 0.001 to 0.003. Again, protective effects were not seen for squamous or small cell tumors.

During the interviews, a few questions directly or indirectly indicating eating habits or tendencies in the subject's household were found to affect the risk ratios (Table 4). The frequencies of consuming Dim Sum (which is the consumption of small savory and sweet dishes for breakfast or lunch at restaurants) and home-cooked soup (which is a Cantonese specialty served frequently as a tonic) (30) did not indicate any statistically significant results.

Table 1. Frequency of Food Consumption and Lung Cancer Relative Risks[a]

	Frequency of Consumption[b]									Trend P Value	
	Low			Medium			High				
	No. of Cases/Controls	RR1	RR2	No. of Cases/Controls	RR1	RR2	No. of Cases/Controls	RR1	RR2	RR1	RR2
Food items/groups[c]											
Cruciferous vegetables (A)	38/61	1.33	1.04	43/61	1.51	1.14	7/15	1.00	1.00	0.702	0.358
Fresh leafy green vegetables (B)	14/15	1.49	2.06	25/44	0.90	1.00	49/78	1.00	1.00	0.212	0.241
Carrots (A)	22/38	1.64	1.96	60/82	2.07	2.57 (1)	6/17	1.00	1.00	0.453	0.404
Beans/legumes (A)	40/59	0.93	0.66	40/66	0.83	0.63	8/11	1.00	1.00	0.952	0.766
Tofu/soy products (A)	20/25	1.98	1.46	51/70	1.80	1.56	17/42	1.00	1.00	0.332	0.524
Fresh fruit (C)	23/22	2.19 (2)	2.39 (3)	21/23	1.91 (4)	1.93 (5)	44/92	1.00	1.00	0.002	0.002
Fresh fish (B)	42/40	2.24 (6)	2.83 (7)	23/48	1.02	1.10	23/49	1.00	1.00	0.021	0.017
Dried/salted fish (E)	43/69	1.00	1.00	27/34	1.27	1.30	18/34	0.85	0.95	0.814	0.865
Smoked/cured meat/poultry (E)	36/51	1.00	1.00	31/54	0.81	0.82	21/32	0.93	0.92	0.944	0.691
Spices and sauces											
Monosodium glutamate at home (D)	63/88	1.00	1.00	14/21	0.93	1.24	11/27	0.57	0.77	0.622	0.960
Fermented fish/shrimp sauce (G)	25/41	1.00	1.00	46/53	1.42	1.23	17/43	0.65	0.64	0.812	0.623
Fermented beans/sauces (E)	28/47	1.00	1.00	45/49	1.54	1.67	15/41	0.61	0.82	0.499	0.827
Chili, fresh and sauce (G)	52/85	1.00	1.00	16/17	1.54	1.67	19/34	0.91	1.03	0.279	0.200
Pickled vegetables (E)	15/34	1.00	1.00	32/43	1.69	1.50	41/60	1.55	1.60	0.962	0.776
Beverages											
Milk (F) (1 cup)	22/43	0.86	1.08	25/25	1.68	1.81	41/69	1.00	1.00	0.243	0.309
Any type of alcohol (no/yes)	61/108	1.00	1.00	27/29	1.65	1.85 (8)				0.163	0.076
Any type of tea (no/yes)	30/52	1.00	1.00	58/85	1.18	1.59				0.333	0.150

a: RR1, unadjusted odds ratio; RR2, odds ratio adjusted for age, no. of live births, and schooling (+/−). *P* value of trend by exact values of RR1 and RR2.
b: Gives 95% confidence intervals as follows (nos. in parentheses): (1) 0.89–7.40, (2) 1.22–5.55, (3) 1.09–5.23, (4) 0.97–4.26, (5) 0.88–4.24, (6) 1.26–5.03, (7) 1.33–6.00, (8) 0.93–3.70.
c: For (A)–(G), definition of each level of consumption is given in text.

However, types of cooking oil did lead to statistically significant results. Those who used peanut oil or rapeseed oil (and not corn oil) had RR values of 2.7–3.2. However, it is questionable whether it is the corn oil itself that is protective. Rather, because of the recent media advertisements proclaiming the health benefits of corn oil for cardiovascular disease and avoiding peanut oil for its aflatoxin levels, those housewives who responded to this change indicated their receptivity to behavioral modification for health reasons. This is because for Chinese cooking, peanut oil produces more flavorful cooking and reaches a higher temperature for the stir-fry method than does corn oil, although both oils are the same price.

In social science literature, the household was symbolized by the hearth, and those who lived together also ate together. Although the relationship of the last household size did not result in significantly raised RR, the lifetime weighted household size did. Those who averaged smaller households in their lifetimes had RR values from 2.0 to 2.4, and the trend P values were also significant.

To see whether household size affected food frequency levels, Table 5 shows this relationship among the 137 nonsmoking controls. For all the fresh vegetables, fresh fruit, dried or fresh fish, and sauces and spices (except pickled vegetables), those with larger household sizes consumed these foods more frequently than did smaller households. These relationships were statistically significant in trend for fresh leafy green vegetables, fresh fish, dried or salted fish, smoked or cured meats and poultry, and fermented beans or fermented bean sauces.

The data on beverages indicated that milk and tea consumption did not vary by household size, but that alcohol consumption did. There was a slight trend ($p = 0.04$) of higher alcohol consumption among women living in larger households, although the actual frequency averaged less than once per month. Because alcohol consumption among "social drinkers" is usually confined to celebrations like marriages, this variable might reflect the fact that larger families would have more such occasions than smaller ones. This possibility seems corroborated by the fact that the consumption of Dim Sum was significantly more frequent per month in larger households (trend P value was 0.03), because this is an activity where the entire family usually gets together and eats out in a restaurant.

The results from the data on nutrient indexes such as β-carotene, retinol, calcium, vitamin C, and Good Diet were similar to the other data in Table 5, which showed larger households as more frequent consumers of these types of foods, especially calcium.

As would be expected, there was a high correlation between the last household size and lifetime weighted household size. Because household size is related to a higher consumption of foods found to reduce the risk for lung cancer, the lifetime weighted household size might be a surrogate measure of "past" dietary habits. To see the effects of combining this measure of past dietary habits with a food item that reflects current habits and is related to risk in this data set, Table 6 shows how combining the two variables gives an even better predictor of RR values. By use of the group with larger household size and more frequent consumption of fruit as the baseline of RR = 1.00 (left upper corner), it can be seen that the RR increased as lifetime weighted household size and/or fruit consumption decreased. The effects were most apparent among the infrequent fruit consumers, where the trend ($p = 0.01$) was significant as household size decreased; also the adjusted RR increased in a dose-response manner from 1.75 to 4.16 to 5.77 for large, medium, and small households, respectively.

The same analysis was done for each of the nutrient indexes, and Table 7 shows how this model indicated a dose-response relationship with the generalized Good Diet variable. As can be seen, the P values for the adjusted trends were statistically significant or nearly significant when either Good Diet decreased (up to down) or the lifetime weighted household size decreased (left to right). When the lifetime weighted household size was large, the deleterious effects of a "poor" diet were minimal. But when the household size was small, an

Table 2. Food Frequency and Lung Cancer Relative Risks[a] by Histological Type

	Relative Risks by Frequency of Consumption[b]							
	Squamous plus small cell				Adenocarcinoma plus large cell			
	Low	Medium	High	Trend P Value	Low	Medium	High	Trend P Value
Food items/groups[c] (no. of cases/no. of controls)								
Cruciferous vegetables (A)	16/61	12/61	4/15		18/61	25/61	3/15	
RR1	0.98	0.74	1.00	0.212	1.48	2.05	1.00	0.788
RR2	0.77	0.68	1.00	0.174	1.21	1.82	1.00	0.772
Fresh leafy green vegetables (B)	2/15	9/44	21/78		10/15	13/44	23/78	
RR1	0.50	0.76	1.00	0.803	2.26 (1)	1.00	1.00	0.147
RR2	0.66	0.97	1.00	0.779	3.09 (2)	1.18	1.00	0.090
Carrots (A)	9/38	18/82	5/17		11/38	34/82	1/17	
RR1	0.81	0.75	1.00	0.370	4.92	7.05 (3)	1.00	0.107
RR2	1.06	0.90	1.00	0.437	6.69 (4)	11.02 (5)	1.00	0.056
Beans/legumes (A)	15/59	12/66	5/11		19/59	24/66	3/11	
RR1	0.56	0.40	1.00	0.179	1.18	1.33	1.00	0.818
RR2	0.32	0.27	1.00	0.122	0.57	0.81	1.00	0.891
Tofu/soy products (A)	5/25	17/70	10/42		12/25	29/70	5/42	
RR1	0.84	1.02	1.00	0.346	4.03 (6)	3.48 (7)	1.00	0.021
RR2	0.65	1.00	1.00	0.372	3.51 (8)	3.55 (9)	1.00	0.042
Fresh fruit (C)	8/22	8/23	16/92		10/22	13/23	23/92	
RR1	2.09	2.00	1.00	0.066	1.82	2.26 (10)	1.00	0.009
RR2	2.30	2.70 (11)	1.00	0.043	1.55	1.80	1.00	0.022
Fresh fish (B)	14/40	7/48	11/49		21/40	14/48	11/49	
RR1	1.56	0.65	1.00	0.320	2.34 (12)	1.30	1.00	0.075
RR2	2.02	0.75	1.00	0.295	3.61 (13)	1.40	1.00	0.032
Dried/salted fish (E)	13/69	12/34	7/34		26/69	11/34	9/34	
RR1	1.00	1.87	1.09	0.918	1.00	0.86	0.70	0.958
RR2	1.00	2.24	1.11	0.911	1.00	0.75	0.75	0.690
Smoked meat/poultry (E)	10/51	12/54	10/32		20/51	16/54	10/32	
RR1	1.00	1.13	1.59	0.096	1.00	0.76	0.80	0.289
RR2	1.00	1.27	1.74	0.064	1.00	0.75	0.79	0.419

Spices and sauces (no. of cases/no. of controls)								
MSG at home (D)	22/88	6/21	4/27		34/88	8/21	4/27	
RR1	1.00	1.14	0.59	0.863	1.00	0.99	0.38	0.375
RR2	1.00	1.21	0.77	0.760	1.00	1.26	0.46	0.466
Fermented seafood sauces (G)	7/41	15/53	10/43		15/41	24/53	7/43	
RR1	1.00	1.66	1.36	0.130	1.00	1.24	0.44	0.113
RR2	1.00	1.34	1.56	0.137	1.00	0.93	0.30	0.070
Fermented beans/sauces (E)	7/47	18/49	7/41		18/47	20/49	8/41	
RR1	1.00	2.47 (14)	1.15	0.782	1.00	1.07	0.51	0.597
RR2	1.00	3.24 (15)	1.55	0.722	1.00	1.20	0.55	0.731
Chili, fresh and sauces (G)	18/85	3/17	10/34		27/85	12/17	7/34	
RR1	1.00	0.83	1.39	0.782	1.00	2.22 (16)	0.65	0.597
RR2	1.00	0.79	1.41	0.723	1.00	2.89 (17)	0.75	0.731
Pickled vegetables (E)	3/34	10/43	19/60		9/34	17/43	20/60	
RR1	1.00	2.64	3.59 (18)	0.328	1.00	1.49	1.26	0.706
RR2	1.00	2.26	3.90 (19)	0.247	1.00	1.04	0.99	0.918
Beverages (no.of cases/no. of controls)								
Milk (F) (1 cup)	14/69	10/25	8/43		21/69	14/25	11/43	
RR1	1.09	2.15	1.00	0.288	1.19	2.19	1.00	0.482
RR2	0.84	1.67	1.00	0.269	0.80	1.84	1.00	0.786
Any alcohol (no/yes)	20/108	12/29			34/108	12/29		
RR1	1.00	2.23		0.201	1.00	1.31		0.592
RR2	1.00	2.07		0.141	1.00	1.41		0.460
Any tea (no/yes)	12/52	20/85			15/52	31/85		
RR1	1.00	1.02		0.567	1.00	1.26		0.285
RR2	1.00	1.42		0.462	1.00	1.69		0.188

a: RR1, unadjusted odds ratio; RR2, odds ratio adjusted for age, no. of live births, and schooling (+/−). *P* value of trend by exact values of RR1 and RR2. $n = 225$ for all except: beans/legumes (224), MSG (224), and chili (223).

b: Gives 95% confidence intervals as follows (no. in parentheses): (1) 0.97–7.24, (2) 1.04–9.14, (3) 1.29–94.29, (4) 0.70–64.26, (5) 0.99–62.90, (6) 1.15–15.29, (7) 1.14–11.05, (8) 0.86–14.22, (9) 1.04–12.04, (10) 0.92–5.10, (11) 0.88–8.26, (12) 1.02–6.19, (13) 1.26–10.36, (14) 0.91–7.89, (15) 1.04–10.03, (16) 1.22–9.12, (17) 0.98–8.54, (18) 0.91–13.72, (19) 0.96–15.73.

c: For (A)–(G), definition of each level of consumption is given in text.

Table 3. Nutrient Levels and Lung Cancer Relative Risks[a]

	Average Frequency of Consumption per Month[b]									Trend P Value	
	Low			Medium			High				
Nutrient[c]	No. of Cases/Controls	RR1	RR2	No. of Cases/Controls	RR1	RR2	No. of Cases/Controls	RR1	RR2	RR1	RR2
β-Carotene (H)[d]											
All subjects	23/32	1.16	1.37	31/50	1.00	1.00	34/55	1.00	1.00	0.212	0.265
Squamous + small cell	7/32	0.75	0.87	9/50	0.62	0.71	16/55	1.00	1.00	0.435	0.420
Adenocarcinoma + large cell	13/32	1.49	1.68	18/50	1.32	1.13	15/55	1.00	1.00	0.091	0.055
Retinol (I)[e]											
All subjects	33/34	2.14 (1)	2.41 (2)	31/50	1.37	1.33	24/53	1.00	1.00	0.018	0.023
Squamous + small cell	11/34	1.43	1.72	9/50	0.80	0.80	12/53	1.00	1.00	0.240	0.237
Adenocarcinoma + large cell	16/34	2.27 (3)	3.11 (4)	19/50	1.83	1.83	11/53	1.00	1.00	0.061	0.052
Calcium (J)[f]											
All subjects	28/36	1.32	1.35	30/50	1.02	0.85	30/51	1.00	1.00	0.016	0.028
Squamous + small cell	6/36	0.57	0.66	11/50	0.75	0.57	15/51	1.00	1.00	0.897	0.919
Adenocarcinoma + large cell	18/36	1.82	1.85	14/50	1.02	1.04	14/51	1.00	1.00	0.016	0.013
Vitamin C (K)[g]											
All subjects	29/30	1.96 (5)	2.11 (6)	28/44	1.29	1.16	31/63	1.00	1.00	0.009	0.015
Squamous + small cell	6/30	1.05	1.26	14/44	1.67	2.27 (7)	12/63	1.00	1.00	0.456	0.426
Adenocarcinoma + large cell	20/30	2.47 (8)	2.42 (9)	9/44	0.76	0.45	17/63	1.00	1.00	0.011	0.014
"Good diet" (L)[h]											
All subjects	29/28	2.11 (10)	2.31 (11)	30/50	1.22	1.28	29/59	1.00	1.00	0.001	0.002
Squamous + small cell	4/28	0.60	0.75	14/50	1.18	1.34	14/59	1.00	1.00	0.226	0.189
Adenocarcinoma + large cell	20/28	3.24 (12)	3.55 (13)	13/50	1.18	1.54	13/59	1.00	1.00	0.002	0.003

a: RR1, unadjusted odds ratio; RR2, odds ratio adjusted for age, no. of live births, and schooling (+/−). *P* value of trend by exact values of RR1 and RR2.
b: Gives 95% confidence intervals as follows (no. in parentheses): (1) 1.15–4.85, (2) 1.12–5.18, (3) 0.96–6.40, (4) 1.05–9.16, (5) 1.15–4.76, (6) 1.02–4.40, (7) 0.86–5.99, (8) 1.10–5.91, (9) 0.98–5.97, (10) 1.22–5.22, (11) 1.08–4.95, (12) 1.42–8.37, (13) 1.36–9.30.
c: For (H)–(L), definition of each level of consumption is given in text.
d: Subjects ate cruciferous veg. + fresh leafy green veg. + carrots + beans/legumes ÷ 4.
e: Subjects ate fresh fish + dry/salted fish + milk ÷ 3.
f: Subjects ate fresh fish + dry/salted fish + cruciferous veg. + fresh leafy green veg. + carrots + beans/legumes + tofu/soy products + milk + pickled vegetables ÷ 9.
g: Subjects ate cruciferous veg. + fresh leafy green veg. + fresh fruit + beans/legumes ÷ 4.
h: Subjects ate cruciferous veg. + fresh leafy green veg. + carrots + beans/legumes + tofu/soy products + fresh fruit + soup + milk + fresh fish ÷ 9.

Table 4. Eating Habits and Relative Risks[a] for Lung Cancer			
	Never Smoked[b]		
	No. of Cases/Controls	RR1	RR2
Years of Dim Sum[c]			
10	14/23	1.00	1.00
1–9	16/54	0.49	0.36
0	58/60	1.59	1.22
Trend *P* value		0.794	0.998
Times/month of Dim Sum[c]			
>15	15/30	1.00	1.00
1–15	15/47	0.64	0.52
<1	58/60	1.93	1.71
Trend *P* value		0.351	0.448
Frequency (times/wk) of home-cooked soup			
1+	54/84	1.00	1.00
<1	34/53	1.00	1.15
Trend *P* value		0.170	0.240
Corn oil for cooking			
Yes	9/36	1.00	1.00
No	79/101	3.13 (1)	2.65 (2)
Trend *P* value		0.005	0.025
Last household size[d] (no. of people)			
>7	23/38	1.00	1.00
4–6	43/73	0.97	1.01
3	22/26	1.40	1.41
Trend *P* value		0.334	0.545
Lifetime weighted average household size[e] (no. of people)			
>6	27/61	1.00	1.00
4.51–6	30/41	1.65	1.85
<4.5	31/35	2.00 (3)	2.36 (4)
Trend *P* value		0.019	0.009

a: RR1, unadjusted odds ratio; RR2, odds ratio adjusted for age, no. of live births, and schooling (+/−).
b: Gives 95% confidence intervals as follows (no. in parentheses): (1) 1.44–7.29, (2) 1.13–6.20, (3) 1.02–4.27, (4) 1.00–5.55.
c: Dim Sum, Cantonese style of cooking where small dishes of savory and sweet items are consumed with large amounts of tea in a restaurant.
d: No. of people living and eating together in a family.
e: Σ (No. of family members, multiplied by no. of years lived together from birth) divided by age.

indirect indicator of poorer dietary quality and variety in the past, then the effects of a poorer "current" diet led to higher adjusted RR of 3.9.

Discussion

This study attempted to see whether diet influenced the risk for lung cancer among Chinese females in Hong Kong who never smoked. The 88 patients and 137 district controls were interviewed about their current frequency of consumption of a list of food items and beverages in addition to certain social variables that would indirectly reflect on dietary habits or life-styles.

In terms of current consumption patterns, fresh fruit and fresh fish were found to confer protection to those who reported the highest frequencies of eating them. Those at the lowest tertile levels of consumption had adjusted RR values of 2.4 for fruit and 2.8 for fish. These risk patterns showed statistically significant trends of dose response.

Table 5. Food Habits and Last Household Size Among Control Subjects Who Never Smoked

	Frequency[a] of Consumption by Last Household Size			
	Large (≥ 6 people) (n = 66)	Medium (4–5 people) (n = 42)	Small (1–3 people) (n = 29)	Trend P value[b]
Food items/groups				
Cruciferous vegetables	2.70	2.52	2.41	0.176
Fresh leafy green vegetables	5.54	5.48	5.21	0.029
Carrots	2.83	2.74	2.79	0.775
Beans/legumes	2.54	2.74	2.45	0.915
Tofu/soy products	3.08	3.24	3.07	0.778
Fresh fruit	4.73	4.67	4.55	0.442
Fresh fish	5.11	4.90	4.93	0.051
Dried/salted fish	2.85	2.60	2.34	0.046
Smoked/cured meat/poultry	3.00	2.69	2.62	0.010
Spices and sauces				
Monosodium glutamate at home	2.08	2.17	1.31	0.106
Fermented fish/shrimp sauce	2.14	2.12	1.90	0.224
Fermented beans/sauces	3.02	3.12	2.31	0.001
Chili, fresh and sauce	1.89	2.00	1.48	0.509
Pickled vegetables	3.18	3.33	3.21	0.542
Beverages				
Milk (1 cup)	2.02	2.24	2.31	0.494
% Any alcohol	26%	19%	14%	0.044
% Any tea	61%	64%	62%	0.467
Eating habits				
Years of Dim Sum	6.32	2.81	6.34	0.142
Times/month of Dim Sum	19.92	12.95	14.42	0.026
Lifetime weighted household size	6.56	5.53	5.44	0.007
Nutrient indexes				
β-Carotene	3.40	3.37	3.21	0.185
Retinol	3.32	3.25	3.19	0.121
Calcium	3.32	3.31	3.19	0.061
Vitamin C	3.88	3.85	3.65	0.123
"Good diet"	3.58	3.59	3.49	0.330

a: Frequency categories for first 15 items were as follows: 0, never; 1, <1/month; 2, 1-3/month; 3, 1-4/week; 4, 5-7/week; 5, ≥2/day.
b: Trend significance level derived from regression on last household size.

When the cases were analyzed by histological type, it was a surprise to find that those with adenocarcinoma or large cell tumors were more affected by diet than those with squamous or small cell tumors. The P values for trends indicating protection from lung cancer were statistically significant, or nearly so, when the consumption of fresh leafy green vegetables, carrots, tofu/soy products, fresh fruit, and fresh fish increased among those with adenocarcinoma or large cell tumors. By comparison, only the consumption of fresh fruit was protective, whereas the consumption of smoked meats/poultry or pickled vegetables increased the risk for squamous or small cell tumors.

These findings contrast with those from other studies, which report that the protective effects of diet were only found for squamous cell tumors and not in adenocarcinomas (19,20) or were stronger in squamous cell tumors than in adenocarcinomas (16,24). Perhaps this is due to the fact that the subjects in those studies were mostly Caucasian males who had a previous history of active smoking.

In the same way, when the foods were grouped by those sharing larger amounts of certain

Table 6. Relative Risks[a] for Lung Cancer by Fruit Consumption and Lifetime Weighted Household Size

	Lifetime Weighted Household Size[b]						Trend P Value	
	Large (> 6 people)		Medium (4.5–6 people)		Small (< 4.5 people)			
	RR1	RR2	RR1	RR2	RR1	RR2	RR1	RR2
Fruit intake								
More	1.00	1.00	1.56	1.97	1.54	2.05	0.45	0.18
(≥5 Times/week)	(15/41)[c]		(16/28)		(13/23)			
Less	1.64	1.75	2.94 (1)	4.16 (2)	4.10 (3)	5.77 (4)	0.01	0.01
(<5 Times/week)	(12/20)		(14/13)		(18/12)			
Trend *P* value	0.04	0.02	0.03	0.02	0.56	0.38		

a: RR1, unadjusted odds ratio; RR2, odds ratio adjusted for age and schooling (+/−). *P* value of trend by exact values of RR1 and RR2.
b: Gives 95% confidence intervals (no. in parentheses) of RR1 and RR2 as follows: (1) 1.29–11.02, (2) 1.37–12.61, (3) 1.83–15.00, (4) 1.91–17.40.
c: No. of cases/no. of controls.

Table 7. Relative Risks[a] for Lung Cancer by Consumption of Fresh Foods and Lifetime Weighted Household Size

	Lifetime Weighted Household Size[b]							
	Large (>6 people)		Medium (4.5–6 people)		Small (<4.5 people)		Trend P Value	
	RR1	RR2	RR1	RR2	RR1	RR2	RR1	RR2
"Good diet"[c]								
More	1.00	1.00	1.28	1.51	1.62	1.68	0.22	0.03
	(16/37)[d]		(15/27)		(14/20)			
Less	1.06	0.94	2.48 (1)	3.10 (2)	2.62 (3)	3.94 (4)	0.11	0.02
	(11/24)		(15/14)		(17/15)			
Trend P value	0.12	0.10	0.10	0.03	0.10	0.04		

a: RR1, unadjusted odds ratio; RR2, odds ratio adjusted for age and schooling (+/−). P value of trend by exact values of RR1 and RR2.
b: Gives 95% confidence intervals (no. in parentheses) of RR1 and RR2 as follows: (1) 1.10–8.49, (2) 1.08–8.85, (3) 1.26–9.17, (4) 1.39–11.20.
c: Good diet, average frequency per month of the following: cruciferous vegetables, leafy green vegetables, carrots, beans/legumes, fruit, soy products, milk, fresh fish, and soup.
d: No. of cases/no. of controls.

nutrients, foods with vitamin C, retinol, and calcium seemed to confer the most protection, especially to those with adenocarcinoma or large cell lung cancers. Studies in the US (20,22) did not find any effect of vitamin C on lung cancer risk, and no one has reported about calcium and lung cancer. Because the population in Hong Kong consumes different foods than western populations and because such traditional food items such as pickled vegetables and salted or preserved fish, meats, and poultry formed a large part of the cuisine before the advent of refrigeration, the local intake of *N*-nitroso compounds might be higher than those on Euro-American diets. Thus, the protective action of vitamin C would depend on the other components of the local diet which may act as cocarcinogens, and these effects would differ, according to the geographic or cultural context of the population.

The possible protective effects of calcium were interesting because a previous study on nutrient intakes of people in Hong Kong (31) showed that the calcium intake levels in this population were well below the current recommended dietary allowances. On the other hand, the local intake levels of protein, carbohydrates, phosphorus, iron, thiamine, and ascorbic acid were similar to the intakes of those in western countries. Physiologically, it is known that calcium ions (Ca^{2+}) act as intracellular messengers and help to mediate the growth of cells (32). A study by Garland and colleagues (33) reported that higher dietary intakes of calcium reduced the risk for colorectal cancer. The role of calcium in cancer needs further research, and its effects may be more pronounced in populations who are generally deficient of this mineral. It may also be difficult to discriminate whether it is the vitamin A precursors, carotenoids, in leafy green vegetables that are protective or calcium because in Hong Kong, and in other countries where people do not consume dairy products, vegetables may be a major source of dietary calcium. The Hong Kong study (31) found vegetables to be the second most important source of dietary calcium; the first was from poultry and fish products.

This study also looked at variables that directly or indirectly inferred attitudes toward healthy eating or were correlated with healthier eating patterns. People in households that used corn oil for cooking had significantly lower RR values than did those who used other types of oil. It is unlikely that the nutrient qualities of corn oil is conferring the 2.7–3.1 times reduction in risk found in this study. Corn oil was only recently introduced into Hong Kong and has been popularly consumed for about five years. It is possible that the use of corn oil reflected the household's attitude in modifying cooking behavior mostly for health benefits rather than for reasons of the palate. This is because the usual alternative, peanut oil, is the same price, is more fragrant, and is the traditionally preferred type of cooking oil. This is because peanut oil can reach hotter temperatures than corn oil and can therefore better seal in the juices of foods when stir-frying.

The dietary significance of household size was also explored, and it was shown that women in larger households had better diets than those in smaller households. In general, the variety of foods in the diet, and the frequency of consumption of fresh foods (e.g., fruit, vegetables, and fish), increased as the household size increased. This is because with more family members eating together, more dishes of food would be prepared for each meal, the labor of purchasing and cooking the food could be shared, and there would be more economic and psychological incentives to cook and eat together. For example, the general rule of planning a meal at home or ordering at a Chinese restaurant states that the number of dishes should equal the number of people eating together, plus a soup. Thus, the larger the numbers of people who eat together, the greater the number of dishes and, therefore, variety of foods in the diet.

From data collected on residence patterns since birth for each subject, the lifetime weighted household size was estimated. Because it is difficult to accurately gather information on dietary patterns 20, 30, or 40 or more years ago, the variable, lifetime weighted household size, could be used as a surrogate index of past dietary patterns. Specifically, larger household sizes would indirectly signify more variety of foods in the diet and greater frequencies of consuming fresh foods, both of which are known to be generally protective against cancer.

This index of past dietary patterns was analyzed in combination with each of the food items and groups elicited in the interviews. The results from lifetime weighted household size and fruit indicated that those subjects from smaller households and the less-frequent consumers of fruit were 4.1–5.8 times more likely to get lung cancer than those from larger households and who were more frequent eaters of fruit. The data were generally consistent in showing that as household size or fruit intake decreased, the RR increased in a dose-response manner.

Similarly, when the lifetime weighted household size was combined with the average consumption frequency per month of items that would constitute a Good Diet (i.e., cruciferous vegetables, leafy green vegetables, carrots, beans/legumes, fruit, soy products, milk, fresh fish, and soup), the trend P values for the adjusted RR values were all ≤ 0.10. It was clear that risks from a poorer current diet combined with an index of poorer past diet (i.e., smaller lifetime weighted household size) led to consistent increases in RR. The adjusted RR for medium and small lifetime weighted household sizes were 3.1 and 3.9, respectively. However, those subjects having a poorer current diet but a better past diet (larger lifetime weighted household size) had an RR value of around 1.00. This shows that better past diets could compensate for the effects of poorer current diets.

Conclusion

In conclusion, the results of this study were consistent with the findings of other retrospective case-control studies of lung cancer and diet by showing that the consumption of fruit and vegetables and food sources rich in vitamin A (β-carotene and retinol) were generally protective. Moreover, these results support the strong role of diet in lung cancer risk, especially among those without a history of active smoking. Unlike the ambiguities surrounding epidemiological studies on environmental tobacco smoke and lung cancer, in which our previous analysis among the same group of subjects (11,12) found unclear relationships, the analysis in this study found many statistically significant and dose-response results. Certain dietary items were strongly protective among Chinese women who never smoked; also, in contrast to all the other studies, the effects of diet were mostly confined to lung tumors of the adenocarcinoma or large cell types.

This report also attempted to develop the idea that the lifetime weighted household size could be used as a surrogate measure of past dietary habits. Larger household sizes were correlated with more frequent consumption of fresh foods and a larger variety of foods. These consumption patterns are generally protective of cancer. However, the usefulness and validity of this index needs corroboration from other studies. But, with the exception of societies facing extremes of malnutrition and starvation (where larger household sizes are correlated with extreme poverty and deprivation), the correlation of larger household sizes with better diets might be applicable to other urbanized societies and may be useful in retrospective studies on diet and cancer.

Acknowledgments and Notes

The author thanks J.F. Fraumeni, Jr., W.J. Blot, J.H. Lubin, and B.J. Stone (Epidemiology and Statistics Program, US National Cancer Institute, NIH, Bethesda, MD) and J.H-C. Ho (Dept. of Surgery, Univ. of Hong Kong) for their invaluable help in the analysis of this report. The author also thanks C.Y. Ho and K. Li for assistance in computer programming and T. Lam, A. Chow, M. Chi, and M. Cheung for secretarial assistance. This work was supported by the Hong Kong Anti-Cancer Society and the US National Cancer Institute's Fogarty

International Center. This work was presented at the Fifth Symposium on Epidemiology and Cancer Registries in the Pacific Basin (Kauai, Hawaii) in Nov. 1986.

Submitted 21 October 1987; accepted in final form 11 December 1987.

References

1. Hong Kong Cancer Registry: *Cancer Incidence in Hong Kong, 1982.* Kowloon, Hong Kong: Hong Kong Government's Medical and Health Department Institute of Radiology and Oncology, Queen Elizabeth Hospital, 1982.
2. Koo, LC, Ho, JH-C, and Lee, N: "An Analysis of Some Risk Factors for Lung Cancer in Hong Kong." *Int J Cancer* **35,** 149–55, 1985.
3. Koo, LC, Ho, JH-C, and Saw, D: "Active and Passive Smoking Among Female Lung Cancer Patients and Controls in Hong Kong." *J Exp Clin Cancer Res* **4,** 367–375, 1983.
4. Hirayama, T: "Non-Smoking Wives of Heavy Smokers Have a Higher Risk of Lung Cancer: A Study From Japan." *Br Med J* **282,** 183–185, 1981.
5. Trichopoulos, D, Kalandidi, A, Sparros, L, and MacMahon, B: "Lung Cancer and Passive Smoking." *Int J Cancer* **27,** 1–4, 1981.
6. Correa, P, Pickle, LW, Fontham, E, Lin, Y, and Haenszel, W: "Passive Smoking and Lung Cancer." *Lancet* **2,** 595–597, 1983.
7. Knoth, A, Bohn, H, and Schmidt, F: "Passivrauchen als Lungenkrebsursache bei Nichtraucherinnen." *Med Klin Prax* **78,** 54–59, 1983.
8. Miller, GH: "Cancer, Passive Smoking and Nonemployed and Employed Wives." *West J Med* **140,** 632–635, 1984.
9. Garfinkel, L, Auerbach, O, and Joubert, L: "Involuntary Smoking and Lung Cancer: A Case-Control Study." *JNCI* **75,** 463–469, 1985.
10. Akiba, S, Kato, H, and Blot, WJ: "Passive Smoking and Lung Cancer Among Japanese Women." *Cancer Res* **46,** 4804–4807, 1986.
11. Koo, LC, Ho, JH-C, and Saw, D: "Is Passive Smoking an Added Risk Factor for Lung Cancer in Chinese Women?" *J Exp Clin Cancer Res* **3,** 277–283, 1984.
12. Koo, LC, Ho, JH-C, Saw, D, and Ho, C-Y: "Measurements of Passive Smoking and Estimates of Lung Cancer Risk Among Non-Smoking Chinese Females." *Int J Cancer* **39,** 162–169, 1987.
13. Koo, LC, Ho, JH-C, and Rylander, R: "Lifehistory Correlates of Environmental Tobacco Smoke: A Study on Non-Smoking Hong Kong Chinese Wives With Smoking vs. Non-smoking Husbands." *Soc Sci Med.* In press.
14. Committee on Diet, Nutr & Cancer, Assembly of Life Sciences, National Research Council: *Diet, Nutrition, and Cancer.* Washington, DC: National Academy Press, 1982.
15. Ames, BN: "Dietary Carcinogens and Anticarcinogens." *Science* **221,** 1256–1264, 1983.
16. Ziegler, RG, Mason, TJ, Stemhagen, A, Hoover, R, Schoenberg, JB, et al.: "Carotenoid Intake, Vegetables, and the Risk of Lung Cancer Among White Men in New Jersey." *Am J Epidemiol* **123,** 1080–1093, 1986.
17. Hirayama, T: "Diet and Cancer." *Nutr Cancer* **1,** 67–81, 1979.
18. MacLennan, R, Da Costa, J, Day, NE, Law, CH, Ng, YK, et al.: "Risk Factors for Lung Cancer in Singapore Chinese, a Population With High Female Incidence Rates." *Int J Cancer* **20,** 854–860, 1977.
19. Byers, T, Graham, S, Haughey, BP, Marshall, JR, and Swanson, MK: "Diet and Lung Cancer Risk: Findings From the Western New York Diet Study." *Am J Epidemiol* **125,** 351–363, 1987.
20. Byers, T, Vena, J, Mettlin, C, Swanson, M, and Graham, S: "Dietary Vitamin A and Lung Cancer Risk: An Analysis by Histologic Subtypes." *Am J Epidemiol* **120,** 769–776, 1984.
21. Samet, JM, Skipper, BJ, Humble, CG, and Pathak, DR: "Lung Cancer Risk and Vitamin A Consumption in New Mexico." *Am Rev Respir Dis* **131,** 198–202, 1985.
22. Hinds, MW, Kolonel, LN, Hankin, JH, and Lee, J: "Dietary Vitamin A, Carotene, Vitamin C and Risk of Lung Cancer in Hawaii." *Am J Epidemiol* **119,** 227–237, 1984.
23. Mettlin, C, Graham, S, and Swanson, M: "Vitamin A and Lung Cancer." *JNCI* **62,** 1435–1438, 1979.
24. Kvale, G, Bjelke, E, and Gart, JJ: "Dietary Habits and Lung Cancer Risk." *Int J Cancer* **31,** 397–405, 1983.
25. Shekelle, RB, Lepper, M, Liu, S, Maliza, C, Raynor, WJ, Jr, et al.: "Dietary Vitamin A and Risk of Cancer in the Western Electric Study." *Lancet* **2,** 1185–1189, 1981.
26. Gregor, A, Lee, PN, Roe, FJC, Wilson, MJ, and Melton, A: "Comparison of Dietary Histories in Lung Cancer Cases and Controls With Special Reference to Vitamin A." *Nutr Cancer* **2,** 93–97, 1980.
27. World Health Organization: "The World Health Organization Histological Typing of Lung Tumours, 2nd Edition." *Am J Clin Pathol* **77,** 123–136, 1982.
28. Breslow, NE, and Day, NE: *Statistical Methods in Cancer Research.* Lyon, France: IARC, 1980. (IARC Sci Publ No 32.)
29. Lubin, JH: "A Computer Program for the Analysis of Matched Case-Control Studies." *Comp Biomed Res* **14,**

138–143, 1981.
30. Koo, LC: "The Use of Food to Treat and Prevent Disease in Chinese Culture." *Soc Sci Med* **18,** 757–766, 1984.
31. Newcombe, K: "Apparent Consumption and Socio-Economic Distribution of Nutrients in an Urban Settlement: Hong Kong." *Ecol Food Nutr* **6,** 9–22, 1977.
32. Rasmussen, H: "The Calcium Messenger System." *N Engl J Med* **316,** 1094–1101, 1986.
33. Garland, C, Shekelle, RB, Barrett-Connor, E, Criqui, MH, Rossof, AH, et al.: "Dietary Vitamin D and Calcium and Risk of Colorectal Cancer: A 19-Year Prospective Study in Men." *Lancet* **1,** 307–309, 1985.