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An Ecological Study of Trends in Cancer Incidence and Dietary Changes in Hong Kong

Linda C. Koo, Oscar W. K. Mang, and John H.-C. Ho

Abstract: *Cancer incidence rates from the Hong Kong Cancer Registry show significant increases in lung and colon cancers and decreases in nasopharyngeal cancer in both sexes from 1973 to 1992. Moreover, cervical cancer and male esophageal cancer have declined significantly, and changes in the trends of cancer of the following sites were of borderline significance: decreasing male laryngeal and female esophageal cancers and increasing prostate and female breast cancers. These changes have occurred along with dietary shifts in the population, from a diet predominantly of rice and small portions of meat, vegetables, and fish to one with larger portions of all foods but rice and eggs. The latter data were gathered from six government household surveys from 1963–64 to 1994–95. By combining the two data sets, correlation coefficients were calculated for per capita consumption patterns of eight foods (rice, pork, beef, poultry, saltwater fish, freshwater fish, fresh vegetables, and eggs) and cancer incidence data of the same year or 10 years later. Higher meat intakes were significantly and positively correlated with cancers of the colon, rectum, prostate, and female breast. The correlations also suggested that current diets were more influential than diets a decade before for cancers of the lung, esophagus, rectum, and prostate. Cancers of the nasopharynx and colon were significantly correlated with current and past diets. These results support the hypothesis that intakes of meat and its associated fat are risk factors for colon, rectal, prostate, and female breast cancers.*

Introduction

Over recent decades, dietary habits have been rapidly changing for many urban populations in response to increasing per capita incomes, better preservation and transportation of food, greater use of home appliances, shorter time spent on cooking activities, increasing influence of advertising and marketing of foods on purchasing behavior, and increasing availability in the variety and quantity of fresh and processed foods. Likewise, cancer incidence patterns have changed over the same period. To study these two trends, data from the Hong Kong Cancer Registry were analyzed for 10 major cancer sites among men and women and correlated with changing per capita food patterns from government census surveys of household expenditures. This gives a diachronic view of changes in diet for the average household and provides additional evidence for the relationship between diet and cancer in human populations unfettered by the problem in retrospective case-control studies that subjects tend to recall past food consumption patterns on the basis of current eating habits.

Methods

Cancer incidence data were obtained from the population-based Hong Kong Cancer Registry (1), which has been fully operational since 1965 as part of the government's medical and health services. Because Hong Kong is basically a large metropolitan area, with total land area of 1,071 km^2 and 6.3 million inhabitants in 1996, coverage of new cases, especially since 1973, has been relatively complete, and histopathological verification of the diagnoses by qualified pathologists has been obtained in a majority of cases. Disease classification follows the International Statistical Classification of Diseases, Injuries, and Causes of Death (ICD), and incidence rates used in the analyses were standardized to the world population, as described by the International Agency for Research on Cancer cancer incidence report (2).

Cancer incidence data have been presented in two ways: showing the trends for the 10 most common sites in males and females from 1973 to 1992 and the age-specific curves for each cancer site for three cohorts for 1973, 1980, and 1990. With the former data, we have tested the significance of the change in trend over time using the χ^2 test for trend. With the latter, the age-specific curves will show whether age at diagnosis and incidence has changed over time for cohorts from different decades.

L. C. Koo is affiliated with the Department of Community Medicine and J. H.-C. Ho with the Department of Radiation Oncology, University of Hong Kong, Hong Kong. O. W. K. Mang is affiliated with the Hong Kong Cancer Registry, Radiotherapy and Oncology Department, Queen Elizabeth Hospital, Kowloon, Hong Kong.

Food purchasing behavior, an indirect index of food consumption patterns, was obtained from the Hong Kong government's household expenditure surveys (3), which began in September 1963, were conducted again in July 1973, and were repeated at 5-year intervals starting in 1979, 1984, 1989, and 1994. Each study was conducted over a period of 12 months to take into account seasonal variations in expenditures. Because the government's purpose in conducting these surveys is to establish a consumer price index, which is then used for indexes of inflation, wage increases, and establishing living allowances, sampling for each of the surveys was intended to be representative of all members of the population who were residents and living on land (excluding those living on boats), although the earliest study from 1963–64 has been acknowledged to be biased toward lower-income households (3). The number of households sampled, their representativeness of the entire population, the reliability and validity of the data, and the quality of data analyses have improved with each succeeding survey. For example, 2,793 households participated in the 1963–64 survey vs. 5,591 in the 1994–95 survey.

Two types of data were collected in the surveys: household expenditures and prices for commodities. For household expenditures, the households identified by random stratified sampling were visited by interviewing officers who explained the study, identified a responsible adult to complete the forms, explained how to complete the daily expenditure forms, and gave a cash honorarium for participation. In addition to expenditures for food consumed at home, the amount spent for meals eaten outside the home and purchases of alcoholic drinks and tobacco was recorded. Approximately twice a week, the officer would visit the household to ensure that the daily forms had been completed and to answer any queries. Data on household expenditures would be collected for one month from each household. Additional information on demographic characteristics and regular payments, e.g., water bills, rent, insurance, were registered on other forms through interviews by the officers.

Inflation and the increasing affluence of Hong Kong households over the ≥30-year period have greatly affected monthly household expenditures. For all items, these monthly expenses averaged $621 (in Hong Kong dollar currency) in 1963–64 and $18,904 in 1994–95, and the proportion of money spent for food at home decreased from 36.5% in the earliest survey to 11.2% in the latest. To show these influences, the amount spent for each food item was shown in Hong Kong dollar amounts, and its percentage of the total budget spent for food at home was also shown. The latter is an indirect indicator of the relative amount of money spent for specific food items and may be more useful for studying changes over time, with the trend P values of these percentages showing its statistical significance. Since the early 1980s, the Hong Kong dollar exchange rate was set at $7.8 to $1.00 US.

Starting with the 1973–74 survey, pricing studies were additionally conducted to estimate the cost of retail goods and services. With the aim of establishing prices actually paid by the ultimate consumer, the prices were collected in terms of units for which the commodities are normally purchased. In Hong Kong, the commonly used unit for fresh food is the catty, which is equivalent to 16 taels or 0.6048 kg. For ease of understanding, the price units have been converted from catties to kilograms. For fresh food (e.g., fish, locally slaughtered meat, vegetables), retail prices were collected daily from several local markets. Consumer prices for rice and eggs were sampled weekly from numerous shops and stalls. Where specific items forming the generic food categories were priced, e.g., long- and short-grain rice, different species of fish, better and lower grades of meat, or several types of vegetables, an average of all the prices for foods within the generic food category, i.e., rice, fish, pork/beef/poultry, and vegetables, respectively, was estimated.

To calculate average monthly amounts of a particular food group consumed per person, the monthly expenditure on that item per household was divided by its cost per kilogram and then divided by the average household size for that period. Average household sizes have steadily dropped for each survey period, from a high of 5.9 persons per household in 1963–64 to 5.4 in 1973–74, 4.4 in 1979–80, 4.1 in 1984–85, 3.7 in 1989–90, and 3.5 in 1994–95. The conversion to per person consumption was limited to eight food items with data on prices and corresponding items in the monthly expenditure data.

Statistical analyses of the data were computed using the SPSS software program. χ^2 Tests for trend were calculated for the site-specific cancer incidence rates, proportional expenditures on food at home, and average intakes of eight foods over time to see whether significant changes had occurred. To study the correlation between per capita food intakes for the eight food items and site-specific cancer incidence rates, Pearson correlation coefficients were computed. Because the cancer incidence rates are based on the calendar year, whereas the food intake data were collected for 12 months but overlapped over two calendar years, the cancer incidence data input for the correlation analyses were for the two years corresponding to the years that the household expenditure and price surveys were conducted. Moreover, two correlations were computed: one using the same years of cancer incidence rates with food intakes and another generally using a 10-year lag between food intakes and cancer incidence. The latter was done to take into account the latency period of cancer development. Because of the lack of cancer incidence data for 1994 and 1995, data from 1991 and 1992 were substituted in the correlation analyses. Statistical significance was defined by $p \leq 0.05$.

Results

Trends in male cancer incidence from 1973 to 1992 are shown in Figure 1, and that for females in Figure 2. Among both sexes, the incidence rates for lung and colon cancers significantly increased and nasopharyngeal cancer significantly decreased over the 20-year period. Additionally, there

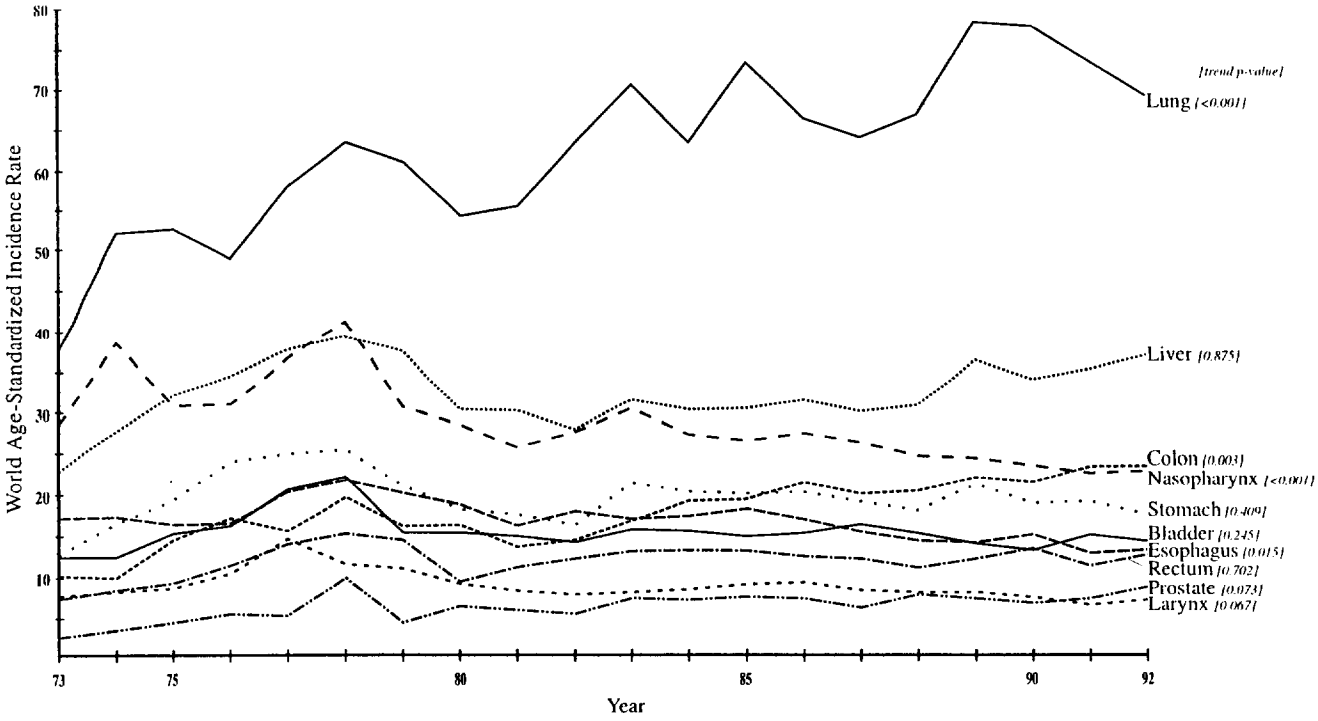

Figure 1. Trends in male cancer incidence in Hong Kong, 1973–1992.

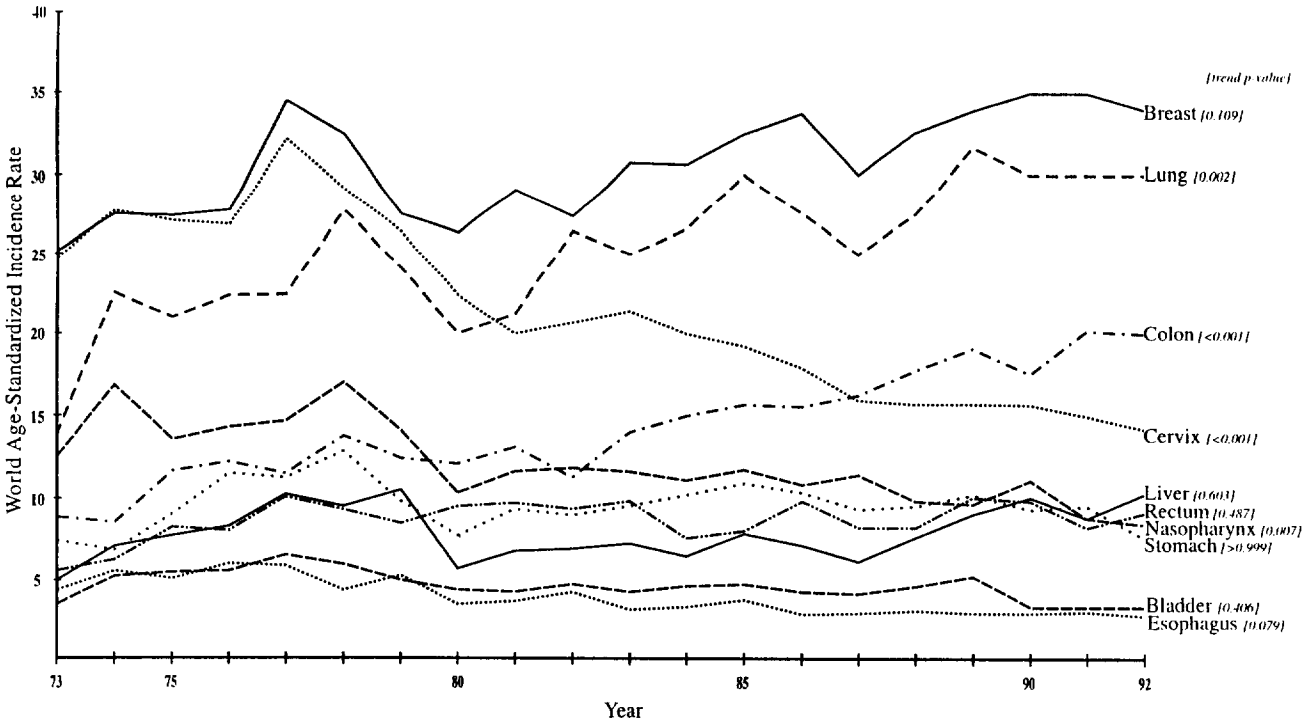

Figure 2. Trends in female cancer incidence in Hong Kong, 1973–1992.

were significant decreases in the incidence of cervical and male esophageal cancers. The trends for the following cancers were of borderline significance: decreasing female esophageal ($p = 0.08$) and male laryngeal ($p = 0.07$) cancers and increasing prostate cancers ($p = 0.07$). The trend for female breast cancer since 1980 was suggestive of an increase, although for the 20-year period the trend was only marginally significant ($p = 0.11$).

Figures 3–6 show the age-specific incidence rates for nine cancer sites for the Hong Kong population in 1973, 1980, and 1990. From Figure 3, it is apparent that the age-specific curves for male and female lung cancer noticeably

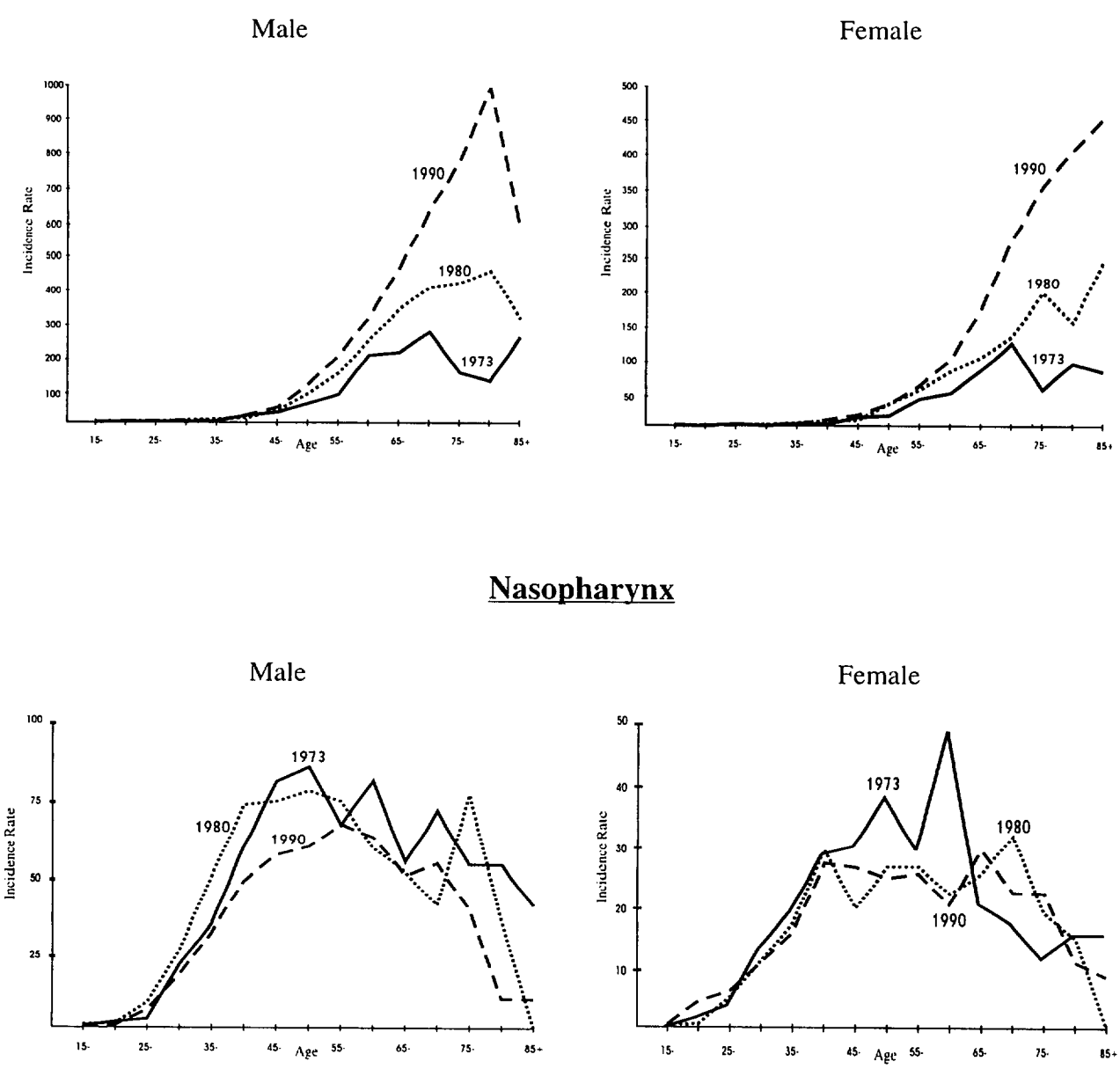

Figure 3. Age-specific incidence of lung and nasopharyngeal cancers by cohorts in 1973, 1980, and 1990. Data are from Hong Kong Cancer Registry.

increased with each succeeding decade. Less obvious but more apparent among the younger-aged 1990 cohort, the curves for nasopharyngeal cancer generally declined. For male nasopharyngeal cancer, the age-specific curve indicated higher incidence among younger men, i.e., those aged 25–45, in 1980 than in 1973, which may suggest earlier diagnosis or earlier development of the tumor, although such patterns were not apparent among women.

For cancers of the colon and rectum in Figure 4, the age-specific curves for both sexes show consistent increases over time. Similarly, the age-specific curves for male and female liver cancer in Figure 5 suggest increasing incidence, whereas those for esophageal cancer show general declines. Finally, Figure 6 shows increasing age-specific curves for succeeding cohorts of prostate and female breast cancers and decreases in cancer of the cervix, especially for the 1990 cohort. Similar age-specific analyses were done for cancers of the larynx, thyroid, bladder, and stomach for both sexes. However, because no noticeable patterns emerged, those values are not shown.

The Hong Kong dollar amounts and its proportion of the total expenditure for food at home from six surveys from 1963–64 to 1994–95 are shown in Table 1. Among the 26 food items/groups, only expenditures on rice showed a significant proportional change, from 15.1% of the total amount spent for food at home in 1963–64 to 3.5% in 1994–95. There were also two trends of borderline significance: egg expenditure seemed to be decreasing ($p = 0.09$) and frozen

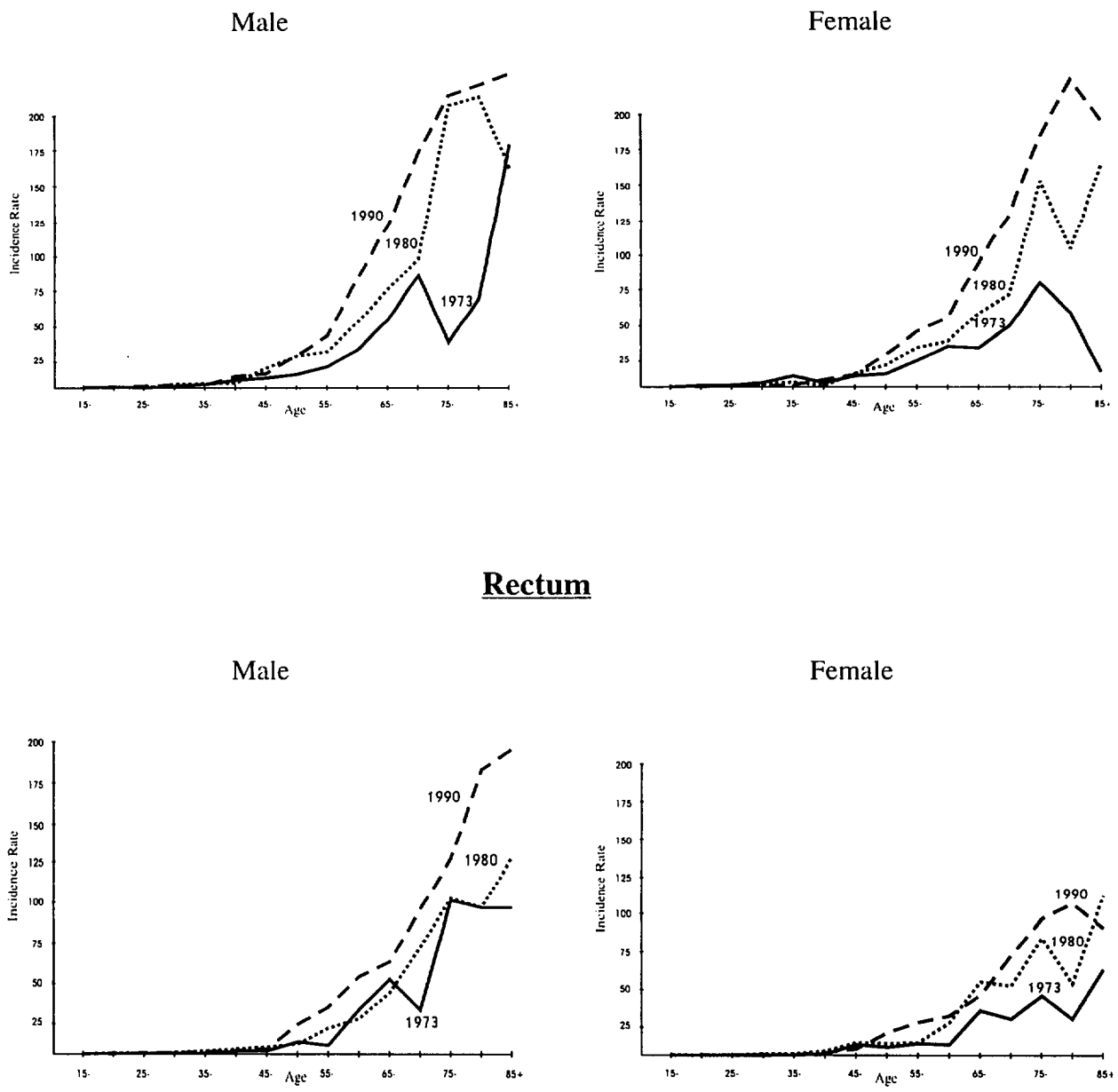

Figure 4. Age-specific incidence of colon and rectal cancers by cohorts in 1973, 1980, and 1990. Data are from Hong Kong Cancer Registry.

meat and poultry expenditures seemed to be increasing ($p = 0.11$).

However, the proportional data from Table 1 assume that prices for each food item increased at similar rates over the ≥30 years. Table 2 shows the price per kilogram of eight food groups/items that were priced by the government surveys. It shows that this assumption is not supported, since the price of rice increased the least over 1973–74 to 1994–95 (2.1 times), whereas that for saltwater fish increased the most (5.6 times). However, the trends in yearly kilograms of intake per person for food consumed at home still showed significant decreases for rice ($p < 0.001$), and there were significant increases in per capita intakes for freshwater fish ($p = 0.038$) and fresh vegetables ($p = 0.006$), with the decreasing egg consumption trend of marginal significance ($p = 0.097$). When a combined analysis of yearly intakes of locally slaughtered pork, beef, and poultry was done, the trend P value of 0.064 for these combined meats showed an increased per capita consumption that was nearly statistically significant.

The expenditure data in Table 3 show the Hong Kong dollar amounts and their proportion of the entire budget spent for food consumed at home, food consumed outside the home, alcoholic drinks, and tobacco. The trends for various alcoholic drinks and tobacco were insignificant. Two trends, however, are clearly apparent: the proportion of the budget

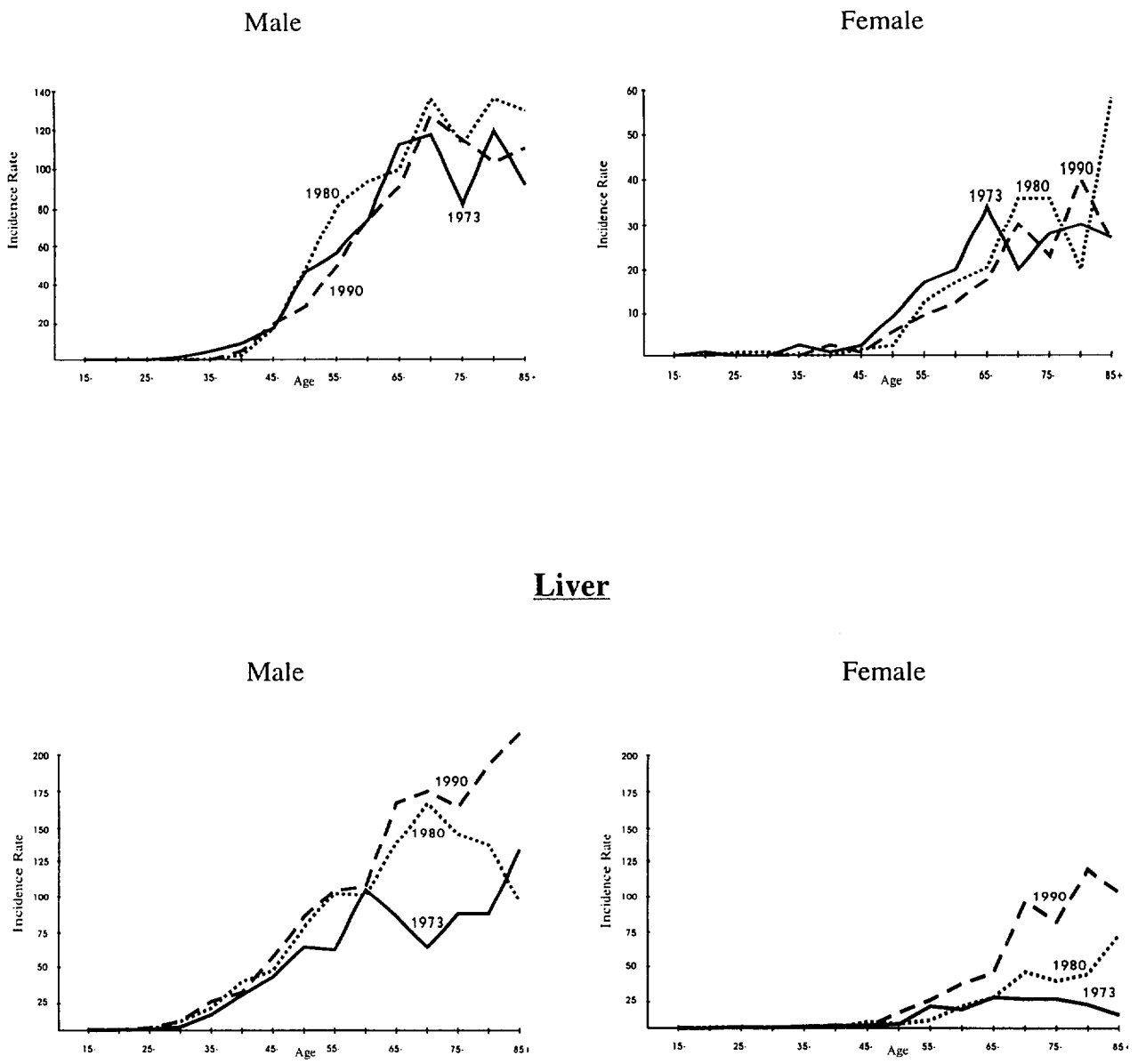

Figure 5. Age-specific incidence of esophageal and liver cancers by cohorts in 1973, 1980, and 1990. Data are from Hong Kong Cancer Registry.

spent for food consumed at home significantly decreased by 69% ($p < 0.001$), whereas that for meals bought away from home increased by 143% ($p = 0.021$). If it is assumed that the overall inflation of both items over time was approximately the same, these values suggest that more meals are eaten outside the home. Yet this also suggests that the significance of food intakes at home as representative of total nutritive intakes also declined over time.

With these caveats in mind and the assumption that most of the diet is consumed at home or that the relative proportions of foods eaten at home are similar to those eaten outside the home, the correlation coefficients of the trend of eight food items with cancer incidence rates for 11 cancer sites are shown in Tables 4–8. In interpreting the large volumes of data, more importance is attached to findings with higher statistical significance and correlations that were consistently significant for both sexes. The analyses for bladder cancer are not shown, because no significant correlations emerged except for egg consumption among males and cancer incidence 10 years later.

Table 4 shows the correlations of food intakes with lung and liver cancer incidence rates. For lung cancer, the same-year correlations with food intake showed that, for men and women, there were significant negative coefficients for rice and positive coefficients for all the other foods except eggs. However, with the exception of pork intakes by females and egg intakes by males, all these correlations became insignificant with a 10-year lag between food intake and lung cancer

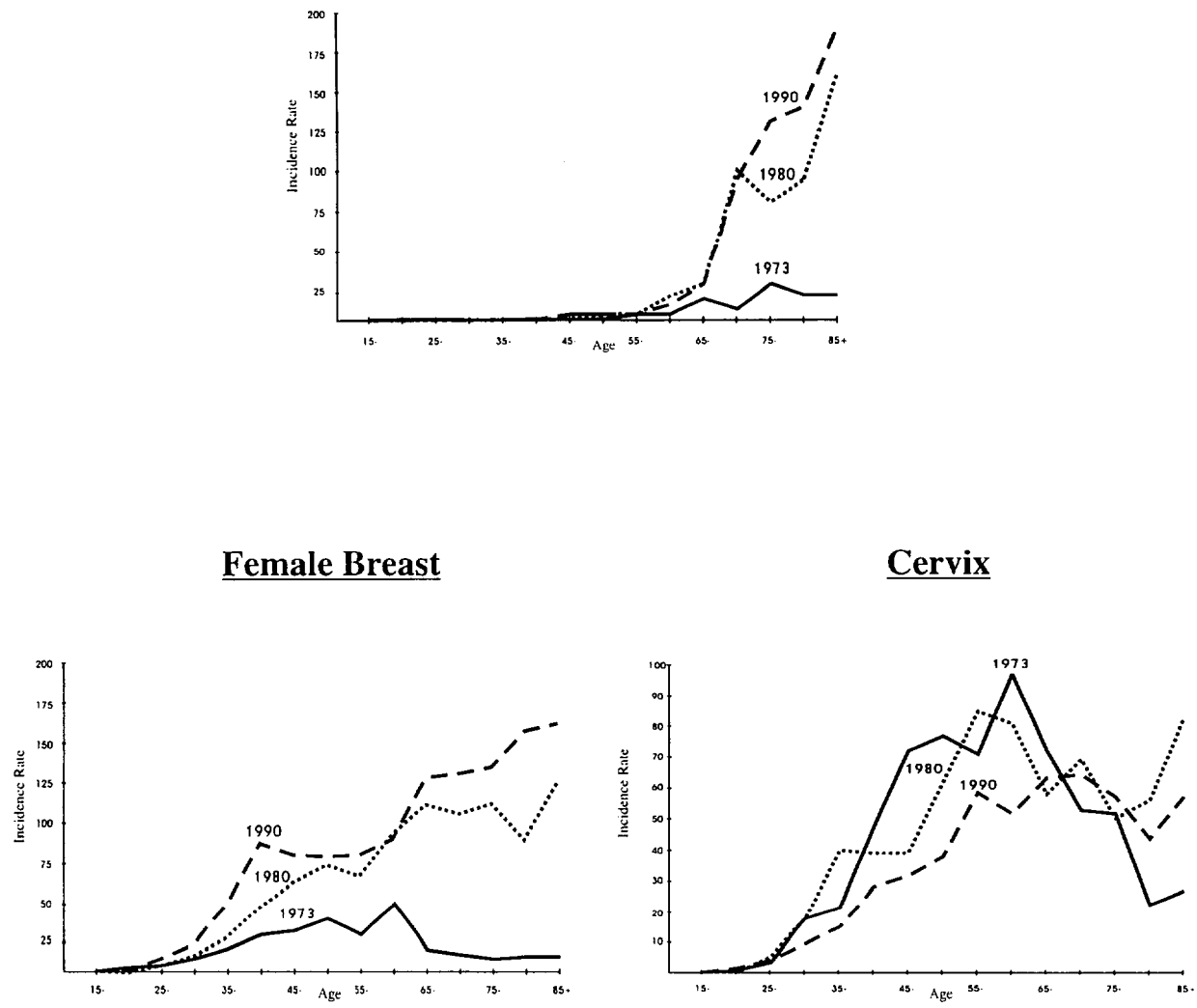

Figure 6. Age-specific incidence of prostate, female breast, and cervical cancers by cohorts in 1973, 1980, and 1990. Data are from Hong Kong Registry.

incidence. These latter two positive correlations may be spurious, since they were isolated and not found for the opposite sex. Overall, however, the differences between same-year and 10-year-lagged correlations may suggest that current diets are more influential for lung cancer incidence than past diets.

The correlations for liver cancer incidence were less consistent between the sexes, with male intakes showing negative associations with rice and positive associations with pork, poultry, fish, and vegetables for the same-year analyses. Similar patterns emerged with a 10-year lag in incidence among males, except freshwater fish and vegetable intakes became insignificant. For females, none of the correlations were significant, except pork intake and liver cancer 10 years later. This lack of coherence between the sexes may suggest that diet is a less significant risk factor for liver cancer in Hong Kong or that the eight food items studied were less relevant for liver cancer etiology.

In Table 5, the same-year correlations of diet with nasopharyngeal and esophageal cancer incidence showed that the correlation coefficients were positive for rice and generally negative for all other foods except eggs for both sexes. For nasopharyngeal cancer in both sexes, the correlations remained significant but generally less so with a 10-year lag between food intakes and cancer incidence. These differences may suggest that past food intakes are still important, although not as important as recent food intakes, for cancer of the nasopharynx. Moreover, higher intakes of meat, e.g., pork, poultry, and fish, are correlated with lower risk, and the effect of fresh vegetable intakes dropped out in the 10-year-lagged data. For the 10-year-lagged esophageal cancer correlations, the male correlations with food became more pronounced and significant, whereas all the correlations for females became insignificant.

In Table 6, the correlations between specific food intakes and colon and rectal cancers were very similar for both sexes when data were analyzed using the same years. For both sites,

Table 1. Monthly Expenditure on Food at Home by Hong Kong Households, 1963–1995[a,b]

	1963–64		1973–74		1979–80		1984–85		1989–90		1994–95		% Trend
	$	%	$	%	$	%	$	%	$	%	$	%	*P* Value[c]
Rice	34.16	15.1	94.50	15.8	63.59	6.7	74.98	5.3	71.33	4.2	73.87	3.5	<0.001
Other cereals and cereal preparations	3.73	1.7	9.60	1.6	14.64	1.6	23.16	1.6	29.76	1.7	34.76	1.7	>0.900
Bread, cakes, and biscuits	12.42	5.5	22.80	3.8	50.31	5.3	94.27	6.6	98.83	5.8	147.74	7.0	0.483
Fish													
Saltwater	12.42	5.5	29.10	4.9	49.69	5.3	82.39	5.8	130.23	7.6	167.29	7.9	0.348
Freshwater	13.04	5.8	32.80	5.5	49.17	5.2	71.98	5.1	83.82	4.9	121.67	5.8	>0.900
Other fresh sea products	3.11	1.4	18.50	3.1	35.91	3.8	41.28	2.9	73.80	4.3	73.87	3.5	0.422
Sea product preparations	5.59	2.5	4.50	0.8	14.06	1.5	42.63	3.0	63.68	3.7	95.60	4.5	0.162
Pork, locally slaughtered	25.46	11.2	68.40	11.4	97.83	10.3	143.91	10.1	161.49	9.4	210.74	10.0	0.657
Beef, locally slaughtered	9.94	4.4	19.50	3.3	29.20	3.1	45.97	3.2	50.19	2.9	56.49	2.7	0.570
Other fresh meat					4.28	0.5	6.08	0.4	5.69	0.3	4.35	0.2	0.804
Live poultry	16.15	7.1	28.10	4.7	45.32	4.8	65.81	4.6	80.47	4.7	99.94	4.7	0.544
Meat and poultry													
Frozen			17.20	2.9	30.76	3.3	36.52	2.6	70.74	4.1	86.90	4.1	0.105
Tinned			8.20	1.4	8.93	0.9	10.23	0.7	8.23	0.5	8.69	0.4	>0.900
Meat, others	11.18	4.9	33.50	5.6	55.73	5.9	79.17	5.6	77.89	4.5	80.39	3.8	0.657
Vegetables													
Fresh	22.98	10.1	64.00	10.7	95.66	10.1	141.94	10.0	180.20	10.5	232.47	11.0	0.869
Processed	3.10	1.4	5.50	0.9	8.13	0.9	9.36	0.7	10.15	0.6	10.86	0.5	0.555
Fruits													
Fresh	10.56	4.7	39.00	6.5	88.66	9.4	142.35	10.0	162.66	9.5	186.85	8.9	0.213
Processed	0.62	0.3	3.80	0.6	8.23	0.9	9.89	0.7	11.19	0.7	8.69	0.4	>0.900
Dairy products	7.45	3.3	14.60	2.4	25.16	2.7	43.00	3.0	58.29	3.4	86.90	4.1	0.664
Eggs	10.56	4.7	17.00	2.8	17.21	1.8	23.99	1.7	24.22	1.4	21.73	1.0	0.086
Edible oils	6.83	3.0	18.20	3.0	28.14	3.0	43.69	3.1	39.17	2.3	47.80	2.3	0.721
Soft drinks and beverages	4.35	1.9	11.30	1.9	45.85	4.8	64.46	4.5	66.29	3.9	91.25	4.3	0.299
Sugar	1.86	0.8	3.90	0.7	4.89	0.5	5.52	0.4	4.71	0.3	4.35	0.2	0.566
Confectionery	1.86	0.8	6.60	1.1	21.05	2.2	36.26	2.6	36.57	2.1	32.59	1.5	0.586
Flavorings and additives			5.60	0.9	9.89	1.0	16.34	1.2	16.25	1.0	21.73	1.0	0.579
Foods, others	9.32	4.1	21.60	3.6	44.99	4.8	68.79	4.8	98.81	5.8	104.29	4.9	0.586
Total	226.69	100.0	597.80	99.9[d]	947.28	100.0	1,423.97	100.0	1,714.66	99.9[d]	2,111.81	100.0	

a: Values are expressed in dollars ($) and as percentage of food bill.

b: Data are from Government Census and Statistics Department General Household Surveys.

c: χ^2 Test.

d: Some percentages may not add up to 100% because of rounding off.

Table 2. Average Intake per Person for Food at Home in Hong Kong, 1973–1995[a]

	1973–74		1979–80		1984–85		1989–90		1994–95		Trend
	Price/kg	kg/person/mo	Price/kg	kg/person/mo	Price/kg	kg/person/mo	Price/kg	kg/person/mo	Price/kg	kg/person/mo	*P* Value[b]
Rice	3.12	5.62	3.01	4.81	4.49	4.07	5.55	3.48	6.67	3.17	<0.001
Pork, locally slaughtered	12.94	0.98	17.56	1.27	23.32	1.39	28.76	1.52	43.12	1.40	0.346
Beef, locally slaughtered	12.82	0.28	17.30	0.38	23.18	0.48	28.90	0.47	41.99	0.38	0.702
Live poultry	11.15	0.47	16.69	0.62	19.58	0.82	24.08	0.90	29.63	0.96	0.129[c]
Fish											
Saltwater	10.92	0.49	19.57	0.58	29.29	0.69	44.55	0.79	61.54	0.78	0.355
Freshwater	12.44	0.49	20.32	0.55	21.46	0.82	24.58	0.92	29.63	1.17	0.038
Fresh vegetables	2.96	4.01	5.34	4.07	7.85	4.41	8.69	5.60	11.45	5.80	0.006
Hen eggs[e]	0.31[d]	10.16	0.35[d]	11.18	0.57[d]	10.27	0.68[d]	9.63	0.67[d]	9.27	0.097

a: Data are from Government Census and Statistics Department General Household Surveys.
b: χ^2 Test for trend of kg/person/yr.
c: For pork + beef + poultry, p (trend) = 0.064.
d: Price for 1 egg.
e: Price/egg and eggs/person/mo.

Table 3. Monthly Expenditure on Food at Home, Meals Bought Away From Home, Alcoholic Drinks, and Tobacco by Hong Kong Households, 1963–1995[a,b]

	1963–64		1973–74		1979–80		1984–85		1989–90		1994–95		% Trend
	$	%	$	%	$	%	$	%	$	%	$	%	*P* Value[c]
Food at home	226.69	36.5	597.80	38.3	947.28	21.1	1,423.97	19.0	1,714.66	15.0	2,111.81	11.2	<0.001
Meals bought away from home	46.58	7.5	211.50	13.6	767.28	17.1	1,450.29	19.3	2,187.11	19.2	3,439.26	18.2	0.021
Beer			4.50	0.3	11.58	0.3	20.10	0.3	24.01	0.2	28.24	0.2	0.856
Chinese wine	3.11	0.5	5.10	0.3	9.17	0.2	9.41	0.1	7.30	0.1	6.52	0.03	0.560
Foreign-style alcoholic drinks	1.86	0.3	5.10	0.3	15.75	0.4	19.71	0.3	22.99	0.2	21.73	0.1	0.869
All tobacco	13.04	2.1	21.10	1.4	53.69	1.2	86.71	1.2	100.03	0.9	147.74	0.8	0.463
Subtotal	291.28	46.9	845.10	54.2	1,804.75	40.3	3,010.19	40.2	4,056.10	36.0	5,755.30	30.4	
Others (e.g., transportation)	329.72	53.1	715.50	45.8	2,676.00	59.7	4,488.76	59.8	7,350.85	64.4	13,148.67	69.5	
Total monthly expenditure	621	100	1,560.60	100	4,480.75	100	7,498.95	100	11,406.95	100	18,903.97	100	

a: Values are expressed in dollars ($) and as percentage of total monthly expenditure.
b: Data are from Government Census and Statistics Department General Household Surveys.
c: χ^2 Test for trend.

Table 4. Correlation Coefficients of Food Intake at Home (1973–1995[a]) With Lung and Liver Cancer Incidence Rates

	Lung Cancer								Liver Cancer							
	Male				Female				Male				Female			
	Same year[b]		10-yr lag[c]		Same year[b]		10-yr lag[c]		Same year[b]		10-yr lag[c]		Same year[b]		10-yr lag[c]	
	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value
Rice	–0.89	0.001	–0.36	0.485	–0.88	0.001	–0.75	0.087	–0.74	0.014	–0.88	0.022	–0.60	0.065	–0.77	0.070
Pork	0.92	0.000	0.51	0.297	0.85	0.002	0.84	0.036	0.74	0.014	0.92	0.009	0.61	0.062	0.86	0.030
Beef	0.80	0.006	0.34	0.508	0.72	0.018	0.74	0.094	0.48	0.164	0.87	0.024	0.39	0.263	0.76	0.077
Poultry	0.90	0.000	0.27	0.612	0.89	0.001	0.68	0.134	0.70	0.024	0.84	0.038	0.57	0.085	0.72	0.110
Fish																
Saltwater	0.92	0.000	0.27	0.602	0.89	0.001	0.69	0.130	0.71	0.022	0.84	0.037	0.59	0.072	0.72	0.107
Freshwater	0.78	0.008	0.04	0.942	0.81	0.004	0.50	0.309	0.63	0.050	0.70	0.120	0.51	0.132	0.55	0.263
Fresh vegetables	0.77	0.009	0.01	0.984	0.77	0.010	0.48	0.338	0.66	0.037	0.68	0.135	0.57	0.088	0.52	0.289
Eggs	–0.50	0.144	0.84	0.035	–0.56	0.093	0.62	0.190	–0.25	0.482	0.41	0.414	–0.25	0.494	0.57	0.236

a: kg of food/person/mo for 1973–74, 1979–80, 1984–85, 1989–90, and 1994–95.
b: Direct correlation of food intake and world age-adjusted cancer incidence in generally the same year, i.e., 1973–74, 1984–85, 1989–90, and 1991–92.
c: Food intake correlated with world age-adjusted cancer incidence data, generally 10 yrs later, i.e., 1983–84, 1989–90, and 1991–92.

Table 5. Correlation Coefficients of Food Intake at Home (1973–1995[a]) With Nasopharyngeal and Esophageal Cancer Incidence Rates

	Nasopharyngeal Cancer								Esophageal Cancer							
	Male				Female				Male				Female			
	Same year[b]		10-yr lag[c]		Same year[b]		10-yr lag[c]		Same year[b]		10-yr lag[c]		Same year[b]		10-yr lag[c]	
	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value
Rice	0.86	0.001	0.87	0.023	0.83	0.003	0.85	0.034	0.70	0.023	0.98	0.001	0.84	0.003	0.62	0.190
Pork	–0.81	0.005	–0.92	0.010	–0.77	0.009	–0.83	0.039	–0.42	0.232	–0.98	0.001	–0.79	0.006	–0.67	0.142
Beef	–0.62	0.058	–0.87	0.026	–0.57	0.085	–0.84	0.034	–0.07	0.837	–0.97	0.001	–0.64	0.048	–0.61	0.197
Poultry	–0.86	0.002	–0.83	0.040	–0.82	0.003	–0.84	0.038	–0.68	0.030	–0.96	0.003	–0.84	0.002	–0.58	0.231
Fish																
Saltwater	–0.85	0.002	–0.83	0.039	–0.81	0.004	–0.84	0.038	–0.71	0.022	–0.96	0.003	–0.84	0.002	–0.58	0.227
Freshwater	–0.81	0.005	–0.70	0.124	–0.78	0.007	–0.77	0.070	–0.82	0.003	–0.87	0.025	–0.78	0.007	–0.45	0.367
Fresh vegetables	–0.77	0.009	–0.68	0.140	–0.75	0.013	–0.76	0.077	–0.90	0.000	–0.85	0.031	–0.75	0.012	–0.44	0.388
Eggs	0.53	0.112	–0.42	0.405	0.50	0.140	–0.14	0.796	0.95	0.000	–0.23	0.661	0.55	0.098	–0.41	0.420

a: kg of food/person/mo for 1973–74, 1979–80, 1984–85, 1989–90, and 1994–95.
b: Direct correlation of food intake and world age-adjusted cancer incidence in generally the same year, i.e., 1973–74, 1984–85, 1989–90, and 1991–92.
c: Food intake correlated with world age-adjusted cancer incidence data, generally 10 yrs later, i.e., 1983–84, 1989–90, and 1991–92.

Table 6. Correlation Coefficients of Food Intake at Home (1973–1995[a]) With Colon and Rectal Cancer Incidence Rates

	Colon Cancer								Rectal Cancer							
	Male				Female				Male				Female			
	Same year[b]		10-yr lag[c]		Same year[b]		10-yr lag[c]		Same year[b]		10-yr lag[c]		Same year[b]		10-yr lag[c]	
	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value
Rice	−0.99	0.000	−0.93	0.006	−0.99	0.000	−0.97	0.001	−0.65	0.042	0.65	0.166	−0.74	0.014	−0.09	0.869
Pork	0.94	0.000	0.96	0.003	0.90	0.000	0.97	0.001	0.78	0.008	−0.61	0.202	0.85	0.002	0.21	0.690
Beef	0.73	0.016	0.93	0.007	0.66	0.039	0.97	0.001	0.77	0.009	−0.65	0.164	0.64	0.044	0.07	0.888
Poultry	0.99	0.000	0.90	0.013	0.98	0.000	0.95	0.003	0.66	0.037	−0.66	0.157	0.70	0.023	0.02	0.974
Fish																
Saltwater	0.97	0.000	0.91	0.013	0.97	0.000	0.96	0.003	0.64	0.045	−0.66	0.157	0.75	0.012	0.02	0.966
Freshwater	0.92	0.000	0.79	0.060	0.95	0.000	0.87	0.026	0.50	0.145	−0.65	0.164	0.55	0.096	−0.14	0.787
Fresh vegetables	0.86	0.001	0.77	0.070	0.90	0.000	0.85	0.031	0.40	0.256	−0.64	0.167	0.64	0.044	−0.16	0.759
Eggs	−0.56	0.092	0.33	0.529	−0.63	0.049	0.22	0.671	−0.06	0.873	0.05	0.928	−0.17	0.629	0.62	0.190

a: kg of food/person/mo for 1973–74, 1979–80, 1984–85, 1989–90, and 1994–95.
b: Direct correlation of food intake and world age-adjusted cancer incidence in generally the same year, i.e., 1973–74, 1984–85, 1989–90, and 1991–92.
c: Food intake correlated with world age-adjusted cancer incidence data, generally 10 yrs later, i.e., 1983–84, 1989–90, and 1991–92.

Table 7. Correlation Coefficients of Food Intake at Home (1973–1995[a]) With Stomach, Laryngeal, and Cervical Cancer Incidence Rates

	Stomach Cancer								Laryngeal Cancer				Cervical Cancer			
	Male				Female				Male				Female			
	Same year[b]		10-yr lag[c]		Same year[b]		10-yr lag[c]		Same year[b]		10-yr lag[c]		Same year[b]		10-yr lag[c]	
	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value
Rice	−0.58	0.082	0.76	0.077	-0.64	0.045	0.50	0.314	0.42	0.224	0.88	0.022	0.95	0.000	0.94	0.004
Pork	0.77	0.009	−0.72	0.110	0.76	0.011	−0.48	0.334	−0.10	0.776	−0.80	0.055	−0.83	0.003	−0.98	0.001
Beef	0.80	0.005	−0.77	0.075	0.85	0.002	−0.50	0.313	0.14	0.693	−0.88	0.020	−0.60	0.068	−0.94	0.006
Poultry	0.59	0.075	−0.78	0.069	0.68	0.029	−0.50	0.313	−0.42	0.232	−0.90	0.014	−0.95	0.000	−0.91	0.012
Fish																
Saltwater	0.58	0.080	−0.78	0.069	0.65	0.043	−0.50	0.313	−0.43	0.220	−0.90	0.014	−0.95	0.000	−0.91	0.011
Freshwater	0.38	0.279	−0.77	0.073	0.52	0.122	−0.48	0.339	−0.61	0.063	−0.92	0.010	−0.95	0.000	−0.78	0.067
Fresh vegetables	0.30	0.394	−0.77	0.076	0.36	0.311	−0.47	0.345	−0.65	0.041	−0.92	0.010	−0.92	0.000	−0.76	0.079
Eggs	0.07	0.837	0.07	0.901	−0.15	0.687	−0.03	0.960	0.88	0.001	0.17	0.752	0.76	0.011	−0.39	0.450

a: kg of food/person/mo for 1973–74, 1979–80, 1984–85, 1989–90, and 1994–95.
b: Direct correlation of food intake and world age-adjusted cancer incidence in generally the same year, i.e., 1973–74, 1984–85, 1989–90, and 1991–92.
c: Food intake correlated with world age-adjusted cancer incidence data, generally 10 yrs later, i.e., 1983–84, 1989–90, and 1991–92.

Table 8. Correlation Coefficients of Food Intake at Home (1973–1995[a]) With Prostate and Female Breast Cancer Incidence Rates

	Prostate Cancer				Female Breast Cancer			
	Same year[b]		10-yr lag[c]		Same year[b]		10-yr lag[c]	
	r^2	*P* value	r^2	*P* value	r^2	*P* value	r^2	*P* value
Rice	−0.92	0.000	−0.62	0.185	−0.94	0.000	−0.86	0.027
Pork	0.87	0.001	0.53	0.275	0.85	0.002	0.94	0.005
Beef	0.74	0.015	0.63	0.178	0.67	0.035	0.85	0.031
Poultry	0.93	0.000	0.66	0.151	0.94	0.000	0.80	0.054
Fish								
Saltwater	0.89	0.001	0.66	0.153	0.95	0.000	0.81	0.052
Freshwater	0.86	0.002	0.72	0.106	0.91	0.000	0.63	0.183
Fresh vegetables	0.74	0.015	0.73	0.103	0.89	0.001	0.60	0.206
Eggs	−0.48	0.164	−0.30	0.561	−0.73	0.016	0.59	0.222

a: kg of food/person/mo for 1973–74, 1979–80, 1984–85, 1989–90, and 1994–95.
b: Direct correlation of food intake and world age-adjusted cancer incidence in generally the same year, i.e., 1973–74, 1984–85, 1989–90, and 1991–92.
c: Food intake correlated with world age-adjusted cancer incidence data, generally 10 yrs later, i.e., 1983–84, 1989–90, and 1991–92.

higher risk was significantly correlated with lower rice and higher meat intakes. However, with a 10-year lag, these patterns significantly persisted for colon cancer but all dropped to insignificance for rectal cancer. These correlations suggest that similar foods are risk factors for both sites, but rectal cancer is more influenced by recent dietary patterns.

Compared with other cancer sites, it is interesting to see how little influence the eight food items had on stomach cancer incidence in Table 7. Higher meat consumption was positively correlated with higher stomach cancer incidence of the same year, but no food item was significant with stomach cancer incidence 10 years later. Fresh vegetable intakes had no significant correlations at any time. On the other hand, male laryngeal cancer was more highly correlated with diet 10 years before than diet in the same year, with rice having positive and meat and vegetables having negative coefficients. Dietary correlations for specific foods for cervical cancer were in the same direction as male laryngeal cancer but had more significant associations with same-year analyses than 10 years later.

Finally, Table 8 shows the correlation coefficients for prostate and female breast cancers. Both show similar associations with current food patterns, such that rice had negative coefficients and the various meats had positive coefficients. These associations were strongly associated with current food intakes and weakened with the 10-year-lagged analyses, so that all became insignificant for prostate cancer, but the rice and meat associations were still significant for female breast cancer.

Discussion

In the 15 years since Ho and co-workers (4) described the epidemiologic patterns of cancer in Hong Kong, some trends from the 1970s, i.e., increases in lung cancer and decreases in cervical cancer, have significantly continued in the intervening ≥20 years. The trends for other sites were not so apparent at that time, i.e., decreasing nasopharyngeal and esophageal and increasing colon cancers. The age-specific curves additionally suggest that the incidence of rectal, liver, prostate, and female breast cancers has been increasing since the early 1970s.

During the same period, the Hong Kong diet shifted from one overwhelmingly dominated by rice to one with increasing portions of beef, pork, poultry, fish, and fresh vegetables. In 1963–64, more money was spent on rice than on any of the other 25 food items. By 1994–95, more was spent on one-half of the food items (n = 13) than on rice. This included bakery items, fish, sea products, pork, poultry, frozen meats, fresh vegetables and fruit, and dairy products. In fact, more was spent on such nonstaples as soft drinks and beverages than on rice in the latest 1994–95 survey. The only food besides rice that has probably declined in intake is chicken eggs.

Meal consumption and preparation have also shifted from home cooking to eating outside the home or eating cooked food from outside vendors. By the mid-1980s, about equal portions of money were spent for food eaten at home and food eaten outside the home. By 1994–95, 60% more was spent for eating outside the home than for eating at home. Hence, food habits in Hong Kong have greatly changed from home cooking and traditional diets of a few items (rice, vegetables, pork, fish, and eggs) to a more varied diet of greater portions of almost everything except rice and eggs and more eating outside the home. The proportion of the total budget spent for alcoholic drinks and tobacco also suggests declines, so overall the changes in consumption patterns suggest a more affluent life-style, with its incumbent problems of overnutrition in some foods and too many processed foods.

The changing composition of the diet is also correlated with some of the cancer incidence patterns. Similar to the findings from other studies (5,6), higher meat intakes were

significantly and positively correlated with cancers of the colon, rectum, prostate, and female breast. On the other hand, they were negatively correlated with esophageal and nasopharyngeal cancers, perhaps because the dietary risk factors for these latter two cancers, i.e., pickled/preserved food (7) and salted fish (8), respectively, have been replaced by fresh meat/fish and other foods. Although meat intake was also positively correlated with lung and liver cancers, such correlations were not consistently apparent for incidence rates 10 years later and/or applicable to diets in both sexes.

A comparison of the same-year vs. 10-year-lagged correlations between cancer incidence and dietary patterns was also revealing in suggesting the relative influence of current vs. past diets. The correlations suggested that current diets were more influential than diets a decade before for cancers of the lung, esophagus, rectum, and prostate. Cancers of the nasopharynx and colon were significantly correlated with current and past diets, whereas only male laryngeal cancer had more correlations with past than with current diets.

The interpretation of the dietary correlations with cancer incidence was limited by the small number of foods that were studied ($n = 8$), the short observation period of only ≥20 years, and the monotonal direction of the food patterns, i.e., rice and egg consumption simply declined and the other six food items (vegetables and different types of meat and fish) generally increased. Because fresh vegetable intakes generally increased along with intake of the various meats and fish, vegetable intakes had little discriminative value in the correlation analyses. Alternatively, or additionally, it could be suggested that the meat intakes overshadowed the possible protective effects of vegetables in our population.

A major problem in interpreting these results is the issue of ecological bias and confounding (9,10), which are difficult to control because of the methodology of looking at whole populations. We have already mentioned the pattern that pork, beef, poultry, fish, and vegetable intakes increased together during the 1973–74 to 1994–95 study period, so the effect of one could not be separated from the other in the correlation data. Ecological bias, i.e., a failure to have information on the exposure status of people with disease vs. those without, is also an inherent problem with correlation studies (11). It is possible that ecological bias is occurring with the positive same-year correlations found for intakes of saltwater fish, freshwater fish, and fresh vegetables with the lung cancer incidence data. In a previous case-control study of lung cancer among nonsmoking Hong Kong Chinese women, increasing consumption of fresh fish and vegetables was generally associated with reduced risk for lung cancer (12). On the other hand, these correlations were all insignificant with the 10-year-lagged data.

In conclusion, cancer incidence trends in Hong Kong from 1973 to 1991 showed significant decreases in traditional cancers (13), i.e., those of the nasopharynx, esophagus, and cervix, and increases in cancers typically found in Western societies, i.e., lung and colon, with increases in prostate and female breast cancers of increasing significance in later cohorts. These trends have been accompanied by dietary shifts from traditional diets of rice and small amounts of meat, fish, and vegetables to larger portions of meat, poultry, fish, processed foods, etc., which are typical of affluent Western societies. Hence, the ecological correlation of dietary changes with cancer incidence in Hong Kong is supportive of the hypothesis that meat and its accompanying fats are risk factors for colon, rectal, prostate, and female breast cancers.

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