

Case-control study of diet and prostate cancer in China

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Introduction: A higher incidence of prostate cancer is observed in the Western world than in Asian countries. Although it is relatively rare in China, an increased incidence has been reported in recent years. Studies in high-risk populations have suggested that dietary fat may play a role in enhancing the risk of developing prostate cancer. However, limited epidemiologic study has never examined the role of diet in low risk populations.

Methods: A case-control study was conducted in 12 cities in China to evaluate the relationship between dietary factors and prostate cancer risk. We conducted personal interviews with 133 histopathologically confirmed prostate cancer cases diagnosed between 1989 to 1992 and 265 neighborhood controls of similar age.

Results: Cases were more likely than controls to consume food with high fat and from animal sources ($p < 0.01$). The daily fat intake and the percentage of energy from fat were statistically significantly higher among cases than among controls ($p < 0.01$). The adjusted odds ratio for total fat between lowest quartiles and highest quartiles was OR = 3.6 (95 percent C.I. 1.8-7.2); for saturated fat, OR = 2.9 (95 percent C.I. 1.5-5.7); and for unsaturated fat, OR = 3.3 (95 percent C.I. 1.7-6.3).

Discussion: The data suggest that dietary fat, both saturated and unsaturated, are associated with an increased risk for prostate cancer in a low risk population. *Cancer Causes and Control* 1998, 9, 545-552

Key words: Case-control, China, diet, prostate.

Introduction

The incidence rate of prostate cancer varies substantially worldwide.¹ A higher incidence is observed in the Western world than in Asian countries.¹ Prostate cancer is one of the most commonly diagnosed cancers among men in the United States, representing about 25 percent of all tumors.² Although it is relatively rare in China, with an estimated incidence of 2.1 per 100,000,³ incidence has been increasing in recent years.³ Despite the high incidence of prostate cancer in the Western world, there are few established clues to its etiology.^{4,5} Etiologic

leads include the hormone dependence of the prostate, geographical, racial and occupational differences in incidence rates.⁴ Data from migrating populations further support the importance of environmental factors. Although the international differences in prostate cancer incidence rates are remarkable, the prevalence of latent prostate cancer, measured at autopsy, appears to be similar in most populations,⁶ again suggesting the role of environmental factors in the etiology of clinically significant prostate cancer.

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It has been suggested that dietary fat may explain part of the large inter-ethnic difference in prostate cancer risk. In particular, positive correlations have been demonstrated between prostate cancer mortality and per capita dietary fat consumption.⁷ Although some case-control studies in the USA have reported a higher risk of prostate cancer with increased intake of dietary fat,⁸⁻¹¹ it is unclear which types of dietary fat may enhance the risk. Low risk populations, such as Chinese in China, have never been investigated in epidemiologic studies on prostate cancer. This study intends to examine the role of dietary factors including fat, fiber, vitamins and minerals in prostate cancer etiology among the low risk Chinese men.

Materials and methods

Major teaching hospitals in 12 cities of China (Beijing, Shanghai, Tianjing, Chongqing, Chengdu, Guangzhou, Shushon, Xian, Wuhan, Shenyang, Wulumugi, and Lanshou) participated in the study. Cases were pathologically confirmed prostate cancer patients (ICD9 code 185), newly diagnosed during 1989 to 1992, ages between 50 to 89 years old, residents of these cities for at least 10 years and were still living at the time of the study. For each index case, two hospital controls (one cancer and one non-cancer patient from the same hospital) and two neighborhood controls were selected. All controls were within five years of age of the index case at diagnosis and living in the same city. Neighborhood controls were selected randomly from the registry roster of the residential community of the index case. The roster is being updated every three months.

We conducted face to face interviews with cases and control subjects. Cases and hospital controls were interviewed at the hospital, while neighborhood controls were interviewed at home. Information obtained included demographic characteristics, marital and occupational history, weight and height, dietary and physical activity habits, medical history and family history of cancer. The period of reference in assessing diet, physical activity, and body size was between 1980 and 1985. A food frequency questionnaire, involving recollection of food consumption tailored to suit the dietary habits of Chinese in all 12 cities, was developed, based on questionnaires from previous studies of cancers of the colorectum¹² and stomach.¹³ It contained 140 food items, that provided more than 90 percent of dietary fat consumed reported by the National Chinese Diet Survey.¹⁴ The food groups were divided into the following nine categories: rice and grain, meat, poultry and fish, soy products and dairy, cooking oil and other fat, vegetables, fruits, sugar and dried nuts, and beverages. Questions included frequency (times per day,

week, year or not at all in the reference period) and quantity (describing the portion size as multiples or fractions of the standard portion size) of consumption of each of the 140 food items listed. A set of 12 questions concerning preference and use of fat and oils in meals is included. To maximize response and improve validity of dietary and other information secured, interviewers (mostly physicians in the participating teaching hospitals) attended a special two-day training session prior to the start of the study. A written instruction manual was distributed at the training session to the interviewers. The same interviewer interviewed both cases and controls in each city. Questionnaire data were edited, coded and entered. A second keypuncher verified all keying of data.

The 140 food items were regrouped into 27 food groups. Weekly consumption of these food groups by 50 g unit (in the past, food was rationed in China by this weight) were calculated. Two-tailed *t*-tests were performed to detect mean differences of food group consumption between cases and controls.

Daily energy and nutrient intake (protein, carbohydrate, fiber, total fat, saturated and polysaturated fat, vitamin A, carotenoids, vitamin C, vitamin E, iron, manganese, copper, selenium, and zinc) were also calculated. Estimated levels of nutrient intake were derived from the summation of the multiplying the frequency and quantities of consumption of each food item in the questionnaire with reference to the published nutrient data bank in China.¹⁵ The energy and fat (total fat, saturated fat, monounsaturated fat and polyunsaturated fat) values were adjusted according to the reported trimmings of fat in meat, the use of fat (saturated and unsaturated) in cooking, and the consumption of skin from poultry. Hospital controls may have illnesses or diseases that are related to diet; therefore, this report is limited to the comparisons of cases with neighborhood controls. Because of the small number of cases contributed by each city and the heterogeneity of the 12 cities, the 12 cities were then grouped into three regions. We grouped them as North region: Beijing, Tianjing and Shenyang; West region: Chengdu, Chongking, Lanshou and Xian; and South region: Shanghai, Shzhou, Hamzou, Quanzou and Wuhan. Quartiles cut off points of mean weekly intake of total fat, saturated fat and unsaturated fat were obtained from the controls. Odd ratios for prostate cancer were calculated by logistic regression analysis¹⁶ and adjusted for region (modeled as factored first), non-fat calorie sources and other nutrients when indicated. For example, the odds ratios associated with total dietary fat were adjusted for calories from sources other than fat. The odds ratios associated with saturated fat were adjusted for calories from sources other than saturated fat. The odd ratios for unsaturated fat were

adjusted for sources other than unsaturated fats. Chi-square tests (two-tailed) for linear trend were also performed.

Results

398 subjects were included in this report. Of these, 133 were cases and 265 were neighborhood controls. Descriptive characteristics of study subjects are presented in Table 1. The age distribution, educational level, body mass index (weight/height²), smoking, marital and socioeconomic status between cases and controls were very similar. Cases, however, reported a higher frequency of past alcohol use and of benign prostate hyperplasia and prostatitis incidence than did the controls.

Table 2 presents the subjects' preferred eating habits. Compared with controls, cases reported significantly higher preferences for fatty cuts of pork, fish prepared by frying, and deep-fried foods ($p < 0.05$). Cases also preferred eating poultry with skin and stir-fried vegetables over boiled vegetables (although these differences did not achieve statistical significance).

The mean weekly consumption of food groups (50 g unit) is presented in Table 3. Cases reported a higher mean weekly intake than controls of the following foods: fresh red meat, all red meat, poultry, eggs, animal protein, oil and high fat foods. On the contrary, controls reported a significantly higher weekly intake of high carotene vegetables (such as pumpkin, carrots, sweet potato, yams and yellow leafy vegetables) and total vegetables ($p < 0.05$). Similarly, not achieving statistical

significant level, controls also consumed more soy, green vegetable, cruciferous vegetables, other fibrous vegetables, and complex carbohydrate than did cases.

The mean daily nutrient intake is shown on Table 4. Total daily fat intake and the percent of energy from fat were higher among the cases than among controls ($p < 0.01$). Compared to controls, cases reported a higher intake of both saturated ($p < 0.001$) and unsaturated fat ($p = <0.001$), as well as selenium ($p = 0.01$). Again controls had a higher consumption of carotenoids than cases, but cases and controls reported similar levels of retinol intake. No significant differences in the intakes of other nutrients were observed between cases and controls.

Table 5 presents the adjusted odds-ratios associated with several nutrients relating to prostate cancer ($p > 0.10$ from Table 4) while controlling for other factors. Risk for prostate cancer was associated with total fat (OR = 1.03, 95 percent C.I. 1.0-1.05, $p = 0.01$), but not with vitamin C, carotenoids, selenium, zinc, and calories from non-fat sources. We also examined the adjusted odd ratios for prostate cancer risk with different quantities (by quartiles) of fat (total fat, saturated and unsaturated fat) consumed (Table 6). There was a positive association between energy-adjusted total fat intake and risk of prostate cancer, with a significant associated trend (p for liner trend = 0.003). A clear gradient of prostate cancer risk was also observed with increasing intakes of energy-adjusted saturated fat (p trend = 0.025), and energy-adjusted unsaturated fat (p trend = 0.007).

Table 1. Characteristics of prostate cancer cases and controls, China, 1989-1992

	Cases N = 133 percent	Controls N = 265 percent	p Value
Age in years			
40-59	9.4	10.5	
60-69	40.0	40.4	0.97
≥70	50.0	49.1	
Education			
Illiterate	13.0	10.3	
Primary School	32.6	39.0	
High School	29.7	27.6	0.99
College	24.6	22.7	
Married status			
Currently Married	91.3	90.9	
Divorced/Widowed	8.7	9.1	0.88
Socioeconomic status			
Low	51.5	46.6	0.12
Medium	43.4	51.2	
High	5.1	2.2	
Body Mass Index, kg/cm ² (mean)	22.8	22.8	1.00
Ever smoked cigarettes	60.9	62.1	0.90
Ever used alcohol	67.2	57.0	0.07
Ever had benign prostate hyperplasia	48.3	13.6	<0.001
Ever had prostatitis	24.3	6.1	<0.001

Table 2. Eating habit preferences by prostate cancer cases and controls, China, 1989-1992

	Cases (N = 133)		Controls (N = 265)		p Value ^a
	N	Percent	N	Percent	
What type of pork do you usually eat?					
Fat	33	24.8	37	14.0	p = 0.001
Lean and fat	69	51.9	125	47.2	
All lean	31	23.3	103	38.9	
Do you eat poultry with skin?					
Always	125	94.0	230	86.8	p = 0.06
Sometimes	3	2.2	24	9.0	
Never	5	3.8	11	4.2	
Do you always prepare fish by frying?					
Always	93	69.9	159	60.0	p = 0.02
Sometimes	25	18.8	87	32.8	
Never	15	11.3	19	7.2	
Do you like deep fried foods?					
Very much	66	49.6	98	37.0	p = 0.03
Somewhat	43	32.3	114	43.0	
Dislike	24	18.0	53	20.0	
Do you eat more stir fried vegetables than boiled vegetables?					
More stir fried	105	78.9	185	69.8	p = 0.07
Some	25	18.8	61	23.0	
More boiled	3	2.2	19	7.2	

^a Two-tailed Chi-square test.

Table 3. Mean weekly consumption of food (50 g unit) by prostate cancer cases and controls, China, 1989-1992

Food groups	Cases (N = 133)	Controls (N = 265)	p Value
Preserved foods	2.9	2.4	0.15
Fermented foods	0.8	0.7	0.71
Fresh red meats	17.1	13.1	<0.01
All red meats	18.4	14.6	<0.01
Organ meat	0.6	0.5	0.17
Poultry	2.2	1.4	0.01
Eggs	7.9	5.7	<0.01
Fresh fish	3.3	3.5	0.82
Dairy products	13.8	11.8	0.24
Foods from animal sources	48.9	39.3	<0.01
High calcium	23.6	23.2	0.88
Soy	9.9	11.7	0.16
Other legumes	1.0	1.1	0.88
Dark green leafy vegetables	3.4	4.0	0.14
Dark orange vegetables	5.2	6.0	0.12
High carotene vegetables	11.0	13.8	<0.01
Cruciferous vegetables	11.1	12.6	0.17
Other fibrous vegetables	6.0	6.6	0.36
High vitamin C vegetables	14.1	15.7	0.17
Other vegetables	10.8	12.3	0.18
Total fruits	23.2	23.5	0.89
Total vegetables	48.6	55.8	0.04
Complex carbohydrates	59.5	63.2	0.12
Sweets	5.7	5.3	0.60
High fat foods	58.8	47.6	<0.01
Oils	5.9	4.9	0.01
Dried nuts	3.4	2.9	0.28

Discussion

The findings from this case-control study support the hypothesis that dietary fat may play a role in prostate cancer etiology. Increased intakes of saturated and unsaturated fats are associated with increased risk of developing prostate cancer in this low risk population.

There are several limitations one should consider in the interpretation of our findings. Selection and misclassification bias could have occurred in this study. We had overall 80 percent response rate. Of the 133 cases diagnosed with prostate cancer, 9, 17, 25 and 33 percent were diagnosed at clinical stages, A, B, C, and D, respectively, while 16 percent did not have clinical stage information and the median age of diagnosis was 69, which was similar to those reported from the high risk countries. All controls were screened for prostate cancer with an offer of free screening as an incentive to recruit controls; those screened with prostate cancer were excluded, thus selection bias is minimal. This dietary questionnaire was designed and tailored to suit the eating patterns of the three regions, though validation study has not been conducted. Since we interviewed subjects retrospectively, recall bias is a potential methodologic limitation. Misclassifications of dietary intake may have occurred due to measurement error associated with the use of the dietary assessment instrument or to the reference time frame (1980-1985) which would have

Table 4. Mean daily dietary intakes (SE) by prostate cancer cases and controls, China 1989-1992

Nutrients	Cases (N = 133)	Controls (N = 265)	p Value ^a
Total energy (Kcal/day)	3354.3 (99.9)	3158.0 (58.8)	0.07
Protein (g)	101.6 (3.5)	96.2 (2.0)	0.15
Carbohydrate (g)	416.6 (12.1)	433.1 (8.2)	0.25
Fat (g)	124.5 (5.5)	101.5 (2.9)	<0.001
Fat (% total Kcal)	33.4 (1.6)	28.9 (0.9)	<0.001
Saturated fat (g)	35.0 (1.7)	28.9 (0.9)	<0.001
Unsaturated fat (g)	84.5 (3.6)	69.6 (1.9)	<0.001
Fiber (g)	15.0 (0.6)	15.5 (0.4)	0.44
Carotenoids (μ g)	2343.9 (130.2)	2617.6 (94.2)	0.09
Retinol (μ g)	664.0 (29.9)	664.6 (20.0)	0.58
Vitamin C (mg)	100.5 (5.5)	111.3 (3.7)	0.10
Vitamin E (mg)	49.3 (2.4)	44.9 (1.8)	0.14
Magnesium (mg)	425.4 (16.2)	427.3 (9.0)	0.91
Iron (mg)	30.1 (1.0)	29.7 (0.6)	0.73
Zinc (mg)	17.0 (0.6)	16.0 (0.3)	0.10
Copper (mg)	3.5 (0.1)	3.5 (0.1)	0.99
Selenium (μ g)	65.4 (2.6)	58.0 (1.5)	0.01

^a Two-tailed *t*-test.

Table 5. Adjusted odds ratios (OR) for prostate cancer associated with dietary factors in China, 1989-1992

	Adjusted ^a (OR)	95 percent C.I.	p Value
Total fat (g)	1.03	1.00-1.05	0.01
Vitamin C (mg)	0.99	0.97-1.02	0.56
Carotenoid (μ g)	1.00	1.00-1.00	0.25
Selenium (μ g)	1.00	0.99-1.04	0.75
Zinc (mg)	0.93	0.73-1.19	0.56
Region ^b	1.01	0.66-1.46	0.71
Calories from other sources (Kcal/day)	1.00	1.00-1.00	0.33

^a From multiple regression model of continuous variables except region using North versus other (West and South).

^b Three regions: North: Cases *N* = 45, Controls *N* = 89; West: Cases *N* = 43, Controls *N* = 87; South: Cases *N* = 45, Controls *N* = 89.

Table 6. Adjusted odds ratios (OR) for prostate cancer associated with quartiles of dietary fat in China

	Cases	Controls	OR ^a	95 percent C.I.
Total fat				
<63.5 g	25	86	1.00	—
63.5-88.9 g	32	77	1.46	0.74-2.87
89.0-128.9 g	37	75	1.90	0.98-3.70
\geq 129.0 g	67	83	3.64	1.84-7.16
Saturated fat			(<i>p</i> for linear trend = 0.003)	
<17.7 g	25	86	1.0	—
17.7-24.4 g	30	75	1.19	0.60-2.35
24.5-38.5 g	44	79	2.21	1.16-4.20
>38.5 g	62	81	2.92	1.50-5.72
Unsaturated fat			(<i>p</i> for linear trend = 0.025)	
<45 g	28	87	1.00	—
45.0-60.6 g	25	75	1.10	0.55-2.20
60.7-86.3 g	40	75	1.85	0.96-3.54
>86.3 g	68	84	3.29	1.70-6.34
			(<i>p</i> for linear trend = 0.007)	

^a Adjusted for calories from sources other than fat, saturated fat and unsaturated fat respectively.

the effect of biasing our result toward the null. Our dietary data are limited to the nutrient consumption taken in these five years close to the beginning of the dramatic economic growth period in China. Therefore, if there were a long latent period before the progression to the clinically apparent prostate cancer, our dietary assessment would not take into account the changing dietary pattern over time. However, one can only assume that the dietary intake of this period may be relevant to the promotional stage of prostate cancer development.

Subjects were from three regions of China. Despite dietary differences between regions, though not extreme, it is reassuring to note that living in any particular region was not associated with prostate cancer in this study.

Our data showing associations of total dietary fat, both saturated and unsaturated fat with prostate cancer risk are consistent with several case-control studies.^{9-11, 17,18} In a recent multi-ethnic case-control study conducted in the USA and in Canada by Whittemore *et al.*,¹¹ prostate cancer risk was positively associated with total fat, particularly saturated fat intake among whites, Asians and Blacks, but the associations were strongest among Asian Americans.¹¹ In a prospective study of Giovannucci *et al.*, only dietary fat intake, particularly animal fat intake, was associated with an increased risk of developing advanced prostate cancer.¹⁹ Our finding of red meat is also consistent with previous studies,^{9,20-23} although no association of red meat with an increased prostate cancer risk was observed in the prospective Lutheran Brotherhood Cohort Study,²⁴ or in studies of Japanese men in Japan²⁵ and in Hawaii.²⁶

A clear dose response relationship of both saturated and unsaturated fats with prostate cancer risk was observed in our study. Higher preference for fatty cut of pork among cases and their significantly higher intakes of red meat, fried meat, and eggs (all animal sources) contributed to their higher intake of saturated fat in their diet. Intake of edible and cooking oil contributed to unsaturated fat intake. Cases report a significantly higher intake of oil than controls.

In our study, we did not evaluate the role of specific fatty acids in prostate cancer risk. However, in a recent study conducted by Giovannucci *et al.*,¹⁹ saturated fat, monounsaturated fat and alpha-linoleic acid, but not linoleic acid, were found to be associated with advanced prostate cancer risk. Fat from meat, mayonnaise, and butter were major contributors of alpha-linoleic acid in their study.¹⁹ Other studies have also shown positive associations with monosaturated fat^{10,20} and total polyunsaturated fat.⁹ In laboratory experiments, n-6 fatty acids have been shown to stimulate and n-3 fatty acids have been shown to inhibit human prostate cells in

culture.²⁷ Our study supports the unsaturated fat hypothesis with prostate cancer in humans.

Findings on the association of beta-carotene and retinol and prostate cancer risk have not been consistent in past studies. In most studies, associations were detected in certain age groups among the studied population. Studies conducted by Graham *et al.*¹⁷ and Kolonel *et al.*¹⁸ found an increase in risk of developing prostate cancer associated with high level of vitamin A or carotenoid intakes over the age of 70; while Mettlin *et al.* found a protective effect of high levels of beta-carotene intake particularly among men 68 years and younger,²⁸ and no association was reported in several case control studies.^{11,20,29} Our data show that carotenoids may be protective; controls consumed significantly more carotene-rich vegetables than cases ($p < 0.01$); however, the effect disappeared when other dietary factors were adjusted.

Recent experimental studies have suggested that soy products may reduce the risk of prostate cancer,^{30,31} and limited epidemiological data have suggested a protective effect of soy.^{26,32} Our study did not show statistically significant differences of soy consumption between cases and controls ($p = 0.16$), though controls did consume more soy products than cases. Possible reasons could be lack of variation in soy consumption and homogeneity in this study population.

Previous studies have hypothesized that high circulating levels of a biologically active form of vitamin D inhibit prostate carcinogenesis^{33,34} and that diets that are high in calcium, phosphorus, and sulfur-containing amino acids (high dairy and meat consumption) tend to decrease this circulating vitamin D,³⁵ thus diminishing the protective effect of the development of prostate cancer. However, a recent study by Normura *et al.* (1998)³⁶ from Hawaii did not show an inverse association between serum vitamin D and prostate cancer. In our Chinese population, we found no differences in the consumption of either dairy products ($p = 0.24$) or high calcium rich foods ($p = 0.88$) between cases and controls, though cases did consume slightly more dairy products than controls. Because we did not collect serum from our study participants, we cannot evaluate the relationship between the biologically active circulating vitamin D and prostate cancer risk.

In the United States, the rate of prostate cancer among Chinese Americans is lower than among US whites and blacks, but higher than the rate of their counterparts in China.³⁷ Our subjects in China showed a higher mean daily intake of total energy and total fat than the Chinese-Americans who participated in a recent prostate case-control study conducted by Whittemore *et al.*¹¹ in North America (Energy kcals: cases 3354 vs. 2162,

controls: 3158 vs. 2042; total fat g/s: cases 124 vs. 73, controls: 101 vs. 63). The percentage of calories from fat is also slightly higher among our subjects as compared with those among Chinese in North America (percent energy from fat: cases: 33.4 vs. 29.4, controls: 29 vs. 27). One can contribute the variations to differences in dietary assessment methods in these two populations. In our study, we included a whole section of 16 items on frequency and portion of cooking oil and fat use. Despite the higher caloric intake, our subjects had a lower body mass index (BMI) than their counterparts in the USA (22 vs. 23). The higher energy consumption and lower BMI in our subjects might be due to the fact that Chinese in China are generally more physically active. Chinese in North America may be more health conscious, they may follow dietary recommendations to reduce both caloric and fat intake. In China, after a long period of food scarcity, Chinese are now enjoying the abundant food supply. Their diet is gradually becoming more westernized, high in animal fat intake. Obesity is becoming a health problem among middle- and high-income urban residents in China.^{38,39} We found no association between prostate cancer risk and BMI in this study. This finding was consistent with other case-control studies.^{9,16-18} A positive association, however, has been shown in several prospective studies.^{21,26,40} These conflicting results might be due to the fact that BMI does not reflect obesity, because it measures both adiposity and lean body mass.

Autopsy studies around the world have shown a similar prevalence of histological prostate cancer in men over the age of 50.^{6,41} The similar prevalence of histologic prostate cancer and remarkable variations in the incidence of clinical prostate cancer in various populations suggest the role of environmental factors in late stage promotion. Identification of factors related to promotion or progression of prostate cancer could provide insights to prevention. Our findings suggest that dietary fat, both saturated and unsaturated fats, may influence the risk of prostate cancer, possibly in the promotion stage. Experimental data suggest that dietary fat might act with testosterone to promote carcinogenesis,⁴² and a fat-free diet might inhibit the growth of the prostate cancer.⁴³ The potential role of dietary fat and its specific mechanism in prostate cancer requires confirmation in future studies. Future investigation of dietary composition in relation to latent carcinoma of the prostate would also be very valuable.

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References

1. Parkin DM, Muir CS, Whelan SL, Gao YT, Ferlay J, Powell J, eds. *Cancer Incidence in Five Continents*, Vol VI. Lyon, France: International Agency for Research on Cancer, 1992.
2. Parker SL, Tong T, Bolden S, Wingo P. Cancer statistics, 1997. *CA Cancer J Clin* 1997; **47**: 5-27.
3. Jin F, Devesa SS, Zhong W, Blot WJ, Fraumeni JF, Gao YT. Cancer incidence trends in urban Shanghai 1972-1989. *Int J Cancer* 1993; **53**: 764-70.
4. Nomura AMY, Kolonel LN. Prostate cancer: a current perspective. *Epidemiol Rev* 1991; **13**: 200-27.
5. Prentice RL, Sheppard L. Dietary fat and cancer: Consistency of the epidemiologic data, and disease prevention that may follow from a practical reduction in fat consumption. *Cancer Causes Control* 1990; **1**: 81-97.
6. Breslow N, Chan C, Dhom G, et al. Latent carcinoma of the prostate at autopsy in seven years. *Int J Cancer* 1977; **20**: 680-8.
7. Armstrong B, Doll R. Environmental factors and cancer incidence and mortality in different countries, with special reference to dietary practices. *Int J Cancer* 1975; **15**: 617-31.
8. Graham S, Haughey B, Marshall J, et al. Diet in the epidemiology of carcinoma of the prostate gland. *J Natl Cancer Inst* 1983; **70**: 687-92.
9. Ross RK, Shimizu H, Paganini-Hill A, Honda G, Henderson BE. Case-control studies of prostate cancer in blacks and whites in Southern California. *J Natl Cancer Inst* 1987; **78**: 869-74.
10. West DW, Slaterry MLI, Robinson LM, et al. Adult dietary intake and prostate cancer risk in Utah. A case-control study in Hawaii. A case-control study with special emphasis on aggressive tumors. *Cancer Causes Control* 1991; **2**: 85-94.
11. Whittemore A, Kolonel L, Wu AH, et al. Prostate Cancer in relation to diet, physical activity and body size in blacks, whites and Asians in the U.S. and Canada. *J Natl Cancer Inst* 1995; **87**(9): 652-61.
12. Whittemore AS, Wu-Williams AH, Lee M, et al. Diet, physical activity, and colorectal cancer among Chinese in North America and China. *J Natl Cancer Inst* 1990; **82**: 915-26.
13. Wong RT. A study of gastric cancer in Beijing. *Chinese J Epidemiol* 1992; **6**: 23-8.
14. Chen J, Campbell JC, Li J, Peto R. *Diet, Lifestyle and Mortality in China: A Study of the Characteristics of 65 Chinese Counties*. Oxford (UK): Oxford University Press, 1990
15. Department of Nutrition, Institute of Occupational Health, *Environment and Nutrition: Table of Food Composition*. Peking (China): The Chinese Academy of Medical Science, 1980.

16. Breslow NE, Day NE. *Statistical Methods in Cancer Research. The Analysis of Case-Control Studies*. Vol I. IARC Sci Publ No 32. Lyon (France): IARC, 1980.
17. Graham S, Haughey B, Marshall J, et al. Diet in the epidemiology of carcinoma of the prostate gland. *J Natl Cancer Inst* 1983; **70**: 687-92.
18. Kolonel LN. Nutrition and prostate cancer. *Cancer Causes Control* 1996; **7**: 83-94.
19. Giovannucci E, Rimm EB, Colditz GA, et al. A prospective study of dietary fat and risk of prostate cancer. *J Natl Cancer Inst* 1993; **85**: 1571-9.
20. Talamini R, LaVecchia C, Decarli A, Negri E, Franceschi S. Nutrition, social factors and prostatic cancer in Northern Italian population. *Br J Cancer* 1986; **53**: 817-21.
21. Snowdon DA, Phillips RL, Choi W. Diet, obesity, and risk of fatal prostate cancer. *Am J Epidemiol* 1984; **120**: 224-50.
22. Mills PK, Beeson WL, Phillips RL, Fraser GE. Cohort study of diet, lifestyle, and prostate cancer in Adventist men. *Cancer* 1989; **64**: 598-604.
23. LeMarchand L, Kolonel LN, Wilkens LR, Myers BC, Hirohata T. Animal fat consumption and prostate cancer: A prospective study in Hawaii. *Epidemiology* 1994; **5**: 276-82.
24. Hsing AW, McLaughlin JK, Schuman LM, et al. Diet, tobacco use, and fatal prostate cancer: results from the Lutheran Brotherhood Cohort Study. *Cancer Res* 1990; **50**: 6836-40.
25. Hirayama T. Epidemiology of prostate cancer with special reference to the role of diet. *Natl Cancer Inst Monogr* 1979; **53**: 149-55.
26. Severson RK, Nomura AMY, Grove JS, et al. A prospective study of demographics, diet and prostate cancer among men of Japanese ancestry in Hawaii. *Cancer Res* 1989; **49**: 1857-60.
27. Rose DP, Connolly JM. Dietary fat, fatty acids and prostate cancer. *Lipids* 1992; **27**: 798-30.
28. Mettlin C, Selenskas S, Natarajan N, Huben R. Beta-carotene and animal fats and their relationship to prostate cancer risk: A case-control study. *Cancer* 1989; **64**: 605-12.
29. Middleton B, Byers T, Marshall J, Graham S. Dietary vitamin A and cancer: A multisite case control study. *Nutr Cancer* 1986; **8**: 107-16.
30. Peterson G, Barnes S. Genistein and biochanin A inhibit the growth of human prostate cancer cells but not epidermal growth factor receptor tyrosine autophosphorylation. *Prostate* 1993; **22**: 335-45.
31. Evans BAJ, Griffiths K, Morton MS. Inhibition of 5 α -reductase in genital skin fibroblasts and prostate tissue by dietary ligands and isoflavonoids. *J Endocrinol* 1995; **147**: 295-302.
32. Jacobsen BK, Knutsen SF, Fraser GE. Does high soy milk intake reduce prostate cancer incidence? The Adventist Health Study. *Cancer Causes Control* 1998; **9**: 553-7.
33. Swartz GG, Hulka BS. Is vitamin D deficiency a risk factor for prostate cancer? (Hypothesis) *Anticancer Res* 1990; **10**: 1307-11.
34. Giovannucci E. Dietary influences of 1,25(OH)₂ vitamin D in relation to prostate cancer: A hypothesis. *Cancer Causes Control* 1998; **9**: 567-82.
35. Chan JM, Giovannucci E, Andersson S, Yuen J, Adami H-O, Wolk A. Dairy products, calcium, phosphorous, vitamin D, and risk of prostate cancer. *Cancer Causes Control* 1998; **9**: 559-66.
36. Nomura AMY, Stemmermann GN, Lee J, et al. Serum vitamin D metabolite levels and the subsequent development of prostate cancer. *Cancer Causes Control* 1998; **9**: 425-32.
37. Yu He, Harris RE, Gao YT, Gao R, Wynder E. Comparative epidemiology of cancers of the colon, rectum, prostate and breast in Shanghai, China versus the United States. *Int J Epidemiol* 1991; **20**: 76-81.
38. Popkin BM, Keyou G, Zai F, Guo X, Ma H, Zohoori N. The nutrition transition China: a cross-sectional analysis. *Eur J Clin Nutr* 1993; **47**: 333-46.
39. Popkin BM, Paeratakul S, Ge K, Zai F. Obesity in China. *Am J Public Health* 1995; **85**: 690-4.
40. Thompson MM, Garland C, Barrett-Connor E, Khaw K, Friedlander NJ, Wingard DL. Heart disease risk factors, diabetes and prostatic cancer in an adult community. *Am J Epidemiol* 1989; **129**: 511-7.
41. Yatani R, Chigusa I, Akazaki K, Stemmerman G, Welsh R, Correa P. Geographic pathology of latent prostatic carcinoma. *Int J Cancer* 1984; **29**: 611-6.
42. Pollard M, Luckert PH. Promotional effects of testosterone and dietary fat on prostate carcinogenesis in genetically susceptible rats. *Prostate* 1985; **6**: 1-5.
43. Clinton SK, Palmer SS, Spriggs CE, Visek WJ. Growth of Dunning transplantable prostate adenocarcinomas in rats fed diets with various fat contents. *J Nutr* 1988; **118**: 908-14.