Diet and cancer among Chinese in Singapore

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Cancer statistics provided by the Singapore Cancer Registry and a series of diet-related studies carried out in Singapore since 1985 are reviewed. Incidence rates for cancers in various Chinese populations are compared. In terms of Singaporean diet a possible protective effect of soyabean products against female breast cancer is highlighted.

Introduction

Singapore, a small island state of almost 600 square kilometres with a predominantly Asian migrant population, is a veritable human laboratory for the study of disease patterns and trends, and their determinants. The last census in 1990 indicated a resident population of 2.7 million, comprising 77.7 % Chinese, 14.1 % Malays, 7.1 % Indians and 1.1 % Others[1]. As a major ethnic group, the Chinese had a sex ratio of 1010 males per 1000 females and a decreasing proportion (15.2 % in 1990) who were foreign-born. Also of interest are the Chinese dialect groups, most of whom are from South-eastern China. The main distributions are: 42.2 % Hokkiens (from Fukien Province), 21.9 % Teochews (from Shan-tou district of Guangdong Province), 15.2 % Cantonese (from the rest of Guangdong), 7.3 % Kheks or Hakkas (of northern origin who had migrated to the south), 7.0 % Hainanese (from the southern island of Hainan) and 6.4 % others.

The compact population, with good communication links and ready access to modern medical facilities, enabled the establishment of a comprehensive population-based cancer registry in 1968[2]. With the co-operation of the medical profession and the various hospitals and institutions, the registry has achieved its objective of estimating and monitoring cancer incidence rates over the last 20 years. It has also stimulated and collaborated in many research projects, one of which was the series of diet-related studies conducted since 1985. This paper seeks to summarize in a coherent manner the main findings from the various results obtained. In doing so, it hopes to add to the growing body of knowledge on cancer risks and their determinants among the Chinese peoples scattered all over the world.

In the interpretation of the findings, it must be borne in mind that migrants carry with them not only their genetic composition but also some of their habits as well, including dietary practices. Changes usually start in the first generation of migrants, progressing slowly with successive generations, especially those born in the adopted country.

Table 1. Age-standardized incidence rates for selected sites among various Chinese populations, 1983–1987.

Site	Singapore					China		USA
	All*	Hok†	Teo†	Can†	HK*	S'hai*	T'jin*	LA*
MALES								
Nasopharynx	18.1	12.3	12.2	18.2	28.5	4.0	1.8	6.5
Oesophagus	10.9	13.3	15.1	3.7	18.1	14.9	16.6	2.9
Stomach	34.7	39.2	33.3	15.2	22.1	51.7	33.4	13.0
Colon	20.2	16.6	14.9	15.0	21.7	9.2	4.2	23.1
Rectum	15.2	12.3	12.5	8.3	13.8	8.6	5.4	12.9
Liver	26.8	27.7	24.2	25.0	39.2	30.6	23.6	14.6
Lung	69.7	74.3	69.6	52.8	78.7	53.0	44.5	42.6
Prostate	7.6	4.2	5.1	5.1	7.6	1.7	1.2	19.8
All Sites	275.1	254.6	239.8	191.1	333.4	228.8	179.9	199.9‡
FEMALES								
Nasopharynx	7.4	3.7	3.9	7.5	11.2	1.9	0.6	3.0
Oesophagus	2.7	3.6	2.8	1.0	3.6	6.4	8.0	0.8
Stomach	15.6	17.6	11.7	9.8	11.2	21.9	12.4	7.9
Colon	18.1	13.5	12.4	14.3	16.7	8.7	4.2	15.3
Rectum	10.5	8.7	6.5	8.3	9.3	6.9	5.0	8.1
Liver	7.0	6.9	6.5	7.5	9.6	10.7	8.7	4.6
Lung	21.9	20.8	19.4	23.8	32.6	18.1	33.2	18.2
Breast	31.6	21.4	15.6	21.4	32.3	21.2	21.5	48.7
Cervix	17.5	11.4	9.7	10.1	19.2	4.3	8.9	12.3
Ovary	8.6	5.6	5.0	5.3	7.2	4.7	4.5	8.9
All Sites	193.0	147.9	122.6	145.1	224.7	147.5	145.1	179.7‡

* From C15 (VI)[3].
† from Singapore Cancer Registry[4].
‡ Excluding Other Skin (ICD 173)
Hok = Hokkien, Teo = Teochew, Can = Cantonese, HK = Hong Kong, S'hai = Shanghai, T'jin = Tianjin, LA = Los Angeles.

Cancer patterns and their changes

The latest published incidence figures (1983–87) for all Singapore Chinese residents and the three main dialect groups as well as those from Hong Kong, Shanghai, Tianjin and Los Angeles are given in Table 1[3,4]. It is to be noted that while Hong Kong is predominantly Cantonese (from Guangdong), Shanghai is further north in China and Tianjin

even more so. There is a good mix of Cantonese and Taiwanese in Los Angeles.

As expected, nasopharyngeal cancer is highest in Hong Kong, followed by Sinagapore Cantonese, and then Hokkiens and Teochews. The incidence is higher in Los Angeles than in Shanghai and Tianjin, which are known to be low-risk areas.

The patterns for oesophageal and stomach cancers appear to be quite similar. In both, rates are high in Hong Kong, Tianjin, Shanghai, Singapore Hokkiens and Teochews, and much lower in Singapore Cantonese and Los Angeles, reflecting generally the socio-economic gradient of the different populations. The opposite effect is seen for both colon and rectum, where the rates are highest in Los Angeles, followed by Hong Kong and Singapore (with minimal dialect group differences), and very low in Shanghai and Tianjin.

Liver cancer rates in both sexes are high in Hong Kong and Shanghai, followed by Singapore and Tianjin, and low in Los Angeles. The patterns for lung cancer are somewhat different between the sexes. In males, some of the highest rates in the world are seen for Hong Kong and Singapore Hokkiens and Teochews. In females, Hong Kong, Tianjin and Singapore Cantonese have higher rates compared to Singapore Hokkiens and Teochews, also in Shanghai and Los Angeles.

Prostate cancer is highest in Los Angeles, followed by Hong Kong and Singapore. The rates are very low in Shanghai and Tianjin. The situation is similar for cancers of the breast and ovary in females, showing the same gradient. Cervical cancer is higher in Hong Kong, Singapore and Los Angeles, and lower in Tianjin and Shanghai.

Cancer patterns have also shown remarkable changes in Singapore over the last two decades[4,5]. The overall average annual rate of increase (1968–87) was about 1.2 % in females and 0.4 % in males. Marked increases were seen for colon (3 % in males and 5 % in females), rectum (3 % in males and females), prostate (5 %), female breast (3 %) and ovary (3 %). The increase in lung cancer incidence was gradual (1.5 %) in both sexes.

Decreasing incidences were reported for oesophagus (–4 % in males and –5 % in females), and stomach (–1.5 % in both sexes). No significant changes were seen for nasopharynx, liver and cervix.

Dietary patterns and their changes

Based on existing knowledge, major determinants responsible for the changes in cancer incidence are likely to be dietary. Relevant information pertaining to trends in dietary patterns and nutritional intakes in Singapore is sadly lacking. The only published individual-based consumption data refer to recent times, ie 1985[6]. Based on 3-day food diaries, adult Singaporeans had a mean daily intake of 55 g of fat, contributing about 27 % of total energy. The P:S ratio was approximately 1:2, and dietary fibre intake was approximately 13 g/day. The dietary changes were more marked in younger subjects below 40 years of age, consistent with the fact that they were more likely to have adopted western lifestyles.

As a surrogate, food availability data were studied to provide some clues on trends in dietary consumption[7]. In the 20-year period from 1961 to 1980, marked increases were seen for meat and offal (135 %), eggs (79 %), animal oils and fats (73 %), nuts and oilseeds (57 %), fruits (61 %), vegetables (32 %) and milk (35 %). The only food which showed a decline was pulses (–38 %).

In terms of nutrient availability (1961–83), increases were recorded for energy (25 %), protein (34 %), fat (67 %) and fibre (63 %). These trends indicate the increasing availability of all kinds of food as a result of growing affluence.

Diet and colorectal cancer

A hospital-based case-control study of colorectal cancer among the Chinese has been reported[8]. Using the dietary history approach (based on intakes one year before diagnosis), a total of 116 common foods and dishes were covered. The items selected contributed about 80 % of the intake of the nutrients concerned as determined in a separate dietary survey. Daily intakes of nutrients and selected food items were computed and stratified by tertiles of the control range for the assessment of risk. In the analysis, effects were adjusted for age, sex, Chinese dialect group and occupation.

For cancers of colon and rectum combined, significant effects observed were a protective effect of high cruciferous vegetable intake (odds ratio [OR] = 0.50, 95 % confidence interval [CI] = 0.32, 0.78) and a predisposing effect of a high meat to vegetable consumption ratio (OR = 1.77, 95 % CI = 1.15, 2.71). Similar results were observed for colon cancer alone. For rectal cancer alone, significant ($P<0.05$) protective effects were observed for high intakes of protein (OR = 0.61), fibre (OR = 0.46), β-carotene (OR = 0.54), cruciferous vegetables (OR = 0.51) and total vegetables (OR = 0.51). When further assessed by multiple logistic regression, tests for trend and assessment of risk in the highest and lowest quintiles of the control range, the factors consistently significant were cruciferous vegetable intake and the meat to vegetable ratio. A particular high relative risk was also noted in association with coffee consumption in the lowest quintile of the control range (OR = 1.59 with $P<0.05$ for trend). No consistent trends were noted for fat or fibre intakes. This was the first such study in an Asian population outside Japan, and it suggested that the protective effects of certain dietary constituents, notably the cruciferous vegetables, may be more important than the hitherto stressed carcinogenic potential of fat and protein.

Diet and female breast cancer

Following the successful completion of the colorectal study, a similar approach was adopted for a study on female breast cancer[9]. Using the same dietary history approach, sources of the following nutrients were obtained: animal and non-animal protein, fat, saturated fatty acids (SFA), monounsaturated fatty acids, polyunsaturated fatty acids (PUFA), cholesterol, β-carotene, vitamin E and caffeine. The main food groups of interest were red meats, coffee, fish and soya products.

The results showed marked contrasts between premenopausal and postmenopausal women. In the premenopausal group, dietary variables associated with increased risk were high intakes of animal proteins and red meat. Those associated with decreased risk were high intakes of PUFA, β-carotene, soya protein, total soya products, a high ratio of PUFA to SFA and a high proportion of soya to total protein. When fitted together, the variables which remained significant when adjusted for the other variables

were red meat as a predisposing factor (OR=3.99, 95 % CI: 1.87, 8.51); and as protective factors PUFA (OR=0.40, 95 % CI: 0.19, 0.85), β-carotene (OR=0.33, 95 % CI: 0.16, 0.69) and soya protein as a proportion of total protein (OR=0.39, 95 % CI: 0.19, 0.80). The analysis of dietary variables in the postmenopausal group showed uniformly non-significant results.

Our dietary findings were mainly confined to younger premenopausal women who have exhibited greater changes in their diet. There was less variability in intakes among the postmenopausal group. The predisposing effect of red meat, and the likely protective effects of β-carotene and PUFA have been corroborated by other studies.

The most interesting finding is the likely protective effect of soyabean products. In the Singapore study, high soya protein intake would be about 3 g/day, which works out to be about 9 % of total protein. Diets high in soya bean products have been shown to be effective in suppressing breast tumour occurrence in rats. Various workers have attributed this effect to phyto-oestrogens, which are readily available in soyabeans. Prominent among the phyto-oestrogens are the isoflavones (daidzein and genistein) which are bacterially converted to equol, which has anti-oestrogenic activity in reducing the sensitivity of oestrogen receptors to oestradiol and thus inhibiting the action of oestrogen-stimulated tumour growth. Could this be a partial explanation of the much lower prevalence of female breast cancer in China and Japan, compared to western Caucasian populations?

Diet and cancer risks

Of the predisposing factors in the diet, animal fats as a risk factor group appear to be a quite inconsistent finding. In 1990, Willett's report on a 6-year cohort study of about 90 000 nurses revealed higher risks for colorectal cancer with increased consumption of total fat, animal fat, saturated fat and red meat[10]. It was not so for vegetable fat, polyunsaturated fat, chicken and fish. Generally, most workers agree that saturated fats are positively associated with colorectal cancer (relative risk=1.5–2.0 %, population attributable risk [PAR]: 25–40 %). A meta-analysis of 12 case-control studies on breast cancer also showed some association with total fat (PAR about 20 %)[11]. However, one latest report from Willett after an 8-year follow-up of the nurse-cohort showed no relationship between for intake and breast cancer risk[12]. On balance, even if an association does occur, it is very weak with a low PAR.

It does seem that intake of meat is an important indicator. The findings from Singapore on colorectal cancer showed that high meat to vegetable ratio (2:1) is an important predisposing factor. Red meat was also found to be positively associated with female breast cancer. This corroborates many other reports in implicating meat and animal fats as important predisposing dietary factors.

On the other hand, much of the focus of diet-related research has been on cancer-inhibition. The nutrients concerned include vitamins A, C and E, β-carotene, trace elements (eg zinc, selenium) and dietary fibre. The nutrients of particular interest are the antioxidants which act by activating cellular free-radical scavenging systems and by enhancing peroxide breakdown.

The antioxidant properties of some micronutrients constitute an area of very active and exciting research. Free radicals are easy to detect, but their reactions are difficult to study because of the widespread nature of radical-mediated oxidative processes. We certainly need to know more about the biological effects related to free-radical oxidation and the mechanisms by which antioxidants act.

The task of an epidemiologist is to pinpoint possible risk enhancing and protective factors, which can then be further studied by laboratory-based researchers who can then work on pathogenic mechanisms. In the meantime, practical public health action can be recommended on the basis of known determinants, crude though they may be.

Many of the sources of the identified inhibitors can be traced to vegetables and fruits[13]. In fact, it is now consistently recognized that higher intake of vegetables is associated with lower risks for a number of epithelial cancers, such as those in lung, larynx, oral cavity, oesophagus, stomach, large bowel, urinary bladder and female breast. A recent meta-analysis showed that dietary fibre (mainly from vegetables) is protective against colorectal cancer (OR=0.57, 95 % CI:0.05, 0.64)[14]. As was indicated in the report, a pure dietary fibre effect cannot be separated from non-fibre effects of vegetables.

Vegetables are also known to contain specific anti- cancer substances[15]. This is particularly so in the cruciferae family of vegetables (Brassica genus), which have been shown by many studies to be protective. They contain indoles (eg indole-3-carotinol, 3,3'-diindolylmethane, indole-3-acetonitrile), which are inducers of aryl hydrocarbon hydroxylase besides having other properties[16]. The Singapore study also confirmed this finding, where high consumers ate twice as much as low consumers.

The other interesting finding from Singapore, from an epidemiological angle, is the likely protective effect of soyabean products against female breast cancer. High soya intake would be about 3 g/day (about 9 % of total protein), as compared to 2 % in western populations and 12 % in China and Japan. Soya diets have been known to suppress the incidence of breast tumours in irradiated rats[17]. One possible explanation is that soyabeans provide a good supply of phytoestrogens (eg isoflavones such as daidzein and genistein), which are bacterially converted to equol in vivo.[18]. Equol has anti-oestrogenic activity in reducing the sensitivity of oestrogen receptors to oestradiol, and thus can inhibit the growth of oestrogen-stimulated tumours such as in female breast.

Conclusion

With the universal acceptance of tobacco as an important aetiological factor in the causation of some cancers, the next group of factors under active investigation are essentially dietary[19]. Unfortunately, the reality of the situation is such that measurement of dietary exposures and estimates of association are difficult. Even though the relative risks linking suspected dietary factors to particular cancers are generally weak, in the range of 1.5 to 2, the very fact that many people are exposed means that the aetiologic fractions (population attributable risks) are large. Hopefully, with the advent of molecular epidemiology, we will be able to use biological markers to make better measurements of exposure and to quantify risks. Taken separately, each nutrient may have a very small effect, but considered as a whole, they can be extremely important. Dietary interventions to lower cancer incidence is definitely a worthwhile area of research to guide

community action. Being such an integral part of human existence, food and nutrition will be a major focus in health promotion for the future.

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新加坡華人的食膳食與癌症

摘要

作者對 1985 年以來新加坡的癌症統計資料進行了評論。這些資料是由新加坡癌症記錄和一系列膳食與癌症的研究提供的。他們比較了不同華人人群的癌症發病率，並論述了大豆製品對婦女乳腺癌的可能保護作用。