Diet and cancer — some results from Singapore

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The notion that diet has an aetiological role in cancer is generally accepted, although the actual agents and mechanisms are still subjects of much research. A major problem in this work is the lack of effective instruments in determining dietary exposures. The wide margin given as the likely population attributable risk (10–70%) is an indication of the relative imprecision of our state of knowledge at this moment.

In Singapore, digestive tract cancers account for about 30% of all cancers in males and 24% in females. In addition, other cancers that have a strong dietary link include lung (24% males, 10% females), liver (9% males, 4% females), nasopharynx (7% males, 4% females), female breast (17%) and prostate (3%). Therefore, this is a very important subject for continued study in view of the preventive potential.

Based on recent studies conducted in Singapore, a review is provided of factors associated with colorectal and breast cancers. The main thrust of our findings point to the role of meat as a predisposing factor and vegetables/fruits as protective foods. Possible agents and mechanisms of action will be discussed.

Introduction

Singapore is a nation of migrants, having started out as a fishing village of about 150 persons at the time of its founding in 1819. Today, it is a modern metropolis of 3 million people (1990 census)[1], comprising 78% Chinese, 14% Malays, 7% Indians and 1% other ethnic groups. Originally established and maintained as a trading centre for the greater part of its short history, it has undergone dramatic socioeconomic changes in the last three decades. The marked improvements in living standards have resulted in better housing, nutrition and health care.

Contemporaneous with these improvements, Singapore has undergone important changes in her disease patterns. The all-cause mortality rates have declined from about 12.0 per 1000 population in 1950 to 5.2 since 1970 until the present.[2] Mortality due to infectious and parasitic diseases as well as nutritional deficiencies have declined in importance. In their place, cancers and circulatory diseases have assumed prominence. All these changes have taken place in a migrant population within one generation.

Changes in cancer incidence

In the last 20 years, since population-based cancer registration started, the cancer patterns have also shown remarkable changes. The most frequent cancer sites (1983-1987) are given in Tables 1(a & b). In males, the most common sites are lung (23.7%), colorectum (12.5%), stomach (11.5%), liver (9.4%) and nasopharynx (7.3%). Among females, the five main sites are breast (17.2%), colorectum (14.0%), lung (10.7%), cervix (9.0%) and stomach (7.7%).

The overall cancer incidence has increased significantly in both sexes, partly due to increased awareness, more accurate diagnosis and improved reporting.[3] The average annual rate of increase was about 1.4% in females and 0.4% in males.[4] Marked decreases were reported for oesophagus (3.9% in males, 5.8% in females) and stomach (2.2% in males, 1.4% in females). No significant changes were seen for nasopharynx, liver and cervix.

Increasing incidences were seen for lung (2.2% in males, 2.4% in females), colon (3.0% in males, 5.0% in females), rectum (3.1% in males, 4.1% in females) and female breast (3.2%). In looking for possible explanations for all these changes, it is only natural that attention should focus on lifestyle factors, prominent among which is the diet.

Changes in dietary factors

Prior to 1980s, there had been very few dietary and nutritional surveys reported in Singapore. None of these provided representative data for a proper assessment of trends in nutritional intakes. Instead, food availability data were studied to provide some clues.[5] The main changes in food groups are given in Table 2. Nutrient availability are shown in Table 3.

A household survey of food consumption showed levels higher than those two decades ago.[6] The 'high affluence' group took more red meat, vegetables, fruits and milk.

Individual-based consumption data were only estimated recently in 1985, based on a 3-day food diary survey. The amount and percentage of total energy attributable to various fat sources are given in Table 4.[7]

Table 1 (a) males. Cancer incidence among all Singapore residents, 1983–1987

	Site	#Cases	%	CR[1]	ASR[2]
1.	Lung	2757	23.7	44.3	59.6
2.	Colorectum	1451	12.5	23.3	30.7
3.	Stomach	1334	11.5	21.4	29.3
4.	Liver	1100	9.4	17.7	23.1
5.	Nasopharynx	851	7.3	13.7	14.6
6.	Oesophagus	402	3.5	6.5	8.8
7.	Skin	398	3.4	6.4	8.5
8.	Prostate	355	3.0	5.7	8.2
9.	Lymphomas	336	2.9	5.4	6.4
10.	Bladder	312	2.7	5.0	6.9
	Others	2345	20.1		
	ALL	11641	100.0	187.1	242.9

[1] Crude Rate (per 100 000)
[2] Age-standardized Rate (per 100 000)

Table 1 (b) females. Cancer incidence among all Singapore residents, 1983–1987

	Site	#Cases	%	CR[1]	ASR[2]
1.	Breast	1717	17.2	28.3	31.0
2.	Colorectum	1397	14.0	23.1	26.1
3.	Lung	1066	10.7	17.6	20.3
4.	Cervix	896	9.0	14.8	16.2
5.	Stomach	767	7.7	12.7	14.4
6.	Ovary	496	5.0	8.2	8.8
7.	Skin	386	3.9	6.4	7.1
8.	Nasopharynx	370	3.7	6.1	6.2
9.	Thyroid	363	3.6	6.0	5.8
10.	Liver	355	3.6	5.9	6.7
	Others	2191	21.9		
	ALL	9996	100.3	165.0	183.0

Table 2. Changes in per capita food supply, 1961–1980[5]

Food group	Percent change
Cereals	+3.6
Roots & tubers	+13.2
Sugar	+12.3
Nuts & oilseeds	+56.9
Vegetables	+32.2
Fruits	+61.2
Meat & offal	+135.1
Fish & seafood	+1.1
Eggs	+79.3
Milk	+35.4
Vegetable oils & fats	+22.1
Animal oils & fats	+72.9
Pulses	–37.7

Table 3. Changes in per capita nutrient availability, 1961–1983

Nutrient	Percent change	1981–83 level per day
Calories	+25	2922 kcal
Protein	+34	74.5 g
Fat	+67	70.1 g
Fibre	+63	38.3 g

Table 4. Mean fat and dietary fibre consumption in adult Chinese Singaporeans[7]

Nutrient	All subjects	Males <40 yrs	Females <40 yrs
Fat (g/day)	55.4	69.2	51.6
D. fibre (g/day)	13.4	14.2	13.2
% of energy			
Total fat	27	28	28
SFA	10	10	10
PUFA	4	3	4

The dietary changes were more marked in the younger subjects below 40 years of age as they were more likely to adopt Western lifestyles. Because of this transitional phase, there would be adequate variability in intake levels between groups to warrant individual-based analytical studies as was done for colorectal and breast cancers.

A study on 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), beta-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 more extreme highest and lowest quintiles of the control range, the factors consistently significant were cruciferous vegetable intake and the meat to vegetable ratio. A particularly 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.

A study on female breast cancer

Following the successful completion of the colorectal study, a similar approach was adopted for the 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, monounsaturated fatty acids, polyunsaturated fatty acids, 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 proteins, 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 3g per day, which works out to be about 9% of total protein. Soya diets have been known to be effective in suppressing breast tumour occurrence in rats.[10] Various workers attribute the effect to phyto-oestrogens, which are readily available in soyabeans.[11] 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. Can this be a partial explanation for the much lower incidence of female breast cancer in China and Japan, compared to the Western Caucasian populations?

Conclusion

From our studies and from international literature, it is clear that vegetables and fruits have a major protective role in cancer aetiology, although the active constituents and mechanisms are not all elucidated as yet. The findings on soyabean would have to be replicated. As a cheap and ready source of non-animal protein, soyabean products hold great potential as an important food group in the near future.

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雖然實際的病尹與机理仍需作大量的研究，但膳食是癌症的一個病因的看法已被一般地認可。這工作的主要問題是欠缺測定膳食的有效手段。從人群得出的危險因素寬達10-70%，正說明了我們現在的知識是相對不精確的。

在新加坡，男性的消化道癌約占總癌症的30%，女性占24%。此外，與膳食有密切關係的癌症包括肺癌（男性24%、女性10%），肝癌（男性9%、女性4%），鼻咽癌（男性7%、女性4%），乳腺癌（17%）和前列腺癌（3%）。所以，繼續研究預防這些癌症的可能性是一個非常重要的課題。

基於最近在新加坡進行的研究，評述了與結一直腸癌和乳腺癌的有關因素。提出了肉食是致癌因素和青菜、水果是保護性食物。其可能的病因與机理將會進一步探討。