RESEARCH COMMUNICATION

An Estimate of the Potential for Cancer Prevention in Japan

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Abstract

Cancer prevention is an important strategy in cancer control and it consists of primary prevention and secondary prevention. Major avoidable or manageable risk factors for cancer identified from previous studies are tobacco, diet and infection. Some cancer could be prevented by controlling those risk factors. In Japan screenings for gastric cancer, cervical cancer, lung cancer, breast cancer and colo-rectal cancer have been widely conducted under the Law of Health Maintenance for the Aged. In planning and evaluating cancer control activities in Japan, it was considered useful to estimate the potential of primary and secondary prevention of cancer. The author estimated the potential of cancer prevention in Japan twice previously in 1990 and 1999. In this paper the potential of cancer prevention in Japan was re-estimated by using a different method and more recent data. From the present study it was estimated that about 25% of cancer occurrence could be prevented by control of smoking, diet and infection, about 9-15% of cancer deaths could be prevented by cancer screening, and about 6- 10 % of cancer deaths could be prevented by application of the state-of-the art diagnosis and treatment of cancer, altogether about 40-50% of cancer occurrences/ deaths could be prevented if all possible measures for cancer prevention are applied to the general public and cancer patients in Japan.

Key words: Cancer – prevention - risk factor - primary prevention - cancer screening - secondary prevention – Japan

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Introduction

Cancer prevention is an important strategy in cancer control and it consists of primary prevention and secondary prevention. A number of environmental risk factors for cancer have been identified from previous epidemiological studies; tobacco, diet, viral, parasitic and bacterial infections, radiation, occupation, environmental pollution, medicines, herbicides & pesticides, food additives, etc (Doll et al, 1981). Some cancer could be prevented by reducing exposure to those environmental risk factors. Some cancer deaths could be prevented by cancer screening. In Japan screenings for gastric cancer, cervical cancer, lung cancer, breast cancer and colo-rectal cancer have been widely conducted under the Law of Health Maintenance for the Aged.

In planning and evaluating cancer control activities in Japan, it was considered useful to estimate the potential of primary and secondary prevention of cancer. Among a number of risk factors for cancer, tobacco, diet and infection have a large attributable risk accounting for 70-80% (Wynder et al, 1977, Doll et al, 1981). Hence, those three risk factors should be the major target of primary prevention of cancer. However, it is not necessarily possible to prevent all cancer associated with environmental risk factors by avoiding all risk factors completely. Greenwald & Sondik estimated proportions of reduction of cancer mortality in the USA by year 2000 by prevention, screening and treatment (Greenwald et al, 1986). They estimated that 8% of cancer could be prevented by dietary control; fat reduction to 25% of total calories and fiber increase to 20-30g/day and another 8(15)% of cancer could be prevented by smoking control; reduction in adults smoking prevalence if achieved in year 2000(1990). All together only 16(23)% of cancer could be prevented by dietary and smoking control, while Doll & Peto had estimated that diet and tobacco occupied 65% of cancer causes in the USA (Doll et al, 1981). They further estimated that 3% of cancer deaths could be prevented if the coverage rates of breast cancer screening and uterine cancer screening were elevated to 80% and 80-90% respectively and that 14(26)% of cancer deaths could be prevented if the survival rate of cancer was elevated 0.5(1.5)% annually by the progress and application of the

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state-of-the-art treatment of cancer. The author has also estimated the percentage of avoidable cancer incidence/ deaths by all possible cancer control methods in Japan (Tominaga, 1999). It was estimated that about 6-12% of cancer incidence could be prevented by improvement of dietary habits; restriction of salt intake and avoidance of excess intake of fat, and increased intakes of fresh vegetables and dietary fibers, etc. If the smoking rate is decreased from 60% to 40-30% in males and from 15% to 10-5% in females, 3-5% of cancer incidence could be prevented. Further 3-6% of cancer incidence could be prevented by control of hepatitis B virus (HBV) and hepatitis C virus (HCV) assuming the carrier rate of those viruses was reduced to 50% and 0% of the present level. Altogether some 12-23% of cancer incidence could be prevented if all possible measures for primary prevention would be promoted strongly. Cancer screening has been conducted widely in Japan. Although the mortality reduction effect of cancer screening has not been evaluated by randomized controlled trial, the effects of screening for cancer of the stomach, colo-rectum, cervix, breast and lung have been estimated by using case-control methods in Japan. Using those estimates, it was estimated that 8-10% of cancer deaths could be prevented if the coverage rate of each cancer screening was elevated from the present 10-20% level to 30% level. Similarly, 6-9% of cancer deaths could be avoided by application of the state of the art treatment. Altogether 25-40% of cancer deaths could be avoided if all possible cancer control measures (primary prevention, cancer screening, and application of state-of-the-art treatment of cancer) were applied to the general public and cancer patients. (Tominaga, 1999). In this paper the potential of cancer prevention in Japan was re-estimated by using a different method and more recent data.

Materials and Methods

The population attributable risk (AR) was calculated by using the following equation: AR = E(R-1)/[1+E(R-1)], where, E = the proportion of population exposed to a risk factor and R = relative risk (or odds ratio). The preventable fraction (PF) was calculated by the following equation: PF = A(R-1)/[1+E(R-1)], where, A = the proportion of population which avoided a risk factor. To simplify the estimation as in previous estimations the time factor was ignored and the residual effect of past exposure to a risk factor was assumed to disappear after some years. In estimating the mortality reduction of cancer by screening odds ratios for previous experience of cancer screening were used which were obtained from case-control studies. The parameters used in the present estimation were in general most recent available information in Japan. The numbers of cancer deaths according to the anatomical site were based on the Vital Statistics of Japan in 1999 and the numbers of cancer incidence were obtained from the Report of the Study Group on Regional Cancer Registry in 1996 (Oshima et al, 2001). The smoking rates for adult males and females were based on the nation-wide smoking survey conducted by the Japan Tobacco Industry, Inc. in 2000.

Results

1) Estimate of cancer prevention by smoking control

Table 1 shows the preventable cancer fraction by smoking control in Japan assuming the smoking attributable cancer deaths were reduced to the half which were estimated from the number of cancer deaths in 1999 and the relative risk of cancer deaths for smokers compared to non-smokers and the percentage of cancer deaths attributable to smoking which were obtained from the cohort study conducted by Hirayama (Hirayama, 1990). It was estimated that 8.8% of cancer deaths could be avoided if the present smoking rates in both genders were reduced to the half of the present level and subsequently cancer deaths attributable to smoking were reduced to the half of the present level. In the present estimate the time factor was ignored and it was assumed the effect of past smoking would disappear after some years.

2) Estimate of cancer prevention by dietary control

In previous estimates of cancer prevention relative risks and percentages having those relative risks for selected foods which either elevated or reduced risks of gastric cancer and colo-rectal cancer were used (Tominaga, 1999), but because of complexity of dietary habits in the present estimate some sweeping assumptions were made (Table 2). In the present estimate it was assumed that one third of general population was a high risk group of cancers of the esophagus, stomach and colo-rectum having a relative risk of 2 compared to the another one third of general population having a relative risk of 1 (reference group) and the rest of one third of general population was a low risk group having a relative risk of 0.5. It was assumed that 50% of the high risk group avoided

Table 1. An Estimate of Smoking Related Cancer Deaths in Japan (2001)

	Males	Females	Both genders
No. of cancer deaths (1999)	175,817	114,473	290,556
Relative risk of all cancer for smokers	1.65	1.32	
Attributable risk to smoking (%)	26.0%	4.6%	17.5%
No of cancer deaths attributable to smoking	45,712	5,278	50,990
Preventable fraction smoking rate is reduced to a half	13.0%	2.3%	8.8%

Table 2. An Estomate of the Preventable Fraction of Cancer by Dietary Control (2001)

	Risk group			
	High risk	Middle risk	Low risk	Total
Disribution of risk group	1/3	1/3	1/3	1
Risk ratio	2	1	0.5	
Proportion of avoidance of risk factor	50%	0	0	
Grade of risk reduction	from 2 to 1	0	0	
Proportion of addition of protective factor	25%	50%	0	
Grade of risk reduction	from 1 to 0.5	from 1 to 0.5		
Preventable fraction of intestinal tract cancer	18.5%	7.1%	0.0%	25.6%
Preventable fraction of all cancers	7.4%	2.9%	0.0%	10.3%

high risk factors and 25% of the 50% took protective factors. Then, it was estimated 18.5% of the digestive tract cancer and 7.4% of all cancer could be avoided. For the middle risk group which has neither high risk factors nor protective factors it was assumed that 50% of them took protective factors. Then, it was estimated that 7.1% of the digestive tract cancer and 2.9% of all cancer could be avoided. For the low risk group taking protective factors it was considered impossible to further reduce the cancer risk. Then, it was estimated that 25.0% of the digestive tract cancer and 10.0% of all cancer could be avoided under the present assumptions.

3) Estimate of cancer prevention by control of tumorassociated viruses and bacteria

Table 3 shows an estimate of cancer prevention by control of tumor associated viruses and bacteria. Among a number of tumor-associated viruses hepatitis C virus (HCV) and hepatitis B virus (HBV) and *Helicobacter pylori* (Hp) are regarded as important viruses and bacteria from a point of view of cancer prevention in Japan. From many epidemiological and clinical studies it is assumed that about 90% of liver cancer is attributable to HCV and HBV infection. If the attributable risk is reduced to a half by prevention and eradication of HCV and HBV, 45% of liver cancer and 3.3% of all cancer could be prevented eventually. Hp infection is regarded as important risk factor of gastric cancer in Japan. The proportion of population infected with Hp was assumed to be 50% and the relative risk of Hp infection for gastric cancer was about 2. Both the proportion of population infected with Hp and the relative risk of Hp infection were slightly underestimated than actual reports to avoid over-estimate of attributable risk and effects of prevention of Hp infection and eradication of Hp. Under these assumptions, it was estimated that the attributable risk was 33% and if the attributable risk was reduced to a half, 16.7% of gastric cancer and 3.7% of all cancer could be prevented by prevention of Hp infection and eradication of Hp.

4) Estimate of effects of mortality reduction by cancer screening

In Japan screening for cervical cancer, stomach cancer, lung cancer, breast cancer and colo-rectal cancer have been conducted widely under the Law of Health Maintenance for the Aged. Although the effects of mortality reduction for those cancer screenings have not been evaluated by randomized control trials, a number of researchers have evaluated the effects of mortality reduction by a case-control study and other methods (Hisamichi, 1998). To estimate the effects of mortality reduction by cancer screening in Japan, rough and rounded estimates odds ratios for receiving previous cancer screening were used (Table 4). An odds ratio of 0.5 for lung cancer screening was rounded from several independent studies (Sobue, 1992, Okamoto, 1999, Fujimura, 1999, Sagawa, 2001). An odds ratio of 0.6 for breast cancer screening was estimated from previous studies excluding screen detected symptomatic breast cancer patients. The preventable fraction was calculated by 1.0 –

Table 3. An Estimate of the Preventable Fraction of Cancer by Infecton Control (2001)

	Infection-associated cancer		
	Liver cancer	Gastric cancer	Total
Cancer-associated microorganisms	HBV/HCV*	*H. pylori***	
Attributable risk	90%	33%	
No. of cancer incidence (1996)	34,706	102,945	137,651
No. of caner attributable to the microorganisms	30,965	34,280	65,245
Attibutable risk reduced to a half	45.0%	16.7%	
No. of attributale cancer incidence reduced to a half	15,483	17,140	32,623
Preventable fraction of all cancer	3.3%	3.7%	7.0%

* HBV: Hepatitis B virus, HCV: Hepatitis C virus

** *H.pylori: Helicobacter pylori*, Infection rate: 50%, relative risk of gastric cancer is 2.0

Table 4. Summary of Estimated Preventable Farction of Cancer in Japan (2001)

	Smoking-associated cancer (Lung cancer et al)	Diet related cancer (Digestive tract cancer)	Microorganisms-raletd cancer (Liver and gastric cancers)	Total
		Improvenment of dietary habits: Avoidance of risk factor*	Prevention and eradication of infection	
Method of primary cancer prevention	Smoking control	Addition of protective factor**		
		* Reduced to a half		
Goal of cancer prevention	Reduce to a half	** Doubled	Reduced to a half	
Preventable fraction of related sites	17.5%	25.0%	13.9%	56.4%
Preventable fraction of all sites	8.8%	10.0%	7.0%	25.8%

odds ratio. The preventable number of cancer deaths could be estimated by multiplying the actual number of cancer incidence by the preventable fraction. The total number of preventable cancer deaths was estimated to be 85,405 (29.4% of all cancer deaths). It was estimated that 8.8% (14.7%) of all cancer deaths could be prevented if 30% (50%) of general population received all of those cancer screenings.

5) Estimate of reduction of cancer deaths by application of the state-of-the-art diagnosis and treatment of cancer

From a report of the population-based cancer registry, it was estimated that the five-year survival rate of all cancer patients had improved by 0.6% per year(Oshima, 1998). If the present level of improvement of the five year survival rate continues for 10 years, the five year survival rate will be elevated by 6% in 10 years. If the level of improvement could be elevated to 1.0% per year, the five year survival rate would be elevated by 10% in 10 years. Thus, it was estimated that 6-10% of cancer deaths could be reduced in 10 years by application of the state-of-the-art diagnosis and treatment of cancer.

6) Overall estimate of prevention of cancer incidence/deaths in Japan

Table 5 summarizes the overall estimate of cancer prevention in Japan. It was estimated that about 25% of cancer incidence could be prevented by smoking control, dietary control and control of tumor-associated viruses (HCV and HBV)/bacteria (Hp) and 9-15% of cancer deaths could be prevented if response rates of cancer screening would be all elevated to 30-50%, and 6-10% of cancer deaths could be avoided in 10 years if the-state-of-the-art diagnosis and treatment for cancer were applied to all cancer patients. Altogether 40-50% of cancer incidence/deaths could be avoided if best efforts are paid to primary prevention of cancer, cancer screening and medical care for cancer patients in Japan.

Table 5. An Estimate of Preventable Fraction of Cancer Deaths by Screening (2001)

	Sites of cancer screening					
	Stomach	Colo-rectum	Uterus	Lung	Breast	Total
A No. of cancer deaths (1999)	50,676	35,363	5,142	52,177	8,949	152,307
B Percentage of all sites of cancer	17.4%	12.2%	1.8%	18.0%	3.1%	52.4%
C Odds raio for receiving cancer screening	0.4	0.4	0.2	0.5	0.6	
D (=1.0-C) Preventable fraction of cancer deaths	60%	60%	80%	50%	40%	
E (=A x D) Preventable number of cancer deaths when response rate is 100%	30,406	21,218	4,114	26,089	3,580	85,405 (29.4%)
E30 Preventable fraction of cancer deaths when response rate is 30% (= E x 0.3)						8.8%
E50 Preventable fraction of cancer deaths when response rate is 50% (= E x 0.5)						14.7%

Table 6. An Estimate of the Potential of Prevention of Cancer Incidence/Deaths in Japan (2001)

Cancer control	Methods and assumptions of cancer control	Preventable fraction	
		Related sites	All sites
Primary prevention	Smoking rate reduced to a half	17.5%	8.8%
	Improvement of dietary habits	25.6%	10.3%
	Prevention/eradication of infecton	13.9%	7.0%
	Subtotal		26.1%
Cancer screening	Response rates of cancer screening for gastric, colo-rectal, cervical, lung and breast cancer are elevated to 30 to 50%	29.4%	8.8-14.7%
Improved diagnosis/treatment	5-year survival rate for all cancers to be elevated by 0.6 - 1.0% per year for 10 years		6.0-10.0%
Total			40.9-50.8%

Discussion

In planning and evaluating cancer control activities, it may be useful to estimate the potential of primary and secondary prevention of cancer. Following the estimation of cancer prevention in the USA by Greenwald & Sondik (Greenwald et al, 1986), the author has estimated the potential of cancer prevention in Japan twice previously 1990 and 1999. In this paper the potential of cancer prevention in Japan was re-estimated by using a different method and more recent data. Admittedly, this kind of bold estimates based on several assumptions may not be precise ones. Nevertheless, it is considered useful in planning and evaluating cancer control activities. The present estimates may be applicable to planning and evaluation of cancer control activities in the early 21st Century in Japan. The preventable fraction of cancer and the methods of prevention may vary from country to country depending on the common cancer, major risk factors and availability of medical resources in each country.

Another serious flaw of the present estimate is the omission of time factor except improvement of survival rate of cancer patients where a time frame of 10 years was considered. In general effects of primary prevention activities such as smoking cessation or prevention of smoking habits among minors may become manifest after many years. In the future study the time factor should be considered and more precise parameters should be used.

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