RESEARCH COMMUNICATION

A Comparison of Two Methods to Estimate the Cancer Incidence and Mortality Burden in China in 2005

Jian-Song Ren[1#], Wan-Qing Chen[2*#], Hai-Rim Shin[1], Jacques Ferlay[1], Kumiko Saika[3], Si-Wei Zhang[2], Freddie Bray[1]

Abstract

Knowledge of the cancer profile is an important step in planning rational cancer control programs and evaluation of their impact. Due to rapid changes in cancer incidence in China, national surveys may be insufficiently timely to provide adequate descriptions of the national burden. To evaluate the utility of cancer registries in describing the national cancer profile, this study compared two methods of estimating national cancer-specific incidence and mortality in China 2005, based on the Third National Death Survey (method I) as compared with registry material (method II). A total of 2.6 million cancer cases and 1.8 million cancer deaths were estimated by method I, as compared to 2.8 million cancer cases and 1.9 million cancer deaths using method II. The higher level of burden using the latter method in part may be due to a sizable differential in the magnitude of incidence rates across registries for certain cancer sites. Most cancer registries have been located in relatively more developed urban areas, or rural areas associated with higher risk for certain cancers. There are substantial differences in the cancer profile between urban and rural communities in China, and there may be concerns regarding the national representativeness of the data aggregated from this set of cancer registries. Timely and reliable estimation of cancer can only be realized if accurate information is available from cancer registries covering representative samples of the country.

Keywords: Cancer - incidence - mortality- estimation - China

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Introduction

Knowledge of the cancer profile in terms of incidence and mortality is an important step in the planning of rational cancer control programmes and evaluating their effects. In China, as a result of demographic and epidemiological transitions - population growth and ageing, industrialization and urbanization, socioeconomic changes and an increasingly westernized lifestyle - the cancer burden has been rising in the last decades. Age-standardized all-cancer mortality rates increased by 11.6% from 1973-1975 to 1990-1992 (Li et al., 1997).

Cancer incidence and mortality has been previously estimated in China for the year 2000 and also projected for the year 2005 (Yang et al., 2004a; 2005). The estimation for 2000 was included in the International Agency for Research on Cancer (IARC) compilation of country-specific cancer burden, GLOBOCAN 2002, with the number of cancer cases and deaths estimated for 2002, based on multiplying the rates in 2000 with the corresponding population in 2002 (Ferlay et al., 2004). The Chinese cancer burden was most recently estimated for 2008 as part of GLOBOCAN 2008 (globocan.iarc.fr), using mortality information from the Third National Death Survey (2004-2005) and incidence and mortality data from 36 cancer registries (2003-2005).

National surveys provide a comprehensive means from which to obtain information on cancer burden. However, given the size of the Chinese population - an estimated 1.3 billion inhabitants in 2005 - it takes great effort and resources to embark on such a project countrywide. Three national death surveys have been conducted in China (in 1973-1975, 1990-1992 and 2004-2005) and the collected data have been utilized to provide estimations of the cancer burden in China in several studies (Li, 1980; Zhang et al., 1999; Ferlay et al., 2004; Chen, 2009). Due to the rather rapid changes in cancer incidence in China however, the 10-20 years duration between surveys may be insufficiently timely to provide an adequate description of the national cancer burden. In comparative terms, data from cancer registries could, for example, be obtained regularly (each year) and in a more timely fashion.

This study therefore compares two methods of estimating the national cancer-specific incidence and mortality burden for 2005 in China, using the Third National Death Survey and good quality regional

*[1]Section of Cancer Information, International Agency for Research on Cancer, France, [2]National Office for Cancer Prevention and Control/National Central Cancer Registry, Cancer Institute, Chinese Academy of Medical Sciences, Beijing, China, [3]Cancer Information Service and Surveillance Division, Center for Cancer Control and Information Service, National Cancer Center, Japan. [#] co-first author, *For correspondence : chenwq@cicams.ac.cn*

Figure 1. Locations of the 36 Cancer Registries in China 2003-2005

population-based cancer registries as sources. Incidence estimates based on registry material are compared with a survey-based approach in order to evaluate the utility of up-to-date material from registries in describing the national cancer profile.

Materials and Methods

In putting together a set of cancer-specific national estimates of incidence and mortality in China for 2005, the following sources of data were examined and the relevant data extracted:

1. The Third National Death Survey (2004-2005).

In 2006, this survey collected deaths from all causes occurring during 2004-2005 within 160 populations defined at the county or city level across China, sampled using a multi-stage, strata-specific, cluster random sampling method accounting for factors related to the natural environment, economic development, population structure, education and health (Chen, 2009). In a first step, all counties and cities in the country were divided into three geographical areas (Eastern, Central and Western China), and within these by degree of urbanization (dichotomized as urban vs. rural). Urban areas were further divided into three strata according to the proportion living in non-agricultural areas or otherwise, and rural areas further stratified into three levels of GDP per capita. The sites within stratum were randomly sampled according to the national urban: rural ratio of 2:3. Excluding two datasets considered of poorer quality, data from 158 counties or cities were included, covering 142,660,482 person-years, and accounting for 5.5% of the national population. The sampling sites have been shown to be statistically representative, and the exclusion of the two datasets did not have a material impact given their relatively minor contribution to the total sample (The Ministry of Health of the People's Republic of China, 2008).

2. Population-Based Cancer Registries (2003-2005).

The numbers of cancer cases and cancer deaths by sex, age group and urban/rural residence were compiled from 36 registries with complete incidence and mortality information for the period 2003-2005 (Figure 1). Specifically, 15 cancer registries were selected from urban areas in 10 provinces: Beijing, Tianjin, Liaoning (4 registries), Shanghai, Jiangsu, Zhejiang (2 registries), Guangdong, Heilongjiang (2 registries), Anhui and Hubei; and 21 cancer registries from rural areas in 10 provinces: Hebei (2 registries), Jiangsu (8 registries), Zhejiang (2 registries), Fujian, Shandong (2 registries), Guangdong (2 registries), Shanxi, Henan, Guangxi and Sichuan. Population data were extracted from the same sources, with the total catchment population of these registries representing 145,489,363 person-years, about 3.8% of the national population.

3. National Population Estimates (2005).

Population data were estimated from a 1% sampling survey in 2005 from the National Bureau of Statistics of China (National Bureau of Statistics of China, 2006). Of the estimated national population of 1,306 million, 562 million were considered urban. Two methods of estimating national incidence and mortality were employed and the results compared.

Method I

The method had two steps: the estimation of Incidence: Mortality (*I:M*) ratios, followed by the derivation of national incidence on applying these ratios to the estimates of national mortality.

Estimation of national I:*M* ratios: Each registry dataset was first weighted by a factor $1/\sqrt{P}$, where P represents the population size of given registry, thus taking into account its relative size and giving additional weight to those with relatively smaller catchment populations (Bray et al., 2002). The 36 registries were then grouped by type of residence (urban or rural) and aggregated. Regional (urban and rural) incidence: mortality ratios were modeled by fitting Poisson models to the log of the incidence counts offset by the corresponding log of mortality in Stata (McCullagh and Nelder, 1989), adjusted for age and sex. The national *I:M* ratios were obtained from the population-weighted averages of the fitted regional *I:M* ratios:

$$(I/M)_N = [(I/M)_U \times W_U + (I/M)_R \times W_R] / (W_U + W_R) \quad (1)$$

where N refers to national, and W_U and W_R to the population size in urban and rural areas, respectively.

Conversion of mortality to incidence: The national incidence was then calculated as the product of the estimated national mortality (age- and sex-specific; M_{Nij}) and the corresponding fitted *I:M* ratios ($\hat{I}_{Rij} / M_{Rij}$):

$I_{Nij} = M_{Nij} \times \hat{I}_{Rij} / M_{Rij}$ (2)

where i and j index the 9 age groups (0-44, 45-49, 50-54, …, 80+) and sex, respectively. Age-standardized rates were calculated using the world standard population (Doll et al., 1966).

Estimation of national mortality: National mortality rates for urban and rural areas were computed using data from the Third National Death Survey in 2004-2005, as described above. The overall rates for China were computed as population-weighted averages of the regional rates, using the population proportions of urban and rural-defined areas obtained from the National Bureau of Statistics of China (2005).

Method II

Estimation of national incidence: Incidence data (2003-2005) from the 36 Chinese cancer registries were grouped by type of residence and by province. Cancer incidence rates by type of residence (15 registries in 10 urban provinces and 21 in 10 rural provinces) were computed, assuming that these cancer registries were representative of the cancer profile of the province and type of residence. For the remaining provinces - for which no cancer registry data were available, we converted the urban/rural mortality rates from the Third National Death Survey to incidence rates using the urban/rural *I:M* ratios obtained from Method I. The overall incidence rates for China are the population-weighted average of the regional rates (by province and type of residence).

Estimation of national mortality: Mortality data (2003-2005) from 36 Chinese cancer registries were first grouped by type of residence and by province. Cancer mortality rates by type of residence (15 registries in 10 provinces for urban areas and 21 registries in 10 provinces for rural areas) were computed, assuming that these cancer registries are representative of the cancer pattern within each province. For the remaining urban/rural provinces - for which no cancer registry data exist we used the corresponding rates from the Third National Death Survey. The overall mortality rates for China are the population-weighted averages of the regional rates (by province and type of residence).

Results

Results are presented for the following cancer sites defined by the 10th edition of the International

Table 1. Estimated Cancer Incidence and Mortality in China 2005, Males (Rates per 100,000)

Site	Method I				Method II				Method II-Method I				Diff %[c]	
	Cases	Inc[a]	Deaths	Mort[b]	Cases	Inc[a]	Deaths	Mort[b]	Cases	Inc[a]	Deaths	Mort[b]	Inc[a]	Mort[b]
Oral cavity and pharynx	36 261	5.2	21 359	3.1	45 695	6.7	26 244	3.8	9 433	1.4	4 884	0.7	27.6	24.0
Oral cavity	9 593	1.4	4 886	0.7	11 806	1.7	5 645	0.8	2 213	0.4	759	0.1	25.5	17.6
Nasopharynx	22 242	3.2	13 933	2.0	29 149	4.3	17 960	2.6	6 906	1.0	4 027	0.6	32.5	29.7
Other pharynx	4 426	0.6	2 540	0.4	4 740	0.7	2 639	0.4	315	0.1	98	0.0	7.3	4.7
Esophagus	166 305	23.7	132 953	18.9	241 572	34.9	193 924	28.0	75 268	11.2	60 971	9.1	47.1	47.9
Stomach	298 718	42.7	214 924	30.6	343 403	49.7	248 751	36.0	44 685	7.0	33 828	5.3	16.4	17.3
Colon/rectum	117 323	16.8	58 597	8.4	116 698	16.9	57 431	8.3	-626	0.1	-1 166	-0.1	0.5	-0.9
Liver	273 772	39.1	249 197	35.5	269 548	38.9	243 565	35.2	-4 224	-0.1	-5 633	-0.4	-0.3	-1.0
Gallbladder	10 951	1.6	8 460	1.2	11 821	1.7	9 194	1.3	870	0.2	734	0.1	9.8	10.6
Pancreas	23 708	3.4	21 414	3.0	25 877	3.7	22 997	3.3	2 169	0.4	1 583	0.3	10.8	8.8
Larynx	16 457	2.4	9 021	1.3	17 341	2.5	9 784	1.4	884	0.2	763	0.1	6.2	9.3
Lung	334 079	47.6	288 660	41.1	318 840	46.0	274 983	39.6	-15 239	-1.6	-13 678	-1.5	-3.4	-3.6
Melanoma of skin	1 922	0.3	1 125	0.2	2 061	0.3	1 059	0.2	138	0.0	-66	0.0	9.3	-4.6
Prostate	27 001	3.8	13 327	1.9	26 928	3.9	11 954	1.7	-73	0.1	-1 373	-0.2	1.4	-8.4
Testis	2 323	0.3	643	0.1	2 442	0.4	558	0.1	119	0.0	-84	0.0	7.6	-10.0
Kidney	17 933	2.6	6 675	1.0	18 735	2.7	6 579	1.0	802	0.1	-96	0.0	5.0	-0.7
Bladder	39 089	5.6	15 030	2.1	38 196	5.5	14 733	2.1	-893	-0.1	-297	0.0	-0.9	0.0
Brain, nervous system	32 763	4.7	24 049	3.5	31 215	4.6	23 174	3.4	-1 548	-0.2	-875	-0.1	-3.6	-2.6
Thyroid	6 413	0.9	1 347	0.2	6 774	1.0	1 428	0.2	360	0.1	80	0.0	6.3	8.3
Hodgkin lymphoma	2 763	0.4	1 591	0.2	2 478	0.4	1 270	0.2	-285	0.0	-320	0.0	-8.5	-19.3
Non-Hodgkin lymphoma	17 662	2.5	10 722	1.5	22 504	3.3	12 818	1.9	4 842	0.8	2 096	0.3	29.8	21.7
Multiple myeloma	3 012	0.4	2 200	0.3	3 701	0.5	2 456	0.4	688	0.1	257	0.0	23.9	12.6
Leukemia	36 467	5.4	28 890	4.3	32 873	4.9	25 859	3.9	-3 593	-0.5	-3 031	-0.4	-8.6	-9.2
All sites but skin	1 552 527	222.0	1 147 920	163.7	1 651 256	239.0	1 228 417	177.4	98 729	17.0	80 497	13.7	7.6	8.4

[a]Incidence rates, [b]Mortality rates, [c]Diff% = (Method II - Method I)/Method I x100%.

Table 2. Estimated Cancer Incidence and Mortality in China 2005, Females (Rates per 100,000)

Site	Method I				Method II				Method II-Method I				Diff %[c]	
	Cases	Inc[a]	Deaths	Mort[b]	Cases	Inc[a]	Deaths	Mort[b]	Cases	Inc[a]	Deaths	Mort[b]	Inc[a]	Mort[b]
Oral cavity and pharynx	16 696	2.4	8 533	1.2	22 951	3.4	11 198	1.6	6 255	0.9	2 666	0.4	37.8	31.0
Oral cavity	5 310	0.8	2 296	0.3	7 617	1.1	3 499	0.5	2 307	0.3	1 203	0.2	41.9	51.6
Nasopharynx	9 948	1.5	5 374	0.8	13 959	2.1	6 910	1.0	4 011	0.6	1 536	0.2	41.8	29.0
Other pharynx	1 438	0.2	862	0.1	1 375	0.2	789	0.1	-63	0.0	-74	0.0	-6.5	-11.1
Esophagus	68 369	9.3	57 855	7.6	131 425	17.9	104 292	13.8	63 057	8.7	46 437	6.2	93.4	81.6
Stomach	130 733	17.8	104 635	13.7	156 593	21.3	125 824	16.6	25 860	3.5	21 189	2.9	19.6	20.8
Colon/rectum	83 545	11.6	43 134	5.7	89 440	12.3	45 198	5.9	5 895	0.7	2 064	0.2	5.9	3.7
Liver	93 482	12.9	91 402	12.4	91 007	12.5	88 192	11.9	-2 475	-0.4	-3 210	-0.5	-3.1	-4.3
Gallbladder	12 461	1.7	9 643	1.3	13 849	1.8	10 621	1.4	1 388	0.2	978	0.1	8.8	7.1
Pancreas	17 601	2.4	16 156	2.2	19 683	2.6	17 698	2.3	2 082	0.2	1 542	0.2	10.2	7.3
Larynx	3 645	0.5	2 591	0.3	3 161	0.4	2 315	0.3	-484	-0.1	-276	0.0	-15.1	-12.5
Lung	150 033	20.3	132 936	17.6	144 810	19.4	127 857	16.7	-5 223	-0.9	-5 080	-0.9	-4.5	-5.3
Melanoma of skin	1 202	0.2	737	0.1	1 511	0.2	807	0.1	309	0.0	70	0.0	25.7	9.0
Breast	139 048	20.4	39 655	5.7	146 739	21.5	40 082	5.7	7 691	1.1	427	0.0	5.2	0.3
Cervix uteri	61 055	9.2	18 264	2.6	58 312	8.7	18 979	2.7	-2 743	-0.4	715	0.1	-4.9	2.6
Corpus uteri	50 698	7.4	10 380	1.5	38 001	5.5	8 407	1.2	-12 697	-1.9	-1 973	-0.3	-25.5	-19.5
Ovary	23 746	3.5	10 357	1.5	26 920	4.0	10 611	1.5	3 174	0.5	254	0.0	14.2	2.5
Kidney	8 573	1.2	3 301	0.4	9 721	1.4	3 619	0.5	1 148	0.2	319	0.0	12.0	7.0
Bladder	10 603	1.4	4 504	0.6	10 575	1.4	4 444	0.5	-28	0.0	-60	0.0	-2.5	-3.6
Brain, nervous system	27 754	4.1	18 017	2.6	26 929	4.0	17 437	2.5	-825	-0.1	-580	-0.1	-3.3	-4.0
Thyroid	13 996	2.1	1 680	0.2	17 214	2.6	2 109	0.3	3 218	0.5	429	0.1	24.6	22.2
Hodgkin lymphoma	1 444	0.2	972	0.1	1 312	0.2	788	0.1	-131	0.0	-184	0.0	-9.5	-18.9
Non-Hodgkin lymphoma	10 687	1.5	6 416	0.9	13 916	2.0	7 662	1.1	3 229	0.5	1 247	0.2	30.6	19.1
Multiple myeloma	2 215	0.3	1 608	0.2	2 850	0.4	1 762	0.2	636	0.1	154	0.0	26.6	7.6
Leukemia	27 811	4.2	21 950	3.3	24 787	3.8	19 440	2.9	-3 024	-0.4	-2 510	-0.4	-10.4	-11.0
All sites but skin	1 030 260	144.1	646 944	87.4	1 117 879	155.7	710 880	95.2	87 619	11.5	63 937	7.8	8.0	8.9

[a]Incidence rates, [b]Mortality rates, [c]Diff% = (Method II - Method I)/Method I x 100%.

Table 3. Chinese Registries with High Incidence Rates of Certain Cancers, Males

Sites	Estimated National Incidence	Estimated National Mortality	Registries	Incidence			Mortality		
				ASR	Abs diff[a]	Rel change[b]	ASR	Abs diff[a]	Rel change[b]
Oral cavity/ pharynx	5.2	3.1	Guangzhou	24.5	19.2	3.7	10.8	7.7	2.5
			Sihui	29.8	24.6	4.7	22.1	19.1	6.2
			Zhongshan	36.1	30.9	5.9	25.4	22.3	7.3
Nasopharynx	3.2	2.0	Guangzhou	19.2	16.0	5.0	9.0	7.0	3.5
			Sihui	27.4	24.2	7.6	20.1	18.1	9.0
			Zhongshan	28.2	25.0	7.8	19.5	17.5	8.8
Esophagus	23.7	18.9	Cixian	191.3	167.6	7.1	153.2	134.3	7.1
			Feicheng	95.3	71.6	3.0	85.4	66.4	3.5
			Huaian	109.8	86.1	3.6	88.9	69.9	3.7
			Linzhou	98.1	74.4	3.1	82.5	63.6	3.4
			Shexian	122.3	98.6	4.2	108.3	89.4	4.7
			Yangcheng	151.7	128.0	5.4	119.4	100.4	5.3
			Yangzhong	105.1	81.4	3.4	82.4	63.5	3.4
			Yanting	104.3	80.6	3.4	88.5	69.5	3.7
Stomach	42.7	30.6	Shexian	194.5	151.9	3.6	162.7	132.0	4.3
			Yangcheng	175.3	132.6	3.1	118.4	87.8	2.9

[a]Abs diff = absolute differences in rates (Registries rate - National rate), [b]Rel change = Abs Diff/National rate. ASR=Age-standardized (world) rates per 100000

Classification of Diseases (ICD-10): oral cavity (C00-08), nasopharynx (C11), other pharynx (C09-10, C12-14), oesophagus (C15), stomach (C16), colorectal cancer (C18-21), liver (C22), gallbladder (C23-24), pancreas (C25), larynx (C32), lung (including trachea, C33-34), melanoma of skin (C43), female breast (C50), cervix uteri (C53), corpus uteri (C54), ovary (C56), prostate (C61), testis (C62), kidney (including renal pelvis and ureter, C64-66), bladder (C67), brain and central nervous system (C70-72), thyroid (C73), Hodgkin lymphoma (C81), non-Hodgkin lymphoma (C82-85, C96), multiple myeloma (C88+C90), leukaemia (C91-95) and all cancers combined, excluding non-melanoma skin cancer (C00-96 but C44). This last category was calculated by summing the estimated numbers for each individual cancer site, and the estimated number in a residual category "other and unspecified cancers" (for which results are not shown).

Table 4. Chinese Registries with High Incidence Rates of Certain Cancers, Females

Sites	Estimated National Incidence	Estimated National Mortality	Registry	Incidence			Mortality		
				ASR	Abs diff[a]	Rel change[b]	ASR	Abs diff[a]	Rel change
Oral cavity/ pharynx	2.4	1.2	Guangzhou	16.5	14.0	5.8	3.9	2.8	2.3
			Sihui	13.0	10.6	4.3	9.1	7.9	6.7
			Zhongshan	14.2	11.7	4.8	8.8	7.6	6.4
Oral cavity	0.8	0.3	Guangzhou	3.3	2.6	3.4	0.6	0.3	1.0
Nasopharynx	1.5	0.8	Guangzhou	12.8	11.4	7.8	3.2	2.5	3.3
			Sihui	11.7	10.3	7.1	8.3	7.5	9.9
			Zhongshan	12.0	10.5	7.2	7.6	6.8	9.0
Esophagus	9.3	7.6	Cixian	101.5	92.3	10.0	67.9	60.3	8.0
			Feicheng	40.3	31.1	3.4	37.8	30.2	4.0
			Huaian	75.4	66.1	7.1	57.4	49.9	6.6
			Jianhu	48.2	38.9	4.2	32.5	24.9	3.3
			Linzhou	69.6	60.3	6.5	56.1	48.5	6.4
			Shexian	54.7	45.5	4.9	52.6	45.0	5.9
			Yangcheng	95.1	85.8	9.3	69.8	62.2	8.2
			Yangzhong	74.9	65.6	7.1	63.3	55.8	7.4
			Yanting	72.9	63.6	6.9	50.4	42.8	5.6
Stomach	17.8	13.7	Shexian	89.4	71.6	4.0	79.2	65.5	4.8
			Yangzhong	73.2	55.4	3.1	57.3	43.5	3.2
			Yanting	72.0	54.2	3.1	62.5	48.8	3.6
Cervix uteri	9.2	2.6	Yangcheng	81.3	72.2	7.9	26.7	24.1	9.3
Thyroid	2.1	0.2	Changle	13.6	11.5	5.5	0.8	0.6	2.4
			Dalian	10.0	7.9	3.8	0.5	0.3	1.1
			Hangzhou	9.2	7.1	3.4	0.2	-0.1	-0.3
			Shanghai	9.3	7.2	3.5	0.5	0.3	1.3

[a]Abs diff = absolute differences in rates (Registries rate - National rate), [b]Rel change = Abs Diff/National rate. ASR=Age-standardized (world) rates per 100000

Table 5. Comparison of Projected and Estimated Age-Standardized (World) Incidence and Mortality Rates per 100000

Cancer	Incidence rates			Mortality rates		
	Yang et al	Method I	Diff[a]	Yang et al	Method I	Diff[a]
Male						
All sites	210.8	222.0	11.2	161.1	163.7	2.6
Lung	49.0	47.6	-1.4	41.8	41.1	-0.7
Stomach	37.1	42.7	5.6	28.8	30.6	1.8
Liver	40.0	39.1	-1.0	36.2	35.5	-0.7
Esophagus	24.0	23.7	-0.3	18.8	18.9	0.1
Colon/rectum	15.0	16.8	1.8	8.6	8.4	-0.2
Nasopharynx	3.8	3.2	-0.6	2.3	2.0	-0.3
Bladder	4.0	5.6	1.6	1.9	2.1	0.2
Leukemia	5.9	5.4	-0.5	4.4	4.3	-0.2
Female						
All sites	140.6	144.1	3.5	88.8	87.4	-1.4
Lung	22.9	20.3	-2.6	19.3	17.6	-1.7
Stomach	17.4	17.8	0.4	13.3	13.7	0.4
Liver	15.3	12.9	-2.5	13.9	12.4	-1.5
Esophagus	9.7	9.3	-0.4	7.7	7.6	-0.1
Cervix	7.0	9.2	2.2	3.2	2.6	-0.6
Breast	24.8	20.4	-4.4	6.7	5.7	-1.1
Colon/rectum	9.7	11.6	1.9	5.4	5.7	0.3
Nasopharynx	1.8	1.5	-0.3	1.1	0.8	-0.3
Bladder	1.5	1.4	-0.1	0.6	0.6	-0.1
Leukemia	4.0	4.2	0.2	2.8	3.3	0.5

[a]Abs Diff = absolute differences between projected and estimated rates.

Method I

According to method I, there were 1.6 million new cases and 1.1 million deaths from cancer for males in China in 2005, and 1.0 million new cases and 0.7 million deaths for females (Tables 1 and 2). In males, the five commonest cancer sites were lung (age-standardized rate 47.6/10^5, 334 079 cases), stomach (42.7/10^5, 298 718 cases), liver (39.1/10^5, 273 772 cases), esophagus (23.7/10^5, 166 305 cases) and colorectum (16.8/10^5, 117 323 cases). In females, the top five comprised cancers

of the lung (20.3/10^5, 150 033 cases), breast (20.4/10^5, 139 048 cases), stomach (17.8/10^5, 130 733 cases), liver (12.9/10^5, 93 482 cases) and colorectum (11.6/10^5, 83 545 cases). The leading causes of death from cancer for males were lung cancer (41.1/10^5, 288 660 deaths), followed by cancers of the liver (35.5/10^5, 249 197 deaths), stomach (30.6/10^5, 214 924 deaths), esophagus (18.9/10^5, 132 953 deaths) and the colorectum (8.4/10^5, 58 597 deaths). For females, the five commonest causes of death from cancer were cancers of lung (17.6/10^5, 132 936 deaths), stomach (13.7/10^5, 104 635 deaths), liver (12.4/10^5, 91 402 deaths), esophagus (7.6/10^5, 57 855 deaths), and the colorectum (5.7/10^5, 43 134 deaths).

Method II

Using method II, 1.7 million new cancer cases and 1.2 million cancer deaths were estimated in men in 2005, and about 1.1 million new cases and 0.7 million deaths in women (Tables 1 and 2). Thus, a slightly greater level of burden was estimated, with the overall all-cancer incidence rate differences of 7.6% and 8.0% in men and women, respectively, compared with method I, with slightly larger differences still in the mortality estimations. The five commonest cancer sites were stomach, lung, liver, esophagus and colorectum for males, and breast, stomach, lung, esophagus and liver for females.

Comparison of the two methods

In both males and females, the greatest difference in the estimated rates between methods was for esophageal cancer, followed by oral cavity and pharynx, nasopharynx, non-Hodgkin lymphoma and multiple myeloma.

We calculated the incidence rates for each registry by sex and cancer site (Tables 3 and 4), and found some registries reported very high incidence for certain cancer sites (national incidence rates using method II were three times more than those estimated from method I). For males, three registries had particularly high rates of cancers of the oral cavity, pharynx and nasopharynx, eight registries had elevated rates of esophageal cancer and two registries had high stomach cancer rates. For females, three registries were found to have a high incidence of cancers of the oral cavity and pharynx and nasopharynx, while nine had high esophageal cancer rates, and four had high incidence rates of thyroid cancer. Such disparities between registries concerning the most frequent cancers likely reflect local epidemiological patterns more than registration differences in the ascertainment of cases.

Comparison with external predictions for 2005

Despite the differences in the sources used in earlier projections and our estimations, the predictions by Yang et al. (2004a; 2005) and our own estimates are quite similar (Table 5). The differences of mortality rates from these two studies were less than 2.0/10^5 for common cancer sites (8 sites for men, 12 sites for women), and less than 3.0/10^5 for all sites combined. We found the differences in incidence rates bigger than for mortality. The biggest incidence rate difference for a specific site was found for male stomach cancer (5.6/10^5 higher) and female breast cancer (4.4/10^5 lower). For all sites combined, the estimated incidence rates were 11.2/10^5 and 3.5/10^5 higher than the projected rates in men and women respectively.

Discussion

This study compared two approaches to the estimation of the national cancer-specific incidence and mortality burden for 2005 in China. One approach (method II) was based on the assumption that the cancer registries are representative of the cancer pattern of the corresponding provinces. However, most of the 36 cancer registries are in fact located in relatively more developed urban areas, or rural areas associated with higher risk for certain cancers. There are substantial differences in the cancer profile between urban and rural communities observed in China (Chen, 2009), and as a result the degree of national representativeness of the cancer registries collectively might be questioned.

For the 34 registries which supplied data for 2005, the total population was 55 million, accounting for 4.3% of the national population. The registry coverage levels were somewhat unbalanced when examined according to region and type of residence; varying from 9% in the eastern region of China, to 2.0% and 0.3% in the central and western regions, respectively. In urban areas, the coverage was 7.3%, but only 2.0% in rural areas. The aggregation of registry rates does not therefore appear entirely representative of the national picture. Given the lack of representativeness of the accrued incidence data from the cancer registries, the results from method I (which uses M:I ratios as a proxy for case fatality) may be a more valid estimation procedure than that of method II (which inherently assumes that the cancer registries are representative of the actual cancer pattern within each province).

Cancer incidence and mortality in China has been projected for 2005 previously (Yang et al., 2004a; 2005). Yang et al (2003) obtained cancer mortality rates from the Second National Death Survey in 1990-1992, and for each year (1991-1999) from the population covered by the cancer reporting system developed by the Center for Health Information and Statistics (CHIS). Incidence rates were obtained by multiplying the mortality rates by the corresponding *I:M* ratios derived from the seven population-based cancer registries in China that were included in *Volume VIII of Cancer Incidence in Five Continents* (Parkin, 2002). Compared with that study, more recent mortality data (the Third National Death Survey in 2004-2005 vs. the Second National Death Survey in 1990-1992) were used here. Moreover, we used more recent incidence and mortality data (from cancer registries 2003-2005 compared with 1993-1997 previously) from a greater number of registries (33 registries vs. 7 previously) in the calculation of *I:M* ratios.

The National Office for Cancer Prevention and Control in China has also estimated cancer burden for 2004-2005 (Chen, 2009). In that analysis, incidence and mortality estimates for 23 sites in male and 25 sites in female were obtained by type of residence (urban and rural) and sex, using the mortality data from the Third National Death Survey data in 2004-2005, with incidence and mortality

(for the calculation of I:M ratio) derived from 32 cancer registries using data 2003-2004. The estimated mean annual number of cancer cases and deaths 2004-5 was 2 596 112 and 1 798 147, respectively, not dissimilar to our estimates using method I.

Besides the availability of national death surveys and cancer registries, the data from special research projects have been used for the estimation of cancer incidence and mortality rates. One project, the National Mortality Statistics system, managed by CHIS, Ministry of Health (Yang et al., 2003), covered about 10% of the population but the sample sites were not representative of the national population as a whole. The data were available for the years 1987-2000 via the WHO Mortality Database (WHO Statistical Information System, 2010). The representativeness of the data from the Disease Surveillance Points system (DSP) (Yang et al., 2003) was considered questionable for sex and region (urban/rural), based on age-standardized mortality rates, with a rather higher male: female ratio in the older age groups and an underestimation of mortality rates in rural areas (Yang et al., 2004b).

The methods realized in the estimation of cancer incidence and mortality are dependant on the availability of cancer information. Using data from the Third National Death Survey in 2004-2005 and *I: M* ratios obtained from the cancer registries, we were able to estimate the cancer burden for 2005 using recent timely data sources. Because the area covered by the cancer registries does not match that of the Third National Survey, a question as to their representativeness remains. In order to obtain cancer information in a consistent and timely manner, incidence data that better capture the disparate regional cancer profiles in China are warranted, particularly within rural catchment areas.

To further this aim, the National Center for Cancer Registration was created in 2002 in China (National Office for Cancer Prevention and Control, China, 2008), with 52 new registries established in 2008 and a further 54 in 2009. At present, 146 million persons (11% of total population) are covered by 149 registries throughout all of the provinces/type of residence. In the future, when these registries are able to provide population-based cancer incidence and mortality information, there will be the opportunity to further validate these sources and assess their individual degree of representativeness in describing the local cancer profiles in China, as well as their collective utility in estimating the national cancer burden.

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References

Bray F, Sankila R, Ferlay J, et al (2002). Estimates of cancer incidence and mortality in Europe in 1995. *Eur J Cancer*, **38**, 99-166.

Chen WQ (2009). Estimation of cancer incidence and mortality in China in 2004-2005. *Zhonghua Zhong Liu Za Zhi*, **31**, 664-8.

Doll R, Payne P, Waterhouse J (1966). Cancer incidence in five continents: a technical report. *Berlin, Springer-Verlag*, 244.

Ferlay J, Bray F, Pisani P, et al (2004). GLOBOCAN 2002. Cancer incidence, mortality and prevalence worldwide. Lyon, France, IARCPress.

Li FP (1980). Cancer mortality in China, 1975-2000: implications for cancer control. *Cancer Detect Prev*, **3**, 499-506.

Li LD, Lu FZ, Zhang SW, et al (1997). Analysis of variation trend and short term detection of Chinese malignant tumor mortality during twenty years. *Zhonghua Zhong Liu Za Zhi*, **1**, 3-9.

McCullagh P, Nelder JA (1989). Generalized linear models. 2nd edition ed. London, Chapman & Hall/CRC.

National Bureau of Statistics of China (2006). China statistical yearbook 2006. Beijing, China, China Statistics Press.

National Office for Cancer Prevention and Control (NOCPC) (2008). National center for cancer registration, department of diseases control CMoH. Cancer registry yearbook of China (2004). Beijing,China, Peking Union Medicai College Press.

Parkin DM, Whelan SL, Ferlay J, et al (2002). Cancer incidence in five continents, Vol. VIII.Lyon,France, IARC Press.

The Ministry of Health of the People's Republic of China (2008). Report on the third national retrospective sampling death survey. Beijing, Peking Union Medical College Press.

WHO Statistical Information System (WHOSIS) (2010). WHO Mortality Database. http://www.who.int/whosis/mort/download/en/index.html.

Yang L, Parkin DM, Li L, et al (2003). Sources of information on the burden of cancer in China. *Asian Pac J Cancer Prev*, **4**, 23-30.

Yang L, Parkin DM, Li LD, et al (2004a). Estimation and projection of the national profile of cancer mortality in China:

1991-2005. *Br J Cancer*, **90**, 2157-66.
Yang L, Parkin DM, Li L, et al (2004b). A comparison of the sources of cancer mortality in China. *Cancer Causes Control*, **15**, 681-7.
Yang L, Parkin DM, Ferlay J, et al (2005). Estimates of cancer incidence in China for 2000 and projections for 2005. *Cancer Epidemiol Biomarkers Prev*, **14**, 243-50.
Zhang S, Li L, Lu F (1999). Mortality of primary liver cancer in China from 1990 through 1992. *Zhonghua Zhong Liu Za Zhi*, **21**, 245-9.