

Cancer Statistics in China, 2015

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With increasing incidence and mortality, cancer is the leading cause of death in China and is a major public health problem. Because of China's massive population (1.37 billion), previous national incidence and mortality estimates have been limited to small samples of the population using data from the 1990s or based on a specific year. With high-quality data from an additional number of population-based registries now available through the National Central Cancer Registry of China, the authors analyzed data from 72 local, population-based cancer registries (2009-2011), representing 6.5% of the population, to estimate the number of new cases and cancer deaths for 2015. Data from 22 registries were used for trend analyses (2000-2011). The results indicated that an estimated 4292,000 new cancer cases and 2814,000 cancer deaths would occur in China in 2015, with lung cancer being the most common incident cancer and the leading cause of cancer death. Stomach, esophageal, and liver cancers were also commonly diagnosed and were identified as leading causes of cancer death. Residents of rural areas had significantly higher age-standardized (Segi population) incidence and mortality rates for all cancers combined than urban residents (213.6 per 100,000 vs 191.5 per 100,000 for incidence; 149.0 per 100,000 vs 109.5 per 100,000 for mortality, respectively). For all cancers combined, the incidence rates were stable during 2000 through 2011 for males (+0.2% per year; $P = .1$), whereas they increased significantly (+2.2% per year; $P < .05$) among females. In contrast, the mortality rates since 2006 have decreased significantly for both males (-1.4% per year; $P < .05$) and females (-1.1% per year; $P < .05$). Many of the estimated cancer cases and deaths can be prevented through reducing the prevalence of risk factors, while increasing the effectiveness of clinical care delivery, particularly for those living in rural areas and in disadvantaged populations. *CA Cancer J Clin* 2016;000:000-000. © 2016 American Cancer Society.

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Introduction

Cancer incidence and mortality have been increasing in China, making cancer the leading cause of death since 2010 and a major public health problem in the country.¹ Much of the rising burden is attributable to population growth and ageing and to sociodemographic changes. Although previous estimates of the national incidence rates have been reported, they either represented a small sample of the Chinese population (<2%)² or were based on data from a specific year.^{3,4} This has a bearing on the uncertainty of the estimates and their degree of national representativeness and, thus, would potentially limit the evidence available to develop appropriate policies for effective cancer control. Because the previous Program of Cancer Prevention and Control in China (2004-2010)⁵ was released more than 10 years ago, a more complete picture of the national and regional scale and profile in China would provide greater clarity in prioritizing and developing specific policies and programs across the spectrum of cancer control aimed at reducing the burden and suffering from the disease at the national level.

Additional supporting information may be found in the online version of this article.

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This study reports the most recent cancer incidence, mortality, and survival estimates nationally; the most recent incidence and mortality patterns for several major cancers by geographic area in China; and temporal trends for some major cancers as well as the implications of this information for cancer control in China.

Data Sources and Methods

Cancer Registration in China

The National Central Cancer Registry of China (NCCR), established in 2002, is responsible for the collection, evaluation, and publication of cancer data in China. Cancer diagnoses are reported to local cancer registries from multiple sources, including local hospitals and community health centers as well as the Urban Resident Basic Medical Insurance program and the New Rural Cooperative Medical Scheme. Since 2002, the implementation of standard registration practices has seen a marked improvement in the quality of cancer registration in China. In 2008, the National Program of Cancer Registries was launched by the Ministry of Health of China through a central financing mechanism. Since then, the number of local population-based registries in China has increased from 54 in 2008 (population coverage of 110 million) to 308 (population coverage of 300 million) in 2014.³

Not all of these registries currently have sufficiently high data quality for reporting purposes. The quality of submitted data for each local registry was checked and evaluated by the NCCR based on the *Guidelines for Chinese Cancer Registration*⁶ and International Agency for Research on Cancer/International Association of Cancer Registries (IARC/IACR) data-quality criteria.⁷ The assessments of quality measures include, but are not limited to, the proportion of morphologic verification (MV%), the percentage of cancer cases identified with death certification only (DCO%), the mortality (M) to incidence (I) ratio (M/I), the percentage of uncertified cancer (UB%), and the percentage of cancer with undefined or unknown primary site (CPU%). Only data from those local registries that consistently met appropriate levels of quality were included in these analyses. Detailed quality categories of the registry data can be found in a previous publication (Table 1).⁸ Data classified as category A or B were deemed acceptable for inclusion in this study. The proportions of cancer registries that submitted data sets and were accepted for inclusion varied by year of submission, from 69.2% (72 of 104 registries) in 2009,⁹ to 66.2% (145 of 219 registries) in 2010,⁴ and 75.6% (177 of 234 registries) in 2011.³ We included data from the 72 cancer registries that were available for all 3 years.

Cancer Incidence Data

To estimate the numbers of new cancers in China in 2015, we used the most recent data (cancer cases registered during 2009–2011) from 72 local population-based cancer registries

TABLE 1. List of Population-Based Cancer Registries in China Used for Incidence/Mortality Estimates, Temporal Trends, or Survival Estimates

PROVINCE	REGISTRY	PROVINCE	REGISTRY
Beijing	Beijing*†‡	Jilin	Dehui
Hebei	Qianxi	Zhejiang	Yanji
	Shexian		Hangzhou†
	Cixian*†‡		Jiaxing*†
	Baoding		Jiashan*†‡
Shanxi	Yangquan		Haining*†‡
	Yangcheng*		Shangyu
Inner Mongolia	Chifeng		Xianju
Liaoning	Shenyang	Anhui	Feixi
	Dalian†‡		Maanshan
	Zhuanghe		Tongling
	An'shan†	Fujian	Changle†‡
	Benxi		Xiamen
	Dandong	Jiangxi	Zhanggong District, Ganzhou
	Donggang	Shandong	Linqi†
Heilongjiang	Daoli District, Harbin		Wenshang
	Nangang District, Harbin*†		Feicheng†‡
	Shangzhi	Henan	Yanshi
Shanghai	Shanghai*†		Linzhou†‡
Jiangsu	Jintan†		Xiping
	Suzhou	Hubei	Wuhan†‡
	Haian		Yunmeng
	Qidong*†‡	Hunan	Hengdong
	Haimen	Guangdong	Guangzhou†
	Lianyungang		Sihui†‡
	Donghai		Zhongshan*†‡
	Guanyun	Guangxi	Liuzhou
	Huaian District, Huai'an†		Fusui
	Huaiyin District, Huai'an	Chongqing	Jiulongpo District, Chongqing
	Xuyi	Sichuan	Qinyang District, Chengdu
	Jinhu		Ziliujing District, Zigong
	Sheyang		Yanting*
	Jianhu†	Gansu	Jingtai
	Dafeng†		Liangzhou District, Wuwei
	Ganyu†§	Qinghai	Xining
	Yangzhong†	Xinjiang	Xinyuan
	Taixing†		

*These are registries from which data were accepted by the International Agency for Research on Cancer for the most recent publication of *Cancer Incidence in Five Continents* (2014).

†These data were used for temporal trends analyses.

‡These data were used for survival analyses.

§All registry data were used to estimate incidence and mortality in 2015 except data from Ganyu.

(Table 1), providing a population coverage of about 85.5 million people, about 6.5% of the national population. A much smaller number of registries (n = 22) (Table 1), which provided a population coverage of 44.4 million, had data of sufficient quality over the 12-year period (2000–2011) for inclusion in incidence trend analyses. The locations of these 2 sets of cancer registries can be found in Figure 1.

We included invasive tumors only in this study, and multiple primary cancers were defined using the international rules

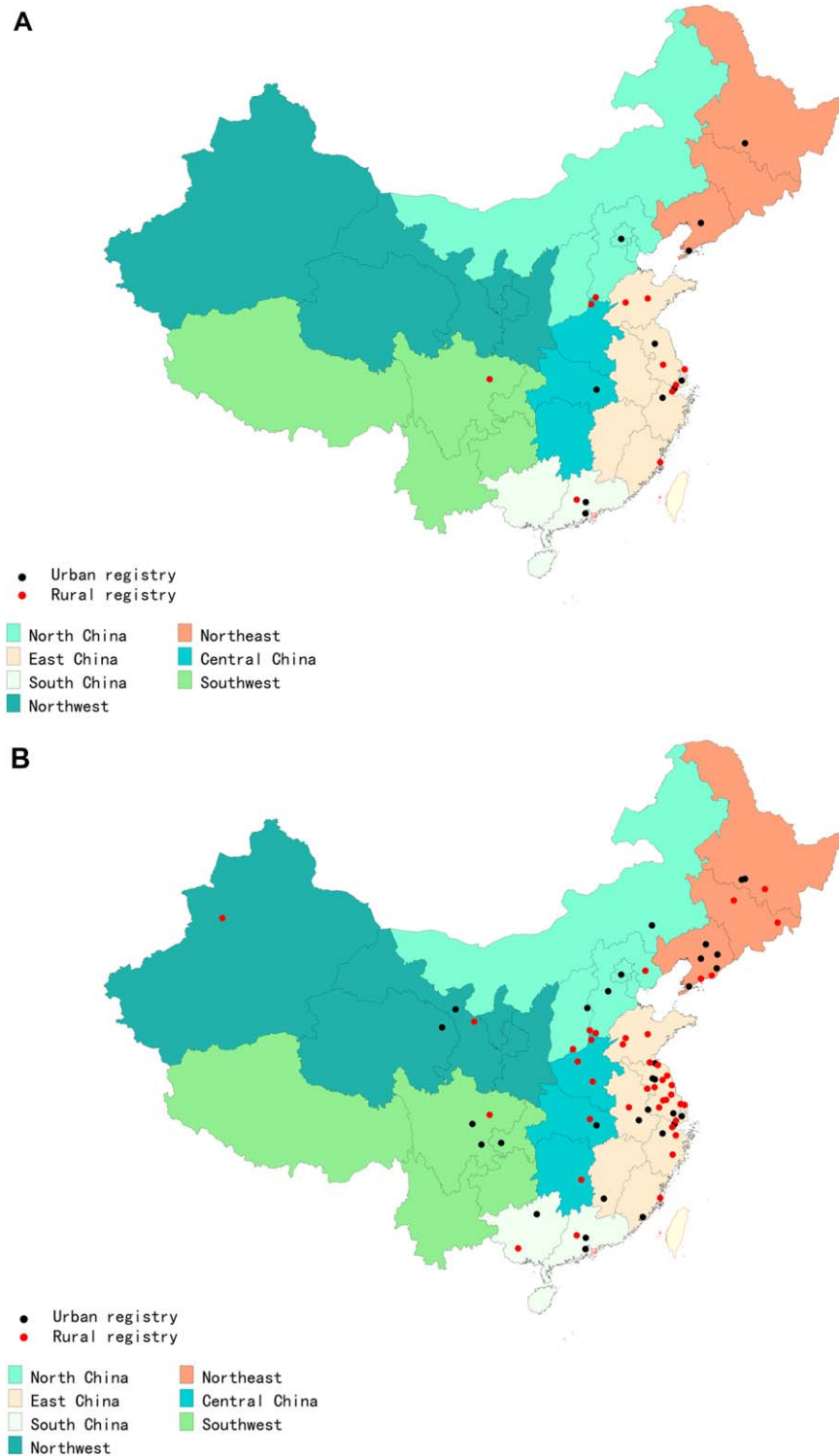


FIGURE 1. Maps of the 2 Sets of Contributing Cancer Registries and Geographic Regions in China.

Dots indicate the locations of the cancer registries. (A) This is a map for 22 cancer registries (data from 2000 to 2011). (B) This is a map for 72 cancer registries (data from 2009 to 2011).

for multiple primary cancers.¹⁰ Incidence data were extracted from the NCCR database. Although cancer site information is available through codes from both the International Classification of Diseases for Oncology, 3rd revision (ICD-O-3), and the International Classification of Diseases, 10th revision (ICD-10), we have reported incidence data using the ICD-10

classification for consistency, with mortality data that were only available in the ICD-10 classification. The variables extracted were sex, age, date of birth, year of diagnosis, cancer site, morphology, residence (urban and rural areas), and region (North China, Northeast, East China, Central China, South China, Southwest, Northwest China). For age-specific

incidence analysis, 5 broad age groups were used (younger than 30 years, 30-44 years, 45-59 years, 60-74 years, and 75 years or older).

Cancer Mortality Data

Mortality data compiled by 72 local cancer registries were used to estimate the numbers of cancer deaths in China in 2015. To estimate trends in mortality because of cancer between 2000 and 2011, mortality data were obtained from the same 22 local registries that were used in the incidence trend analyses. These registries compile data on cancer deaths from local hospitals, community health centers, vital statistics (including data from the national Disease Surveillance Points [DSP] system), and the Civil Administration Bureau.¹¹ The DSP system, which was established by the Ministry of Health in the early 1980s, routinely collects information on deaths based on the death certificate provided by hospitals or obtained from the next of kin by a household visit if a death certificate was unavailable.¹¹ While the DSP uses a nationally representative sample of sites, these cover only a very small (~1%) proportion of the population.^{12,13}

Cancer Survival

In the absence of precise follow-up information from the 72 cancer registries, estimates of 5-year relative survival in China for 2015 are presented in this report using the complement of the cancer M/I ratio (1-M/I) from these registries, a method that has been used previously.^{14,15} We present these survival estimates only for all cancers combined, because survival from certain cancer types may have led to an overestimation or underestimation using this proxy measure.¹⁴ We calculated the M/I ratio for all cancers combined by assuming that the ratio between incidence and mortality has not changed between 2009 to 2011 and 2015, so we divided the age-standardized mortality rate (2009-2011) by the age-standardized incidence rate (2009-2011).

Population Data

National population data by 5-year age group and sex were obtained from statistics or public security census (data.stats.gov.cn/; accessed April 20, 2014).⁸ Individual registries provided population data in the respective areas to the NCCR. These data were sourced from local Statistical or Public Security Bureaus or from calculations based on census data.

Statistical Analysis

We estimated the numbers of new cases in China in 2015 for all cancers combined and for 26 individual cancer types by sex by applying age-specific incidence rates from 72 cancer registries (2009-2011) to the projected age-specific population in China in 2015. We estimated the numbers of cancer deaths in China in 2015 using the same method. For the 10 most

common cancers, these estimated numbers of new cases and cancer deaths were further stratified by urban/rural registries and by 7 administrative regions that cover China. Age-specific numbers of new cases and cancer deaths by 5 broad age groups (younger than 30 years, 30-44 years, 45-59 years, 60-74 years, and 75 years or older) are also presented for all cancers combined and for the 6 most common cancers for 2015.

Temporal trends in incidence and mortality rates from 2000 to 2011 (22 registries) were examined by fitting joinpoint models^{16,17} to the log-transformed, age-standardized rates (per 100,000 population), standardized according to the world standard population.¹⁸ To reduce the possibility of reporting spurious changes in trends over the period, all models were restricted to a maximum of 2 joinpoints (3 line segments). Trends were expressed as an annual percentage change (APC), and the Z test was used to assess whether the APC was statistically different from zero. In describing trends, the terms “increase” or “decrease” were used when the slope (APC) of the trend was statistically significant ($P < .05$). For nonstatistically significant trends, the term “stable” was used. For all those analyses, we present the results for all cancers combined and for the 10 most common cancers stratified by sex.

Results

Data Quality

The 3 main measures (MV%, DCO%, and M/I ratio) of data quality for population-based cancer registries, stratified by cancer type, show that overall data quality is reasonably good for both sets of cancer registries (Fig. 2). Because half of the 22 cancer registries are certified by the IARC, their data quality was considerably higher than when considering data from the combined 72 cancer registries, indicated by higher MV% and lower DCO%. Values of these data-quality measures plus UB% (the percentage of uncertified cancer) and CPU% (the percentage of cancer with undefined or unknown primary site) are presented Supporting Table 1 (see online supporting information).

Expected Cancer Incidence in 2015

It is predicted that there will be about 4292,000 newly diagnosed invasive cancer cases in 2015 in China, corresponding to almost 12,000 new cancer diagnoses on average each day. The 5 most commonly diagnosed cancers among men, in descending order, are: cancers of the lung and bronchus, stomach, esophagus, liver, and colorectum, accounting for about two-thirds of all cancer cases. The corresponding cancers among women are breast, lung and bronchus, stomach, colorectum, and esophagus, accounting for nearly 60% of all cases. Breast cancer alone is expected to account for 15% of all new cancers in women (Table 2).

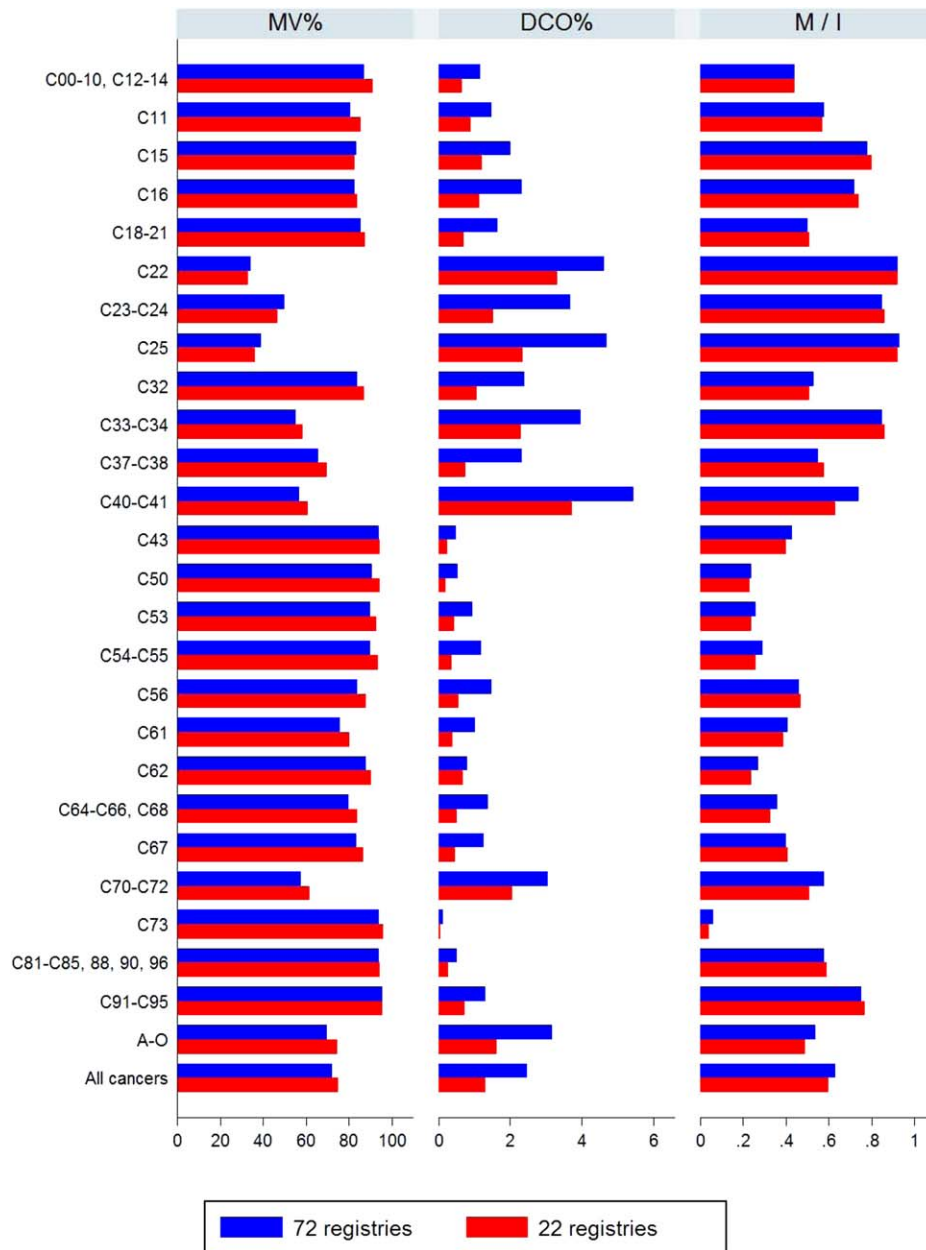


FIGURE 2. Three Major Measures of Data Quality by Cancer Types for the 2 Sets of Cancer Registries in China.

Codes in the far left column are from the International Classification of Diseases, 10th Revision. DCO% indicates the percentage of cancer cases identified with death certification only; M/I, mortality-to-incidence ratio; MV%, proportion of morphological verification.

The estimated incidence rates for all cancers combined and the number of new cases for the most common 10 cancer types by urban versus rural status and region of residence are presented in Table 3. For all cancers combined, the age-standardized incidence rates per 100,000 population per year are higher in men than in women (234.9 vs 168.7 per 100,000) and are higher in rural areas than in urban areas (213.6 vs 191.5 per 100,000). Southwest China has the highest cancer incidence rates, followed by North China and Northwest China; and Central China has the lowest incidence rate.

Expected Cancer Mortality in 2015

It is estimated that about 2814,000 Chinese will die from cancer in 2015, corresponding to over 7500 cancer deaths on average per day. The 5 leading causes of cancer death among both men and women are cancers of the lung and bronchus, stomach, liver, esophagus, and colorectum, accounting for about three-quarters of all cancer deaths (Table 2). Similar to the incidence rates, the age-standardized mortality rate for all cancers combined is substantially higher in men than in women (165.9 vs 88.8 per 100,000) and in rural areas than in urban areas (149.0 vs

TABLE 2. Estimated New Cancer Cases and Deaths (Thousands) by Sex: China, 2015*

SITE	ICD-10	INCIDENCE			MORTALITY		
		TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE
Lip, oral cavity, & pharynx (except nasopharynx)	C00-C10, C12-C14	48.1	31.1	16.9	22.1	15.3	6.8
Nasopharynx	C11	60.6	43.3	17.3	34.1	24.9	9.2
Esophagus	C15	477.9	320.8	157.2	375.0	253.8	121.3
Stomach	C16	679.1	477.7	201.4	498.0	339.3	158.7
Colorectum	C18-C21	376.3	215.7	160.6	191.0	111.1	80.0
Liver	C22	466.1	343.7	122.3	422.1	310.6	111.5
Gallbladder	C23-C24	52.8	24.5	28.3	40.7	18.8	21.8
Pancreas	C25	90.1	52.2	37.9	79.4	45.6	33.8
Larynx	C32	26.4	23.7	2.6	14.5	12.6	1.9
Lung	C33-C34	733.3	509.3	224.0	610.2	432.4	177.8
Other thoracic organs	C37-C38	13.2	8.2	5.0	6.5	4.1	2.3
Bone	C40-C41	28.0	16.4	11.6	20.7	12.4	8.3
Melanoma of the skin	C43	8.0	4.3	3.7	3.2	1.8	1.5
Breast	C50	272.4	3.8	268.6	70.7	1.2	69.5
Cervix	C53	98.9	—	98.9	30.5	—	30.5
Uterus	C54-C55	63.4	—	63.4	21.8	—	21.8
Ovary	C56	52.1	—	52.1	22.5	—	22.5
Prostate	C61	60.3	60.3	—	26.6	26.6	—
Testis	C62	4.0	4.0	—	1.0	1.0	—
Kidney	C64-C66, C68	66.8	43.2	23.6	23.4	15.2	8.2
Bladder	C67	80.5	62.1	18.4	32.9	25.1	7.8
Brain, CNS	C70-C72	101.6	52.3	49.3	61.0	35.8	25.2
Thyroid	C73	90.0	22.2	67.9	6.8	2.5	4.3
Lymphoma	C81-C85, C88, C90, C96	88.2	53.0	35.2	52.1	32.7	19.4
Leukemia	C91-C95	75.3	44.4	30.9	53.4	32.0	21.3
All other sites and unspecified	A_0	178.1	95.5	82.6	94.0	55.0	39.0
All sites	ALL	4291.6	2512.1	1779.5	2814.2	1809.9	1004.4

CNS, central nervous system; ICD-10, International Classification of Diseases, 10th revision.

*The total number of cases projected for 2015 are based on the average incidence rates for the most recent 3 years (2009 to 2011) of data from 72 population-based cancer registries.

109.5 per 100,000) (Table 4). Likewise, the highest cancer mortality rates were found in Southwest China, followed by North China and Northwest China, with Central China exhibiting the lowest rate.

Age-Specific Incidence and Mortality of Selected Cancers by Sex in 2015

Before the age of 60 years, liver cancer is the most commonly diagnosed cancer and the leading cause of cancer death in men, followed by lung and stomach cancer, which are the dominant types of cancer for both cases and deaths in the group ages 60 to 74 years (Table 5). Lung cancer is the most commonly diagnosed cancer and the leading cause of cancer death in men aged 75 years or older. Most new cancer cases and cancer deaths in men occur in the age range from 60 to 74 years.

Among women, thyroid cancer is the most commonly diagnosed cancer before the age of 30 years, followed by breast cancer at ages 30 to 59 years, and lung cancer in women aged 60 years or older (Table 5). Breast cancer is the leading cause of cancer death in women younger than 45 years, followed by lung cancer. The largest proportion of new cancer cases and deaths among women are diagnosed among those between ages 60 and 74 years.

Expected Cancer Survival in 2015

It is predicted that, for all cancers combined, 36.9% of cancer patients in China will survive at least 5 years after diagnosis around 2015, with women having much better survival than men (47.3% vs 29.3%) (Table 6). There is substantial variation in the 5-year survival estimate according to residence at the time of diagnosis: rural patients have much lower survival than their city counterparts (30.3% vs 42.8%). Likewise, the lowest survival rates were found in Southwest China (24.9%), with Central China showing the highest rate (41.0%).

Trends in Cancer Incidence and Mortality

For all cancers combined, the age-standardized incidence rates were stable over the study period (2000-2011) for males, while significant upward trends were observed for females ($P < .05$) (Fig. 3, Table 7). In contrast, the age-standardized mortality rates decreased significantly for both males and females (Fig. 3, Table 8). Despite this favorable trend, however, the number of cancer deaths substantially increased (73.8% increase) during the corresponding period (from 51,090 in 2000 to 88,800 in 2011) because of the aging and growth of the population (Fig. 4).

TABLE 3. Age-Standardized (Segi Standard Population) Incidence Rates for All Cancers Combined and Estimated New Cases (Thousands) for Selected Cancers in China, 2015, by Geographic Location

AREAS	SEX	ASR*	ESTIMATED NEW CASES (THOUSANDS)										
			ALL CANCERS	LUNG	ESOPHAGUS	STOMACH	COLORECTUM	LIVER	BREAST	CERVIX	THYROID	BRAIN	PANCREAS
All areas	Total	201.1	4291.6	733.3	477.9	679.1	376.3	466.1			90.0	101.6	90.1
	Male	234.9	2512.1	509.3	320.8	477.7	215.7	343.7			22.2	52.3	52.2
	Female	168.7	1779.5	224.0	157.2	201.4	160.6	122.3	268.6	98.9	67.9	49.3	37.9
Urban areas	Total	191.5	2305.8	445.0	113.8	235.2	263.2	205.2			72.1	55.8	59.5
	Male	215.9	1302.4	306.0	87.4	164.7	150.8	156.8			18.1	26.8	34.2
	Female	168.9	1003.4	139.0	26.5	70.4	112.4	48.4	189.5	53.2	54.0	29.0	25.4
Rural areas	Total	213.6	1985.8	288.3	364.1	444.0	113.2	260.9			17.9	45.7	30.5
	Male	259.6	1209.7	203.3	233.4	313.0	64.9	187.0			4.1	25.5	18.0
	Female	168.5	776.2	85.0	130.7	130.9	48.2	73.9	79.0	45.7	13.9	20.3	12.5
North China	Total	213.2	528.1	79.5	85.2	97.7	38.8	42.4			9.8	11.0	9.2
	Male	240.3	298.3	52.3	55.3	71.9	22.1	30.1			2.3	5.4	5.4
	Female	187.0	229.8	27.2	30.0	25.8	16.7	12.3	37.2	16.7	7.5	5.5	3.8
Northeast	Total	189.2	359.8	83.7	9.8	36.1	41.5	36.4			10.7	8.5	10.3
	Male	208.4	199.6	54.2	8.6	26.2	24.5	27.4			2.5	4.0	6.2
	Female	169.8	160.2	29.5	1.2	9.9	16.9	9.1	33.2	10.5	8.2	4.5	4.1
East China	Total	193.7	1280.2	218.6	122.8	179.5	125.6	126.8			40.2	29.6	38.1
	Male	224.1	735.3	150.6	84.2	124.5	70.5	94.1			10.2	14.6	21.5
	Female	165.8	544.8	68.0	38.6	54.9	55.1	32.7	83.9	27.6	30.0	15.0	16.6
Central China	Total	185.5	666.8	115.7	70.7	91.1	58.5	70.5			14.3	20.6	11.4
	Male	208.3	374.9	82.9	44.1	62.2	32.7	51.5			3.1	9.6	6.6
	Female	164.7	291.9	32.8	26.6	28.9	25.8	19.0	46.7	17.4	11.2	11.0	4.8
South China	Total	202.4	427.3	80.5	10.8	24.3	50.8	68.8			9.0	10.8	6.0
	Male	242.1	254.3	55.4	9.0	16.9	28.8	55.8			2.2	5.2	3.6
	Female	165.2	173.0	25.1	1.8	7.3	22.0	13.1	30.9	8.1	6.9	5.6	2.4
Southwest	Total	226.7	744.8	117.8	143.2	174.7	42.9	92.6			3.1	12.8	8.5
	Male	281.4	469.7	87.4	93.6	118.2	26.5	64.6			1.1	8.8	4.7
	Female	170.9	275.2	30.4	49.5	56.5	16.4	28.0	23.2	11.3	2.0	4.0	3.8
Northwest	Total	207.9	284.5	37.5	35.4	75.7	18.3	28.4			2.8	8.3	6.6
	Male	253.9	179.9	26.4	26.0	57.8	10.6	20.3			0.7	4.6	4.2
	Female	158.5	104.6	11.1	9.5	17.9	7.7	8.2	13.4	7.3	2.1	3.7	2.4

ASR, age-standardized mortality rate.

*Age-standardized incidence rates for all cancers are based on the Segi standard population.

Among the 10 most common cancers considered in the temporal trend analyses for men, incidence rates from 2000 to 2011 increased for 6 cancer types (pancreas, colorectum, brain and central nervous system, prostate, bladder, and leukemia), whereas the rates decreased for cancers of the stomach, esophagus, and liver ($P < .05$). A stable trend was observed for cancer of the lung (Fig. 5, Table 7).

For women, 6 of the 10 most common cancers had a significant upward trend in age-standardized incidence rates (cancers of the colorectum, lung, breast, cervix, uterine corpus, and thyroid; $P < .05$). As with men, a downward trend was seen for cancers of the stomach, esophagus, and liver (Fig. 6, Table 7).

An upward trend in age-standardized mortality rates was observed for 4 of the 10 most common cancers in men (colorectum, pancreas, prostate, and leukemia; $P < .05$), whereas stable trends were seen for other cancer types (cancers of the lung, bladder, and brain) (Fig. 7, Table 8). In women, an increasing trend in mortality was observed for 3 of the 10 most common cancers (breast, cervix, and ovary), with trends stable for colorectum, lung, uterine, and thyroid cancers (Fig. 8, Table 8).

Similar to the trends in cancer incidence rates, declining trends in age-standardized mortality rates were observed for cancers of the stomach, esophagus, and liver in both sexes (Figs. (7 and 8)). Stable trends were observed in both men and women for lung cancer, which was the leading cause of cancer mortality for both men and women.

Discussion

Although national estimates of cancer for China have been previously reported, these are limited to only a snapshot of the patterns by cancer site during a single year^{3,4,12,19} or are reported for specific cancers,²⁰⁻²² making comparisons of trends across cancer types difficult. This study provided more comprehensive nationwide cancer statistics in China using the latest and most representative data and including information on temporal trends.

Cancer prevention and control rely on population-based incidence and mortality data as an incentive both to act and to assess the effectiveness of current interventions and policies.

TABLE 4. Age-Standardized (Segi Standard Population) Mortality Rates for All Cancers Combined and Estimated Deaths (Thousands) for Selected Cancers in China, 2015, by Geographic Location

AREAS	SEX	ASR*	ESTIMATED DEATHS (THOUSANDS)										
			ALL CANCERS	LUNG	ESOPHAGUS	STOMACH	COLORECTUM	LIVER	BREAST	CERVIX	THYROID	BRAIN	PANCREAS
All areas	Total	126.9	2814.2	610.2	375.0	498.0	191.0	422.1			6.8	61.0	79.4
	Male	165.9	1809.9	432.4	253.8	339.3	111.1	310.6			2.5	35.8	45.6
	Female	88.8	1004.4	177.8	121.3	158.7	80.0	111.5	69.5	30.5	4.3	25.2	33.8
Urban areas	Total	109.5	1382.3	373.4	89.1	162.9	126.6	185.1			4.5	30.6	53.8
	Male	142.9	884.4	261.7	69.1	112.5	73.7	139.7			1.6	16.8	30.7
	Female	77.1	497.9	111.6	20.0	50.4	52.9	45.4	43.8	13.6	2.9	13.8	23.2
Rural areas	Total	149.0	1431.9	236.9	285.9	335.1	64.5	237.0			2.3	30.4	25.5
	Male	195.1	925.5	170.7	184.7	226.8	37.4	170.9			0.9	19.0	14.9
	Female	103.8	506.4	66.1	101.2	108.2	27.1	66.1	25.7	16.9	1.4	11.5	10.6
North China	Total	134.5	338.6	64.2	67.5	68.6	19.4	38.4			0.7	6.3	8.0
	Male	171.9	215.7	43.1	45.6	49.6	11.3	27.5			0.2	3.6	4.6
	Female	97.5	122.9	21.1	21.9	18.9	8.1	10.9	8.1	6.1	0.5	2.7	3.5
Northeast	Total	116.4	224.0	71.7	7.9	24.8	18.8	33.6			0.6	5.0	10.1
	Male	146.9	142.9	46.9	6.9	18.0	11.3	25.2			0.2	2.8	6.1
	Female	85.5	81.2	24.8	0.9	6.9	7.4	8.3	6.8	2.4	0.4	2.2	4.0
East China	Total	115.6	815.1	182.9	94.3	130.5	62.7	115.8			2.1	18.6	33.8
	Male	152.8	517.1	128.9	64.3	88.3	35.1	85.1			0.7	10.1	19.0
	Female	80.6	298.0	54.0	30.0	42.2	27.6	30.6	21.1	6.7	1.4	8.5	14.8
Central China	Total	109.4	409.5	94.0	53.4	65.8	27.0	59.9			0.9	10.7	9.5
	Male	142.2	260.0	69.1	33.8	45.2	15.1	43.6			0.3	6.0	5.4
	Female	77.9	149.5	25.0	19.6	20.6	12.0	16.3	11.9	4.1	0.6	4.6	4.1
South China	Total	122.4	270.2	68.8	8.8	18.0	24.8	60.1			0.9	5.3	5.5
	Male	168.7	180.9	48.3	7.6	12.4	14.3	48.6			0.4	2.9	3.3
	Female	77.5	89.3	20.4	1.2	5.6	10.5	11.5	7.7	2.3	0.5	2.3	2.3
Southwest	Total	170.2	574.9	100.3	118.0	141.0	29.1	90.2			0.6	10.7	7.5
	Male	219.5	371.5	75.9	75.8	88.8	18.8	63.2			0.3	7.5	4.2
	Female	119.7	203.4	24.5	42.2	52.3	10.3	26.9	8.8	6.2	0.3	3.1	3.3
Northwest	Total	133.2	182.0	28.2	25.1	49.3	9.2	24.1			0.9	4.5	4.9
	Male	171.5	121.9	20.2	19.7	37.1	5.1	17.3			0.3	2.7	3.0
	Female	91.9	60.1	8.0	5.4	12.2	4.0	6.8	5.2	2.6	0.6	1.8	1.9

ASR, age-standardized mortality rate.

*ASRs for all cancers are based on the Segi standard population.

Thus, the updated nationwide estimates of cancer burden and time trends presented here are critical to understanding the etiology of cancer and the effectiveness of prevention, early detection, and management of cancer in China. These results will also serve as a baseline for future assessment of the overall effectiveness of the cancer control effort in China and will provide insights into the areas of greatest need for prioritization.

Because of China's large population size, approximately one-fifth of the world population, these Chinese data contribute significantly to the global burden of cancer: almost 22% of global new cancer cases and close to 27% of global cancer deaths occur in China.²³ More importantly, the cancer profile in China is markedly different from those of developed countries. The 4 most common cancers diagnosed in China were lung, stomach, liver, and esophageal cancer. These cancers account for 57% of cancers diagnosed in China, compared with 18% in the United States.²⁴ Also, these cancers diagnosed in China comprise between one-third and one-half of the global incidence burden from

lung, stomach, liver, and esophageal cancers.^{23,25} In comparison, the most common cancers diagnosed in the United States are cancers of the lung, breast, prostate, and colorectum.²⁶ The most common cancers in China are those associated with rather poor survival; whereas those in the United States, with the exception of lung cancer, are dominated by cancers with a good to excellent prognosis, and, for prostate and breast cancers, the incidence may be inflated by diagnostic activities linked to early detection and screening.^{24,27} This difference in cancer type distribution contributes significantly to the higher overall cancer mortality rate in China.

Our cancer estimates for 2015 were based on data from 72 Chinese population-based cancer registries capturing cancer diagnoses from 2009 to 2011. These registries cover only about 6.5% of the Chinese national population, but they remain the best-available nationwide data for cancer incidence, representing a base population of 85.5 million people. Moreover, the data used in this study have an enlarged population coverage compared with previous

TABLE 5. Estimated New Cancer Cases and Deaths (Thousands) for Selected Cancers by Age Groups: China, 2015

SITE	AGE, y					ALL
	<30	30-44	45-59	60-74	≥75	
Male (thousands)						
Incidence						
Prostate	0.1	0.1	3.4	24.2	32.4	60.3
Colorectum	1.1	13.0	58.0	90.9	52.7	215.7
Esophagus	0.2	7.4	89.0	161.3	62.9	320.8
Liver	4.4	41.3	130.4	116.1	51.6	343.7
Stomach	1.9	15.8	134.1	232.7	93.2	477.7
Lung	1.3	15.8	122.0	231.8	138.4	509.3
All sites	41.6	151.6	707.5	1061.8	549.5	2512.1
Mortality						
Pancreas	0.1	1.4	10.1	19.3	14.6	45.6
Colorectum	0.5	5.0	22.5	41.6	41.5	111.1
Esophagus	0.1	4.2	56.0	121.3	72.1	253.8
Liver	3.5	32.5	111.9	106.4	56.3	310.6
Stomach	1.3	8.0	74.7	160.6	94.7	339.3
Lung	0.8	10.0	88.5	188.7	144.5	432.4
All sites	19.8	79.9	434.0	748.7	527.6	1809.9
Female (thousands)						
Incidence						
Thyroid	6.1	20.5	27.8	11.3	2.1	67.9
Cervix	1.5	28.2	45.7	19.0	4.5	98.9
Colorectum	1.1	10.1	40.7	64.2	44.4	160.6
Stomach	1.0	11.5	49.2	89.6	50.0	201.4
Lung	0.7	10.9	53.9	91.2	67.4	224.0
Breast	4.3	55.5	128.7	62.3	17.8	268.6
All sites	38.8	202.9	566.6	623.2	348.0	1779.5
Mortality						
Breast	0.5	8.7	28.3	18.8	13.2	69.5
Colorectum	0.3	3.4	13.7	27.4	35.1	80.0
Liver	0.7	5.8	26.9	44.8	33.2	111.5
Esophagus	0.1	1.4	19.1	56.1	44.5	121.3
Stomach	0.6	5.2	29.2	66.5	57.2	158.7
Lung	0.3	5.8	32.5	69.7	69.4	177.8
All sites	11.0	52.8	219.8	381.0	339.7	1004.4

studies (with coverage less than 2% of the population),^{2,28} including more registries in the western regions of China and are thus more representative of the general population in China. In addition, all 12 population-based cancer registries in mainland China with high-quality data that fulfilled the *Cancer Incidence in Five Continents* (CI5) inclusion criteria for the present CI5 volume X were included in the analysis.²⁹ These national incidence estimates for China are broadly comparable to those published previously.^{3,4,12} The 2 most recently published annual reports in China found that the estimated number of new cancer cases were 3.09 million and 3.37 million for 2010 and 2011, respectively.^{3,4} An earlier estimate was 2.96 million for 2005, although a different method was used.¹²

Our estimate of cancer incidence for 2015 (4.29 million cases) in China is considerably higher than that reported by the GLOBOCAN 2012 initiative of 3.40 million.^{23,25} Reasons for these discrepancies may include differences in data timelines (2009-2011 vs 2003-2007) and representativeness and geographic coverage (72 cancer registries covering 6.5% of the national population vs 23 cancer registries covering 3.0% of the population). In particular, rural residents,

who have a higher incidence rate than urban residents (213.6 per 100,000 vs 191.5 per 100,000), account for 32.7% the population in our estimates compared with 21.5% in the 2012 GLOBOCAN estimates. The methods used to obtain the national incidence estimates are also different, because GLOBOCAN 2012 converts national mortality estimates for 2012 to incidence by modeling the age-specific, sex-specific, and site-specific M/I ratios from the 23 Chinese cancer registries. While acknowledging that not all of these cancer registries met the IARC quality standards,^{15,30} these discrepancies in published estimates underscore the need for further improvements in the coverage and quality of registries in China to provide more accurate statistics on the cancer burden in the country.

In contrast to incidence, there was greater consistency in our mortality estimates and those in GLOBOCAN. We estimated that there would be 2.81 million cancer deaths in 2015, and the corresponding figure was 2.46 million in GLOBOCAN 2012.²³ This may reflect that the mortality data used by both studies were obtained from a similar source: DSP data (2004-2010) were used for GLOBOCAN 2012, while we used mortality data collected from

TABLE 6. Expected 5-Year Survival for All Cancers Combined by Sex and Geographic Area: China, 2015

AREAS	SEX	ASR INCIDENCE*	ASR DEATHS*	1-(M/I)
All areas	Total	201.1	126.9	36.9
	Male	234.9	165.9	29.3
	Female	168.7	88.8	47.3
Urban areas	Total	191.5	109.5	42.8
	Male	215.9	142.9	33.8
	Female	168.9	77.1	54.4
Rural areas	Total	213.6	149.0	30.3
	Male	259.6	195.1	24.8
	Female	168.5	103.8	38.4
North China	Total	213.2	134.5	36.9
	Male	240.3	171.9	28.5
	Female	187.0	97.5	47.9
Northeast	Total	189.2	116.4	38.5
	Male	208.4	146.9	29.5
	Female	169.8	85.5	49.6
East China	Total	193.7	115.6	40.3
	Male	224.1	152.8	31.8
	Female	165.8	80.6	51.4
Central China	Total	185.5	109.4	41.0
	Male	208.3	142.2	31.7
	Female	164.7	77.9	52.7
South China	Total	202.4	122.4	39.5
	Male	242.1	168.7	30.3
	Female	165.2	77.5	53.1
Southwest	Total	226.7	170.2	24.9
	Male	281.4	219.5	22.0
	Female	170.9	119.7	29.9
Northwest	Total	207.9	133.2	36.0
	Male	253.9	171.5	32.5
	Female	158.5	91.9	42.0

1-(M/I), complement to the mortality (M) to incidence (I) ratio; ASR, age-standardized mortality rate.

*Age-standardized rates for all cancers are based on the Segi standard population.

72 cancer registry areas (2009–2011) for which DSP data were part of the whole set of data on cancer deaths. The DSP data were based on counties and stratified by geographic regions, with sampling further stratified by urban or rural location and per capita gross domestic product, and the DSP system was specifically designed to be nationally representative.¹⁹ For both incidence and mortality estimates, data from Hong Kong and Macao were also used in the estimates from GLOBOCAN 2012 but were excluded from our analyses.

We found significant differences in cancer incidence rates for all cancers combined by place of residence (rural vs urban and between regions) in China. Rural residents have higher incidence compared with their urban counterparts, and incidence rates varied substantially across the 7 administrative regions. It is likely that many factors contribute to this geographic differential, but the higher smoking prevalence in rural populations compared with those in urban areas^{31,32} likely plays a dominating role. The 12 cancers formally established as being caused by smoking³³ account for about 75% of all cancers combined in China. Consistent with this

hypothesis, the area with the highest observed cancer incidence rate, Southwest China, was also reported to have the cities with the highest smoking prevalence in 2002.³⁴

We found even greater geographic variations in cancer mortality and the survival proxies across China. It is likely that at least part of these geographic disparities could be explained by the more limited medical resources, lower levels of cancer care, and a larger proportion of patients diagnosed with cancer at a late stage in rural and underdeveloped areas in China.²⁷ Recognizing that differences in other factors, such as competing causes of death and comorbidities, may also contribute, the results reported here, together with those reported previously,^{27,35} provide a strong justification for providing more government-funded health resources and services for cancer control in rural and underdeveloped areas in China to reduce these apparent inequalities.

There has been a marked increase in the numbers of cancers diagnosed in China between 2000 and 2011. Much of this is explained by the aging and growth of the population. Other factors that may have contributed to the increase in the burden of cancer include increases in the prevalence of unhealthy behaviors or cancer-related lifestyle and improvements in disease awareness, detection services, and data completeness. The largest increase in incidence was seen for cancers of the prostate, cervix, and thyroid for women. The factors driving the increase in prostate cancer are not entirely understood; however, they may include gradual implementation of prostate-specific antigen screening and improved biopsy techniques³⁶ or the impact of an increasingly westernized lifestyle.^{37,38} Westernized lifestyle, particularly increases in the prevalence of obesity and physical inactivity in recent decades in China, is likely to have had an impact on the observed rise in colorectal and breast cancer incidence.^{39,40} For breast cancer, the increasing trend may also reflect changes in reproductive behavior in China in recent decades because of the one-child policy implemented since the 1970s.⁴¹

In contrast to the decreasing incidence trends in developed countries, a substantial increase in cervical cancer incidence was seen in China. This may reflect the inadequacy of Papanicolaou (Pap) test screening in China, because only one-fifth of Chinese women reported having ever had a Pap test for cervical cancer screening.^{42,43} The increasing prevalence of human papillomavirus (HPV) infection, especially in younger women,^{44,45} and the lack of HPV vaccines in mainland China due to the absence of formal drug approvals,³⁹ suggest that the disparity in cervical cancer incidence trends between China and international countries may continue for the foreseeable future.

The dramatic rise in thyroid cancer among women is consistent with that observed in other countries^{46–49}; and, while it may reflect “overdiagnosis” through increased use of new imaging technologies (ultrasound, computed

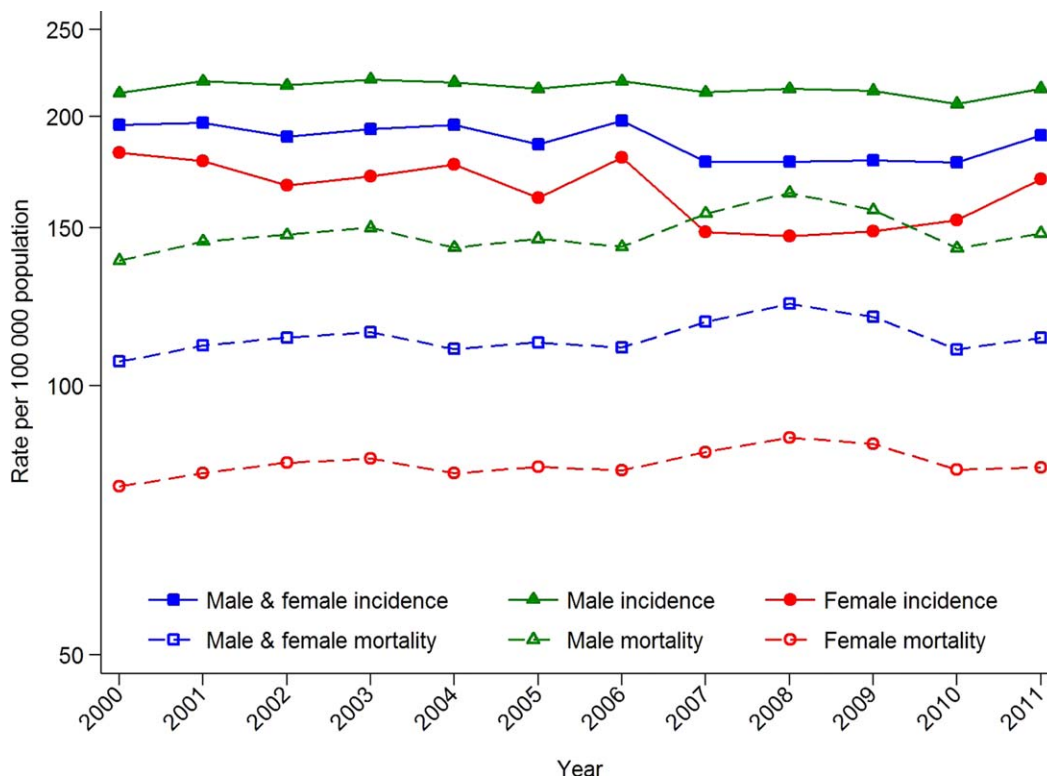


FIGURE 3. Trends in Cancer Incidence and Death Rates (Age-Standardized to the Segi Standard Population) for All Cancers Combined by Sex: China, 2000 to 2011.
Data source: 22 population-based Chinese cancer registries.

tomography, and magnetic resonance imaging) in the assessment of the thyroid gland,^{50,51} in the absence of information about disease stage, it is not possible to rule out a real increase in incidence.

A significantly decreasing incidence and mortality trend was observed for cancers of the stomach, esophagus, and liver in China. Despite the declining rates for this group of cancers, population growth and ageing still led to a large and rising number of new cases in 2015. Control of infections may contribute for these temporal patterns, including hepatitis B virus (HBV) and hepatitis C virus (HCV) for liver cancer and *Helicobacter pylori* for stomach cancer.⁵² Primary prevention of HBV infection through vaccination of infants has been shown to be effective: liver cancer deaths were reduced by 95% for the younger population (ages 0-19 years) 15 years after implementing HBV vaccination program in high-risk areas in China in 1986.⁵³ Despite the success of HBV vaccine to prevent liver cancer in children in China,^{53,54} it may be too early to affect the incidence trend for all ages combined. Factors that may have contributed to the decreasing trend in overall liver cancer rates in China include a reduction in the consumption of corn contaminated with aflatoxins and improved quality of drinking water by removal of cyanotoxins from water sources.⁵⁵ The single-child policy, which reduces the horizontal (child-to-child) transmission of HBV infection at home, and safer injection practices, which reduce

TABLE 7. Trends in Cancer Incidence Rates (Age-Standardized to the Segi Standard Population) for Selected Cancers and All Cancers Combined by Sex: China, 2000 to 2011

ICD-10	SITES	TREND 1		TREND 2	
		YEARS	APC	YEARS	APC
Incidence male					
C15	Esophagus	2000-2011	-3.2*		
C16	Stomach	2000-2003	-5.3*	2003-2011	-1.8*
C18-C21	Colorectum	2000-2006	4.2*	2006-2011	1.3*
C22	Liver	2000-2011	-1.8*		
C25	Pancreas	2000-2011	1.3*		
C33-C34	Lung	2000-2011	-0.2		
C61	Prostate	2000-2005	12.6*	2005-2011	4.7*
C67	Bladder	2000-2005	4.1*	2005-2011	0.1
C70-C72	Brain, CNS	2000-2011	2.1*		
C91-C95	Leukemia	2000-2011	2.5*		
ALL	All sites	2000-2011	0.2		
Incidence female					
C15	Esophagus	2000-2011	-5.5*		
C16	Stomach	2000-2011	-2.7*		
C18-C21	Colorectum	2000-2006	3.2*	2006-2011	0.2
C22	Liver	2000-2008	-1.5*	2008-2011	-4.4*
C33-C34	Lung	2000-2011	0.9*		
C50	Breast	2000-2011	3.9*		
C53	Cervix	2000-2007	15.6*	2007-2011	4.1
C54-C55	Uterus	2000-2011	3.7*		
C56	Ovary	2000-2006	6.3*	2006-2011	-2.8*
C73	Thyroid	2000-2003	4.9	2003-2011	20.1*
ALL	All sites	2000-2011	2.2*		

APC, annual percentage change; CNS, central nervous system; ICD-10, International Classification of Diseases, 10th revision.

*The APC is significantly different from zero ($P < .05$).

TABLE 8. Trends in Cancer Mortality Rates (Age-Standardized to the Segi Standard Population) for Selected Cancers and All Cancers Combined by Sex: China, 2000 to 2011

ICD-10	SITES	TREND 1		TREND 2		TREND 3	
		YEARS	APC	YEARS	APC	YEARS	APC
Male							
C15	Esophagus	2000-2004	-6.1*	2004-2011	-2.7*		
C16	Stomach	2000-2003	-7.5*	2003-2011	-2.3*		
C18-C21	Colorectum	2000-2011	1.6*				
C22	Liver	2000-2003	-5.5*	2003-2006	1.9	2006-2011	-4.0*
C25	Pancreas	2000-2011	1.2*				
C33-C34	Lung	2000-2003	-4.1*	2003-2006	2.1	2006-2011	-1.2
C61	Prostate	2000-2011	5.5*				
C67	Bladder	2000-2011	-0.3				
C70-C72	Brain, CNS	2000-2003	-5.9	2003-2011	1.7*		
C91-C95	Leukemia	2000-2011	1.6*				
ALL	All sites	2000-2003	-4.4*	2003-2006	1.1	2006-2011	-1.4*
Female							
C15	Esophagus	2000-2011	-6.4*				
C16	Stomach	2000-2003	-7.1*	2003-2011	-2.7*		
C18-C21	Colorectum	2000-2011	0.5				
C22	Liver	2000-2003	-4.5*	2003-2006	0.6	2006-2011	-4.2*
C33-C34	Lung	2000-2011	-0.4				
C50	Breast	2000-2011	1.1*				
C53	Cervix	2000-2011	5.9*				
C54-C55	Uterus	2000-2011	0.0				
C56	Ovary	2000-2003	21.6*	2003-2011	1.7		
C73	Thyroid	2000-2011	1.6				
ALL	All sites	2000-2003	-2.7*	2003-2006	0.5	2006-2011	-1.1*

APC, annual percentage change; CNS, central nervous system; ICD-10, International Classification of Diseases, 10th revision.

*The APC is significantly different from zero ($P < .05$).

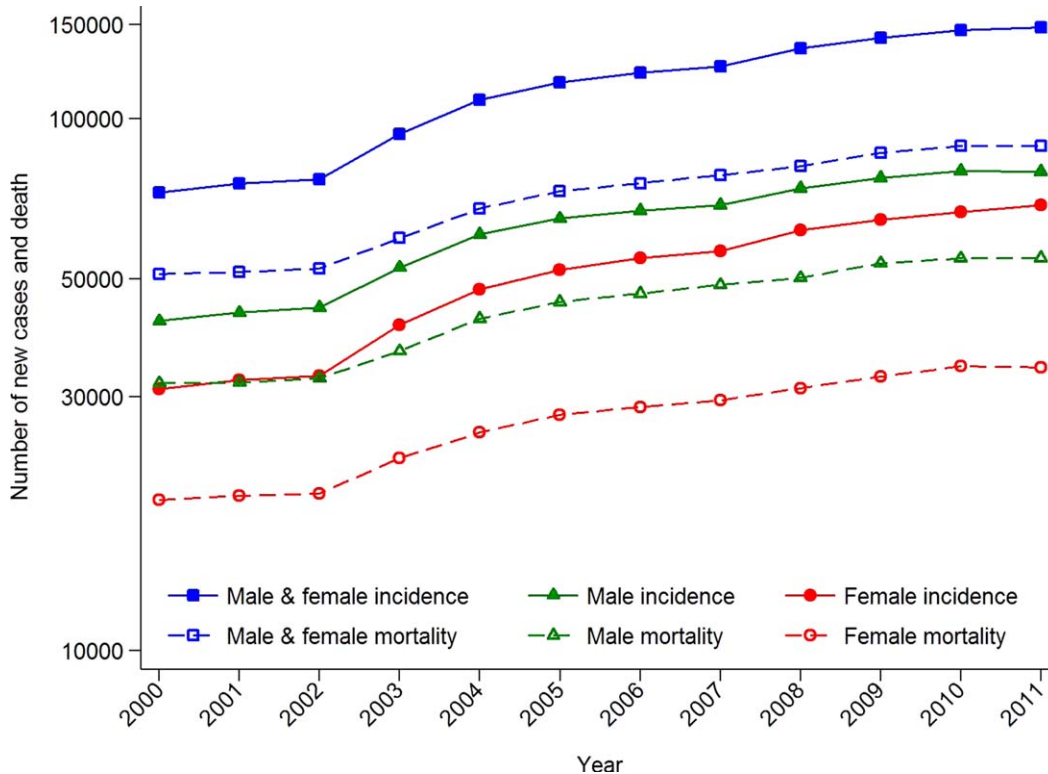


FIGURE 4. Trends in the Number of New Cancer Cases and Deaths for All Cancers Combined by Sex: China, 2000 to 2011. Data source: 22 population-based Chinese cancer registries.

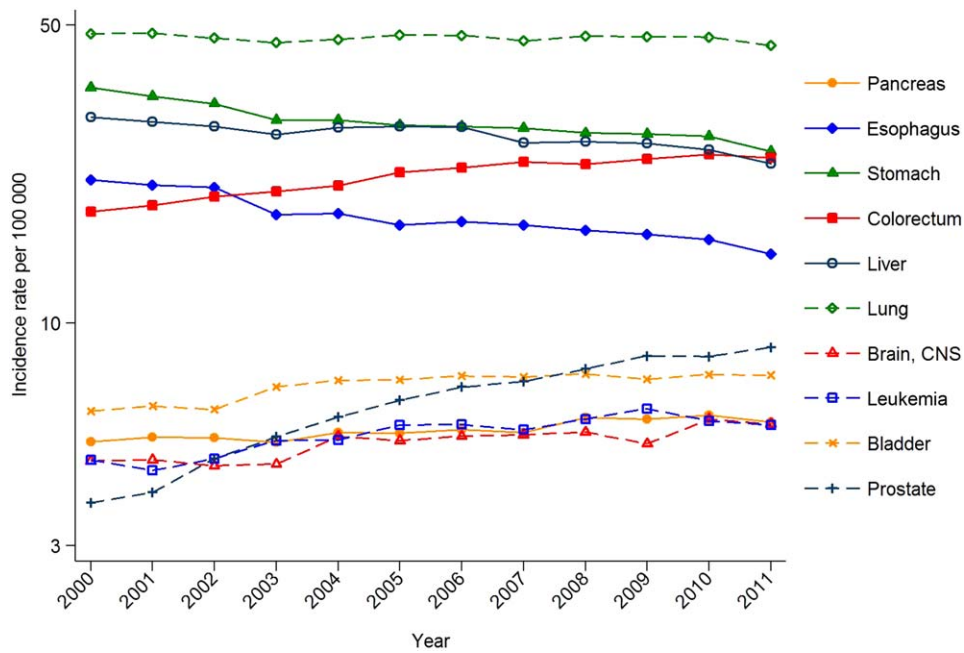


FIGURE 5. Trends in Incidence Rates (Age-Standardized to the Segi Standard Population) for Selected Cancers for Males: China, 2000 to 2011.

CNS indicates central nervous system. Data source: 22 population-based Chinese cancer registries.

nosocomial HBV and HCV,⁵⁶ may also have contributed to the decrease in overall liver cancer rates.

Implications for Cancer Prevention in China

It has been estimated that nearly 60% of cancer deaths can be avoided by reducing exposure to modifiable risk factors.⁵⁷ The largest contributor to avoidable cancer deaths in China is chronic infection, which is estimated to account for 29% of

cancer deaths, predominantly from stomach cancer (*H. pylori*), liver cancer (HBV and HCV), and cervical cancer (HPV).

Tobacco smoking accounted for about 23%⁵⁷ to 25%⁵⁸ of all cancer deaths in China; yet over one-half of adult Chinese men were current smokers in 2010,³¹ and smoking rates in adolescents and young adults are still rising.⁵⁹ Even if current rates remain stable, it has been estimated that the one million smoking-related deaths in China annually

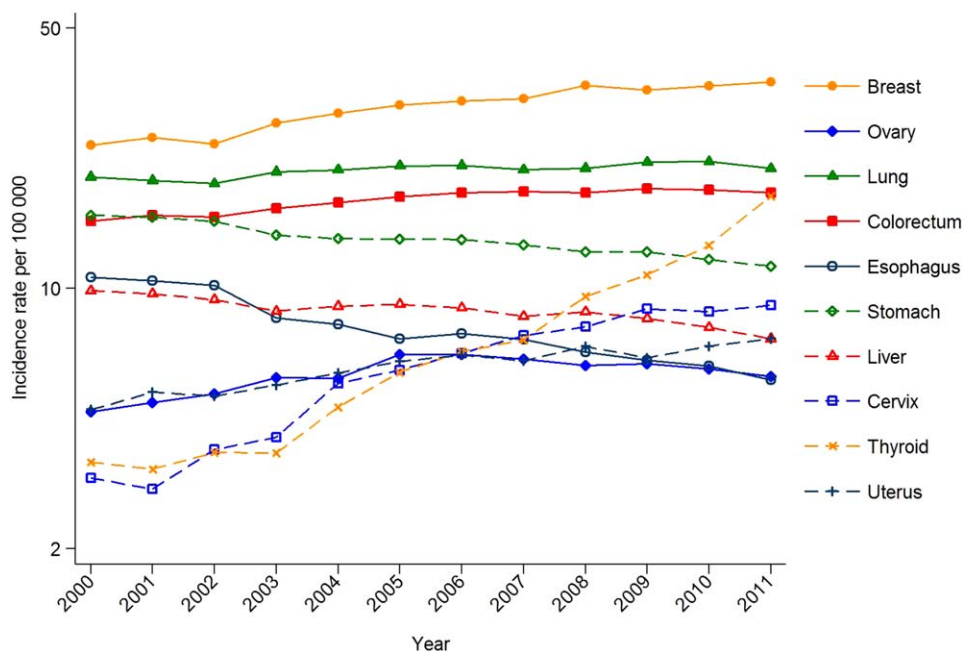


FIGURE 6. Trends in Incidence Rates (Age-Standardized to the Segi Standard Population) for Selected Cancers for Females: China, 2000 to 2011.

Data source: 22 population-based Chinese cancer registries.

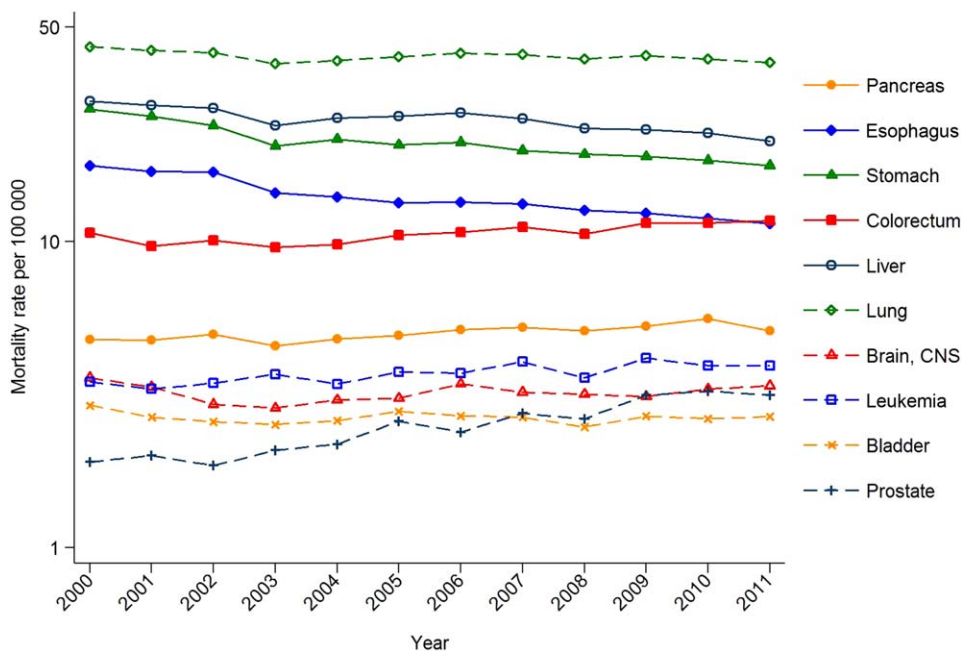


FIGURE 7. Trends in Mortality Rates (Age-Standardized to the Segi Standard Population) for Selected Cancers for Males: China, 2000 to 2011.

CNS indicates central nervous system. Data source: 22 population-based Chinese cancer registries.

during the 2010s will double by 2030.⁶⁰ With the impact of smoking-related disease becoming evident 20 to 30 years after the onset of smoking,⁶¹ it is likely that the burden of cancer in China will continue to increase in the next decades irrespective of changes in tobacco-control programs. Although, at present, there remains a generally positive image of smoking in China⁶² with heavy exposure to tobacco promotion,⁶³ legislative

changes have been enforced,⁶⁴ including strict smoking-control laws taking effect in Beijing in June 2015.⁶⁵ If implemented on a national scale, and if the tobacco industry can be separated from the government tobacco-control activities,⁶⁶ then these changes have the potential to provide hope that subsequent generations of Chinese will benefit from a much lower burden of tobacco-related cancers.

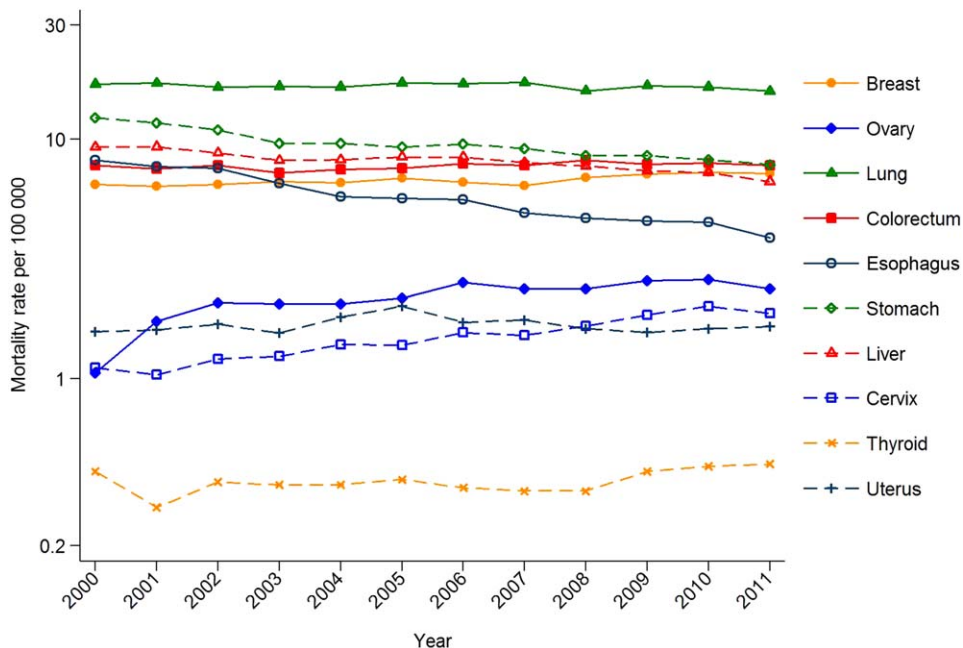


FIGURE 8. Trends in Mortality Rates (Age-Standardized to the Segi Standard Population) for Selected Cancers for Females: China, 2000 to 2011.

Data source: 22 population-based Chinese cancer registries.

The economic growth and increasingly urbanized and westernized lifestyle experienced in China has resulted in increased environmental pollution.³⁹ Outdoor air pollution, considered to be among the worst in the world,⁶⁷ indoor air pollution through heating and cooking using coal and other biomass fuels, and the contamination of soil and drinking water mean that the Chinese population is exposed to many environmental carcinogens. While the measured attributable risk for environmental pollution is low (<1.0%),⁵⁷ the existence of “cancer villages” in China that have particularly high cancer incidence and mortality provides strong circumstantial evidence for an association.^{39,68} Some efforts are being made to reduce the burden of environmental pollution in China^{68,69}; however, the gap between legislation and implementation remains high. The impact of environmental pollution on cancer and other health outcomes is likely to be felt for many decades in China, particularly for people in rural areas who are facing very rudimentary living environments.

Implications for Early Detection and Management in China

Although prevention efforts are critical to reduce the long-term burden of cancer, any effects will not be seen in the near future.⁷⁰ For this reason, facilitating the earlier diagnosis of cancer and improving the access and availability of optimal treatments may hold the greatest potential to have a more immediate impact on the existing burden of cancer in China. In particular, the large survival differences by geographic region²⁷ demonstrate the potential to improve the survival of Chinese cancer patients through ensuring equitable timeliness of diagnosis, access to cancer care, and quality of care delivered irrespective of where a person resides.

One barrier to addressing these issues is the immense scale of the Chinese population and its geographic diversity. Even with the current rate of expansion for breast screening programs, it would take an estimated additional 40 years to screen each woman in the target age group once.⁷⁰ In addition, the younger median age at breast cancer diagnosis compared with high-income countries limits its cost effectiveness, with some suggestions that Chinese resources might be better targeted in raising awareness and early detection when detecting breast lumps.⁷¹ Despite these geographic and population barriers, endoscopy screening programs for esophageal cancer are being expanded,⁷² and new generations of screening tests based on high-risk HPV are being developed to overcome the difficulty of maintaining high-coverage, cytology-based cervical screening programs in low/middle-income countries.⁷³

Because surgical treatment for stage I lung cancer has demonstrated survival benefits,⁷⁴ using low-dose computed tomography⁷⁵ to detect lung cancers earlier not only could

reduce the existing mortality but also could indirectly improve the effectiveness of public health prevention and tobacco-control campaigns.⁷⁴ Because many hospitals in China continue to use x-rays to detect lung cancer,⁷⁴ building functional medical capacity, particularly in rural China, remains a priority.

To address the geographic diversity and the inequitable distribution of medical resources to urban areas (which contain 30% of the population but receive 70% of the medical resources), China has implemented the strategy of supercenters for cancer care, which have extremely high concentrations of cancer surgical specialists with high caseloads.⁷⁶ However, removing geographic and financial barriers to access optimal treatment remains a priority, with rural and disadvantaged people facing not only a relative shortage of doctors but greater travel distances to access them. In addition, while basic medical insurance coverage is nearly universal,^{77,78} these schemes do not provide even partial coverage for cancer treatments, meaning that patients are either forced to pay out-of-pocket or go without.^{39,79}

Any initiatives to improve the earlier detection and treatment of cancer in China need to consider the unique traditions and cultural beliefs among the Chinese population. There are widespread fatalistic attitudes toward cancer, a reluctance to discuss treatment and prognosis for fear of provoking unnecessary worry and poor outcomes, and a perception that, regardless of any treatment, death is inevitable after a cancer diagnosis.³⁹ Better understanding the roles of these beliefs is critical to enable appropriate programs and interventions and to facilitate trusting relationships between doctors and patients.³⁹ In parallel to these beliefs, traditional Chinese medicine has been embedded in the Chinese health system for thousands of years and is entwined with the culture, history, and politics of China.³⁹ As such, there may be potential to integrate cancer care and treatment with the role of clinical care through these existing traditional medical academic centers.

To better quantify the impact of early detection and treatment on the observed trends in cancer incidence and mortality, more detailed data on both the stage of disease at presentation and the treatment received after diagnosis are required.^{80,81} Given that these type of data are not currently available in the Chinese cancer registry system, this will require specific research studies with a sufficiently large, representative, population-based cohort.

Limitations

Although the data presented in this study represent a doubling of the population coverage compared with previous estimates, they still only represent less than one-tenth of the total Chinese population. There remains an unknown level of uncertainty in these estimates. In addition, while

quality-control efforts continue to improve the completeness and validity of data within specific local cancer registries, as evidenced by the increasing number of Chinese cancer registries being included in the CI5 series (from just 3 registries from mainland China in volume VII [1997], to 8 in volume VIII [2002], and then 12 in volume X [2014],⁸² and 23 used to estimate the national incidence burden in GLOBOCAN for 2012),²³ there remains some variability in the quality of data, as evidenced by many registries not being selected for inclusion in the last volume of the IARC CI5 series (ci5.iarc.fr; accessed June 10, 2015). The M/I ratio was required as an approximation for 5-year relative survival. The interpretation of the M/I ratio can be problematic, because the mortality rate involves a different cohort of people than the incidence rate.⁸³ This makes it particularly susceptible to any changes in incidence over time, and so provides a more accurate estimate of survival for those cancers with high case fatality. However, unpublished data from the 17 Chinese cancer registries showed that the M/I ratio for all cancers combined was only about 1.4% higher (in absolute values) than the calculated 5-year relative survival reported previously.²⁷ Finally, in a country of 1.4 billion people, there remain many challenges in ensuring that the incidence and mortality numerator data represent the same population at risk as the estimated resident population denominator, particularly when considering cases treated in major urban facilities and migrant workers from rural areas. Geographic information of incident cases is based on the place of permanent residence, not place of treatment. In addition, cancers diagnosed among the sizable population of migrant workers (9% of the population³⁹) through the Urban Resident Basic Medical Insurance program or the New Rural Cooperative Medical Scheme, which cover the majority of the Chinese population,^{77,78} both of which are based on their place of household registration.

Conclusions

To develop an appropriately targeted national cancer control plan in China, it is critical to have a detailed assessment

of the cancer burden in China based on representative and accurate, population-based data. These estimates and the ongoing cancer registration efforts in China are important steps supporting this aim. While there is still imprecision associated with these national estimates, these estimates are based on the best available data on cancer incidence and mortality. They may serve as a baseline for future comparisons and further assessments to better understand the overall effectiveness of cancer control in China and provide insights into the areas of greatest need for targeted support. Internationally, there is a long history of governments and other health providers having greater incentive to act when there is clear, quantitative evidence demonstrating the need. In this regard, these latest estimates demonstrate that China faces huge challenges in managing the very large and increasing burden of cancer now and in the future, requiring a concerted effort and commitment from all levels of government and nongovernment organizations.

Key areas may include the improvement of clinical cancer care delivery at the population level, through targeted policy changes and investment in increasing access to health service in rural areas and providing basic health care to the disadvantaged populations. Primary prevention programs, such as an effective tobacco-control policy and initiatives to mitigate the negative influences of a more westernized lifestyle, are crucial, along with efforts to increase the effectiveness and coverage of the diagnostic techniques and screening programs that are critical to reversing the cancer epidemic in China. It remains a priority to ensure that the existing air and water pollution-control legislation is adequately implemented to ensure that real improvements occur in practice. Given the importance of the contribution of China to the worldwide burden of cancer, especially for the 4 major cancers (cancers of the lung, liver, stomach, and esophagus), strategies and policies to reduce these preventable cancers (by reducing the prevalence of tobacco smoking and the prevalence of infections associated with cancer risk) will have a great impact on the future cancer burden both in China and worldwide. ■

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