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Journal of Cancer Biology & Research

Short Communication

The Epidemiology of Lung Cancer in China

Wanqing Chen*, Rongshou Zheng, Hongmei Zeng and Siwei Zhang

National Cancer Center, China

Special Issue on
Lung Cancer China

***Corresponding author**

Wanqing Chen, National Cancer Center, Beijing, 100021, China, Email: chenwq@cicams.ac.cn

Submitted: 25 March 2014

Accepted: 18 April 2014

Published: 24 April 2014

INTRODUCTION

Cancer is an emerging health issue in China and many other countries of the world. Lung cancer is the first leading cancer diagnosed and cause of cancer death for many years in China with a rapid increasing trend during the past several decades [1,2]. The incidence rate of lung cancer in China was relatively higher and also increasing with a more rapid rate than in western countries. Lots of risk factors such as cigarette smoking, air pollution has been proved as the risk factor of the disease [3-6].China, with a lot of people smoking, may have more patients with lung cancer in the future. This article provides an up-to-date description of the epidemiologic of lung cancer in China and this information will provide the evidence base for future interventions to improve health in China.

Lung cancer incidence and mortality

Lung cancer has been the most common cancer in the world for several decades. There are estimated to be 1.8 million new cases in 2012 (12.9% of the total), 58% of which occurred in the less developed regions. The disease remains as the most common cancer in men worldwide (1.2 million, 16.7% of the total) with the highest estimated age-standardised incidence rates in Eastern Asia (50.4 per 100,000). Lung cancer is the most common cause of death for cancer worldwide, estimated to be responsible for nearly one in five (1.59 million deaths, 19.4% of the total). Because of its high fatality (the overall ratio of mortality to incidence is 0.87) and the relative lack of variability in survival in different world regions, the geographical patterns in mortality closely follow those in incidence. As the most populous country in the world, China contains 19% of the word population with 21.75% of all newly diagnosed cancer case and 26.90% deaths, with 35.78% of all newly diagnosed lung cancer case and 37.56% deaths worldwide [7].

Incidence

According to the estimates of cancer burden in China by National Center Cancer Registry (NCCR) with using 145 cancer registries data, covered about 158 million population(account for 11.58% of national population), there were about 605 946 new lung cancer diagnoses in China in 2010 (416 333 men and 189 613 in women), with a crude incidence rate of 46.08 per 100 000 (the age-standardized rates by Chinese population 2000 (CASIR) of 35.23 per 100 000 and age-standardized rates by world population (Segi's population, WASIR) of 35.04 per 100,000), accounted for 19.59% of all new cancer cases. Among the new cases, 348 107 (57.45%) came from urban areas and 257 839 (42.55%) from rural areas.

The crude incidence rate for lung cancer was 46.08/100 000 in 2010, accounting for 19.59% of overall new cancer cases in China. The CASIR and WASIR were 35.23/100 000 and 35.04/100 000, respectively. Among the patients aged 0–74, the cumulative incidence rate was 4.28%.

Lung cancer occurred more often in men than women. For men, the crude incidence rate was 61.86/100 000, whereas the CASIR and WASIR were 49.27/100 000 and 49.16/100 000, respectively. For women, the crude incidence rate was 29.54/100 000, whereas the CASIR and WASIR were 21.66/100 000 and 21.40/100 000, respectively. The crude incidence rate in urban areas was 52.52/100 000, which was higher than in rural areas (39.54/100 000). After age standardization, the incidence rate in urban areas (36.39/100 000 for WASIR) was still higher than in rural areas (33.25/100 000 for WASIR) (Table 1).

The 10 most common cancers in male accounted for 85.01% of all new cases and lung cancer was the most common cancer diagnosed in male in China accounted for 23.03% of all new cases, followed by stomach cancer, liver cancer, esophageal cancer and colorectal cancer. In female, lung cancer was the second frequently diagnosed cancers followed with breast cancer, accounted for 16.20% of all new cases, and followed by colorectal cancer, stomach cancer and liver cancer (Table 2).

Age-specific incidence rates of lung cancer for both genders and areas were compared. The lung cancer age-specific incidence rates were relatively low before 45 years of age in each area and aftrt then increased dramatically, peaking in age group of 80–84 or above 85 years old. Generally, lung cancer among men had a higher age-specific incidence rate than those among women, except for those in younger age groups (<30 years old). Similarly, the age-specific lung cancer rates in urban areas were generally higher than in rural areas, except for subjects in younger age groups. The age-specific incidence rates varied in different areas with a similar curve (Figure 1).The lung cancer incidence rates

Table 1: Lung cancer incidence in China, 2010.

Areas	Gender	No. of cases	Crude rate ($1/10^5$)	Ratio (%)	CASIR ($1/10^5$)	WASIR ($1/10^5$)	Cum rate 0–74 (%)	TASR 35–64 ($1/10^5$)	Rank
ALL	Both	605 946	46.08	19.59	35.23	35.04	4.28	50.61	1
	Male	416 333	61.86	23.03	49.27	49.16	5.98	69.26	1
	Female	189 613	29.54	14.75	21.66	21.40	2.56	31.33	2
Urban	Both	348 107	52.52	20.48	36.62	36.39	4.42	50.48	1
	Male	238 816	70.39	24.48	51.22	51.05	6.15	68.80	1
	Female	109 291	33.78	15.10	22.52	22.24	2.63	31.36	2
Rural	Both	257 839	39.54	18.50	33.39	33.25	4.10	50.74	1
	Male	177 517	53.20	21.33	46.75	46.73	5.75	69.85	1
	Female	80 322	25.23	14.31	20.49	20.25	2.47	31.25	2

CASIR: age-standardized rates by Chinese population, 2000
WASIR: age-standardized rates by world population(the Segi's population)
TASR: Truncated age-standardized rate (Segi's population)

Table 2: The top 10 cancer incidence in China in 2010.

Rank	Male					Female				
	Site	Cases	Incidence ($1/10^5$)	(%)	CASIR[a] ($1/10^5$)	Site	Cases	Incidence ($1/10^5$)	(%)	CASIR[a] ($1/10^5$)
1	Lung(C33-C34)	416333	61.86	23.03	49.27	Breast(C50)	208192	32.43	16.20	25.89
2	Stomach(C16)	287844	42.77	15.92	34.05	Lung(C33-C34)	189613	29.54	14.75	21.66
3	Liver(C22)	268757	39.94	14.87	32.21	Colorectal(C18-21)	117486	18.30	9.14	13.63
4	Esophagus(C15)	204449	30.38	11.31	24.05	Stomach(C16)	116721	18.18	9.08	13.55
5	Colorectal(C18-21)	157355	23.38	8.70	18.75	Liver(C22)	90083	14.03	7.01	10.41
6	Bladder(C67)	46102	6.85	2.55	5.49	Esophagus(C15)	83183	12.96	6.47	9.46
7	Pancreas(C25)	40394	6.00	2.23	4.78	Cervix(C53)	76884	11.98	5.98	9.84
8	Brain, CNS(C70-C72)	39782	5.91	2.20	5.10	Uterus(C54-55)	47751	7.44	3.72	5.84
9	Prostate(C61)	38373	5.70	2.12	4.56	Ovary(C56)	41516	6.47	3.23	5.22
10	Leukaemia(C91-C95)	37523	5.58	2.08	5.10	Thyroid(C73)	41213	6.42	3.21	5.62

aAge –standardized incidence rate (China population 2000)

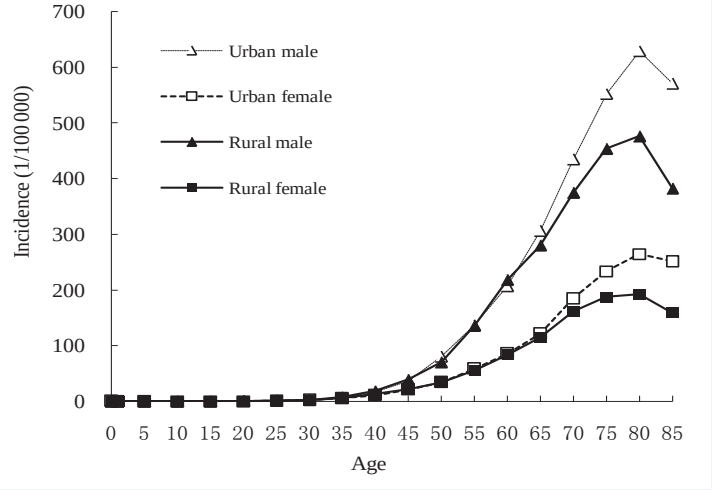

Figure 1 Age-specific incidence rate of lung cancer in China in 2010 ($1/10^5$).

were higher in urban areas than in rural areas [8]. A unique age-specific incidence of Lung cancer can be observed in Chinese women.

Mortality

It was estimated that about 486 555 people died of lung cancer in 2010 (336 786 men and 149 769 women), with a crude mortality rate of 37.00 per 100 000 (the age-standardized rates by Chinese population (CASMR) 27.93 per 100 000 and age-standardized rates by world population (WASMR) of 27.72 per 100 000). The cumulative rates of incidence and mortality from age 0 to 74 were 4.28% and 3.24%, respectively. Among the 486 555 lung cancer deaths, 279 919 (57.53%) came from urban areas and 206 636 (42.47%) from rural areas.

In 2010, the mortality rate was 37.00/100,000, while the mortality rates in urban areas (42.23/100,000) are higher than that in rural areas (31.69/100,000), and smoothly higher of ASR world rates (28.62/100,000 vs. 26.47/100,000).The mortality rate of lung cancer was much higher in men than in women. In men, the crude mortality rates, CASMR, and WASMR were 50.04/100 000, 39.79/100 000, and 39.62/100 000, respectively. In women, the crude mortality rates, CASMR, and WASMR were 23.33/100 000, 16.62/100 000, and 16.41/100 000, respectively. In urban areas, the crude mortality rates, CASMR, and WASMR were 42.23/100 000, 28.88/100 000, and 28.62/100 000, respectively. In rural areas, they were 31.69/100 000, 26.61/100 000, and 26.47/100 000, respectively, which were much lower than those in urban areas (Table 3).

Because of high mortality for lung cancer in each age group, the trend for lung cancer mortality in different age groups was similar to the trend of incidence. Age-specific mortality rates of lung cancer for both genders and areas were compared. The lung cancer age-specific mortality rates were relatively low before 50 years of age in each area and after then increased dramatically, peaking in age group of 80–84 or above 85 years old. Generally, lung cancer among men also had a higher age-specific mortality rate than those among women, except for those in younger age groups (<40 years old) because of fluctuations of incidence those age groups. Similarly, the age-specific mortality of lung cancer in urban areas were generally higher than in rural areas[8].The age-specific mortality rates varied in different areas with a similar curve (Figure 2).

The 10 most common cancers died in male accounted for 89.35% of all death cases and lung cancer was the most common cancer mortality in male in China accounted for 23.33% of all death cases, followed by liver cancer, stomach cancer, esophagus cancer and colorectal cancer. Lung cancer was not the top cancer incidence in female, but the disease become the first leading cause of cancer death in female, account for 21.32% of all death cases, because of high mortality compared with other cancers, followed stomach cancer, liver cancer, esophagus cancer and breast cancer (Table 4).

Trends over time

Lung cancer incidence and mortality was increased during the past decades in China, especially in rural areas [9,10]. According to the statistics of the retrospective investigation of death by the National Office for Cancer Prevention and Control in the mid-1970s, the death rate for lung cancer in China was 5.47/100 000, accounting for 7.43% of the total cancer-related deaths and

Table 3: Lung cancer mortality in China, 2010.

Areas	Gender	No. of cases	Crude rate ($1/10^5$)	Ratio (%)	CASIR ($1/10^5$)	WASIR ($1/10^5$)	Cum rate 0–74 (%)	TASR 35–64 ($1/10^5$)	Rank
ALL	Both	486 555	37.00	24.87	27.93	27.72	3.24	34.36	1
	Male	336 786	50.04	26.85	39.79	39.62	4.59	48.49	1
	Female	149 769	23.33	21.32	16.62	16.41	1.86	19.75	1
Urban	Both	279 919	42.23	27.05	28.88	28.62	3.32	33.10	1
	Male	192 438	56.72	29.46	41.04	40.81	4.69	46.95	1
	Female	87 481	27.04	22.92	17.31	17.04	1.91	18.65	1
Rural	Both	206 636	31.69	22.42	26.61	26.47	3.12	35.76	1
	Male	144 348	43.26	24.02	38.09	38.00	4.45	50.19	1
	Female	62 288	19.56	19.42	15.64	15.50	1.81	21.02	1

CASIR: age-standardized rates by Chinese population 2000
WASIR: age-standardized rates by world population(the Segi's population)
TASR: Truncated age-standardized rate (Segi's population)

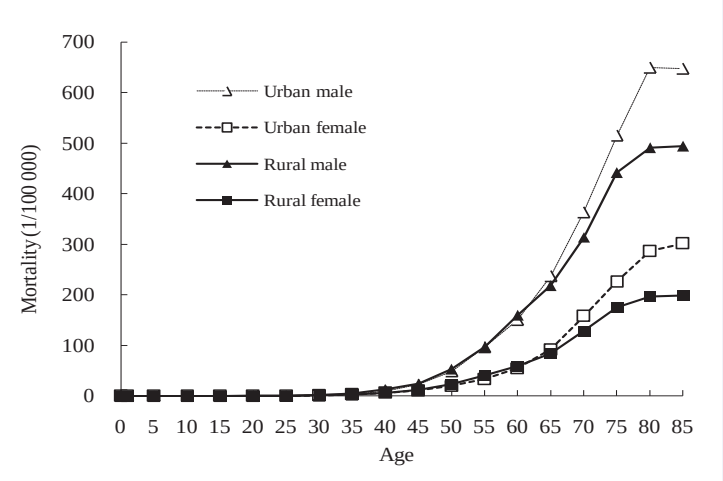

Figure 2 Age-specific mortality of lung cancer in China in 2010 ($1/10^5$).

ranking fifth after gastric cancer, oesophageal carcinoma, liver cancer and uterine cervix cancer, a lower ranking than in other countries at that time. The second sampling survey during the early 1990s revealed the lung cancer death rate was 17.27/100 000, ranking third after gastric cancer and oesophageal carcinoma.

And the third national retrospective investigation of death showed that cancer patterns in China have changed. Lung cancer becomes the first leading cause of cancer death with mortality rate was 30.83/100 000, account for 22.69% of all cancer death, followed with liver cancer, stomach cancer and oesophagus cancer (Table 5).

According to data of 21 fixed cancer registries from 2000 to 2010 (data comes from National Central Cancer Registry of China), age-specific incidence of lung cancer changes smoothly. For males in urban areas, only age group of 50-59 was increased during the past decades, but a litter difference for females in urban areas, older age groups such as 70- years old was also increased during the past decades (Figure 3).

The age-specific mortality trend of lung cancer changes similar to the trend of incidence, with a little decrease for each age group in urban areas expect 80-years old age groups for female. The pattern of lung cancer mortality trend in rural areas was not obviously increase or decreases during the past decades expect 70- years' old age groups. (Figure 4)

Predictions

The technical aspects of analyzing and predicting the cancer burden have been developed and refined over the past few decades. Different mathematical models such as Age models, age-period models, Age-Period-Cohort (APC) models have been widely used to describe disease trends in populations. Estimates of the future number of lung cancer patients can provided to relatively department of health to plan the best possible allocation of finite resources to the core elements of cancer control: primary prevention, screening and early diagnosis, treatment, rehabilitation and palliative care [11].

The most important risk behaviour for lung cancer is tobacco smoking. The relationship between smoking and lung cancer is one of the most thoroughly investigated issues in biomedical research, and compelling evidence has built up since the middle of the twentieth century to indicate that smoking is the predominant causal factor for lung cancer [12]. According to the GLONOCAN2012, there may be 733280 lung cancer patients in 2015 and 845133 lung cancer patients in 2020 [7], and this prediction of lung cancer cases was relatively higher than what we have did before [13]. But the common is lung cancer will increase in the future in China.

DISCUSSION

Population-based cancer registry system plays a very

Table 4: The top 10 cancer mortality in China in 2010.

Rank	Male					Male				
	Site	Cases	Mortality ($1/10^5$)	(%)	ASR[a] ($1/10^5$)	Site	Cases	Mortality ($1/10^5$)	(%)	ASR[a] ($1/10^5$)
1	Lung(C33-C34)	336786	50.04	26.85	39.79	Lung(C33-C34)	149769	23.33	21.32	16.62
2	Liver(C22)	231950	34.47	18.49	27.69	Stomach(C16)	87833	13.68	12.50	9.83
3	Stomach(C16)	200018	29.72	15.95	23.70	Liver(C22)	80482	12.54	11.46	9.15
4	Esophagus(C15)	148865	22.12	11.87	17.54	Esophagus(C15)	59608	9.29	8.49	6.52
5	Colorectal(C18-21)	76646	11.39	6.11	9.10	Breast(C50)	55500	8.65	7.90	6.56
6	Pancreas(C25)	34509	5.13	2.75	4.08	Colorectal(C18-21)	55464	8.64	7.90	6.12
7	Leukaemia(C91-C95)	26212	3.89	2.09	3.45	Pancreas(C25)	23226	3.62	3.31	2.58
8	Brain,CNS(C70-C72)	26029	3.87	2.08	3.27	Cervix(C53)	21626	3.37	3.08	2.60
9	Lymphoma(C81-85,88,90,96)	22178	3.30	1.77	2.70	Brain,CNS(C70-C72)	20711	3.23	2.95	2.55
10	Bladder(C67)	17386	2.58	1.39	2.05	Leukaemia(C91-C95)	19441	3.03	2.77	2.56

[a]Age –standardized incidence rate (China population 2000

Table 5: The top 10 cancer mortality in three times National Retrospective Investigation of Death.

Sites	1973-75			1990-92			May-04		
	Mortality ($1/10^5$)	(%)	CASMR ($1/10^5$)	Mortality ($1/10^5$)	(%)	CASMR ($1/10^5$)	Mortality ($1/10^5$)	(%)	CASMR ($1/10^5$)
ALL sites	74.20	100.00	75.60	108.26	100.00	94.36	135.88	100.00	91.24
Stomach	17.40	23.45	17.70	25.16	23.24	21.76	24.71	18.19	17.86
Esophagus	16.70	22.51	17.10	17.38	16.05	15.02	15.21	11.19	9.97
Liver	10.75	14.49	11.00	20.37	18.82	17.83	26.26	19.33	17.86
Cervix	5.55	7.48	5.70	1.89	1.75	1.64	1.40	1.03	0.94
Lung	5.46	7.36	5.60	17.54	16.20	15.19	30.83	22.69	20.24
Colorectal	4.17	5.62	4.20	5.30	4.90	4.54	7.25	5.34	4.67
Leukemia	2.54	3.42	2.50	3.64	3.36	3.53	3.84	2.83	3.43
Nasopharynx	1.99	2.68	2.00	1.74	1.61	1.53	1.46	1.07	1.01
Breast	1.48	1.99	1.50	1.72	1.59	1.49	2.90	2.13	1.98
Bladder	0.51	0.69	0.50	1.01	0.93	0.85	1.41	1.04	0.85

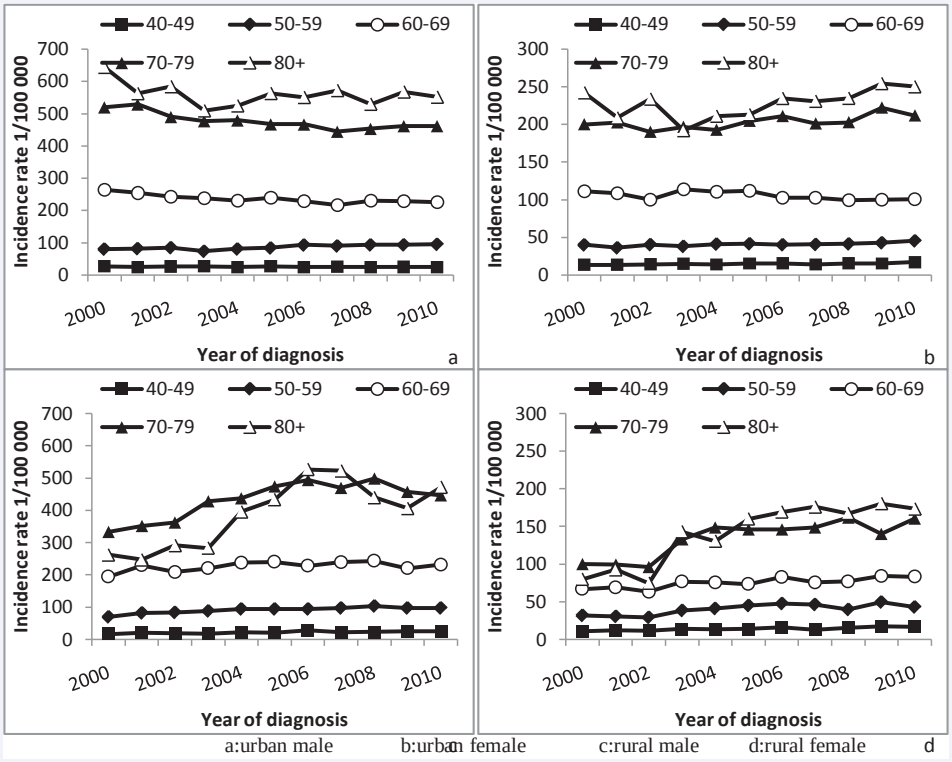

Figure 3 Age-specific incidence rates per 100,000 population, China, 2000-2010.

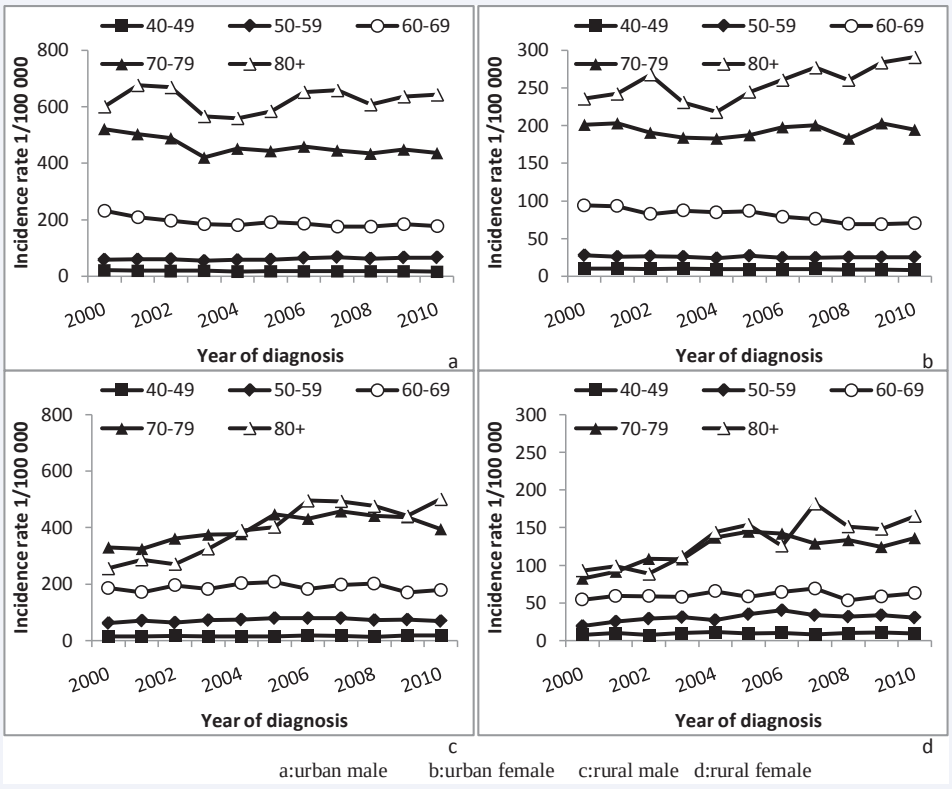

Figure 4 Age-specific mortality rates per 100,000 population, China, 2000-2010.

important role in collecting and providing cancer statistics for cancer control and prevention. In China, the first population-based cancer registry was established in 1958 in Linzhou, Henan province [14]. But the development of cancer registration was limited since then and lasted for decades. The National Central Cancer Registry (NCCR) of China was established in 2002, acting as a federal bureau for systematic management of cancer surveillance for nationwide in China. NCCR of China was responsible for cancer data collection, evaluation, analysis and publication from population-based cancer registries located in each province of China. All hospitals, community health centres and other medical institutions with cancer diagnostic capabilities covered by cancer registry should record and report new cancer cases to the cancer registry when case first diagnosed, and also including canters of township medical insurance and the New Rural Cooperative Medical System. The death record database was regular linked and matched with cancer registration database for identifying vital status and also as a source of supplement for case finding. Due to lack of reliable cancer registries in different regions in the 20th century, only about 11 cancer registries established in China until 1998, the documentation of cancer cases throughout China was limited in the 20th century. Because of an increasing demand for cancer information and an emphasis for effective cancer prevention and control, in 2002, a National Central Cancer Registry (NCCR) was established by the Health Ministry [15]. However, by 2014, the number of cancer registries had increased to 252, distributed in each province with covered about 260 million populations, coverage accounted for 19% of the national population and this National Cancer Registry does adequately reflect the general population of China.

Lung cancer is the leading cause of cancer mortality in China for many years, and its incidence is growing throughout the world. The high morbidity and mortality of lung cancer largely results from the fact that most people are diagnosed with advanced disease. Although many risk factors have been implicated, such as tobacco exposure, air pollution made a very important contribution for developing lung cancer. Tobacco use is currently increasing among specific population groups. It is probable that lung cancer will continue as a major medical and social problem for the foreseeable future. Lung cancer incidence and mortality trends closely reflect patterns in smoking prevalence from 20 to 30 years earlier. In more developed countries, incidence and mortality rates are generally declining among males and are starting to plateau for females, reflecting previous trends in smoking prevalence. In contrast, there are some populations in less developed countries where increasing lung cancer rates are predicted to continue, due to endemic use of tobacco[12]. Tobacco use is the most preventable cause of cancer death, accounting for 20% of cancer deaths worldwide and for about 6% of cancer deaths in Africa [16]. In women, the incidence rates are generally lower and the geographical pattern is a little different, mainly reflecting different historical exposure to tobacco smoking [17,18]. But actually in China, about 52.4% of lung cancer can be attributed to smoking in male, and about 19.4% of lung cancer in women can be attributed to smoking [19]. Maybe risk factors for lung cancer such as indoor air pollution, indoor radon [9,20] also plays an important role for women patients in China. Many differences have been identified of lung cancer in China compare with developed countries, such as later stage distribution. There should be improvement in the health care system in China in order to optimise care for people with lung cancer.

The age-specific incidence trend seemed contradictory to the crude incidence trend of lung cancer showed in previous study [2] that the trend of age-specific incidence rate changes stabilizing or even with a little decreasing, however, the trend of crude incidence rate was continuously increased over the past decade both for male and female in urban and rural areas of China. The increasing of predicted lung cancer in future and the trend of lung cancer during the past decades can be explained by aging population in China. The tobacco consumption, air pollution, unhealthy lifestyles and other risk factors exposure may reflected in the future data if we did nothing for the disease control. This article described the epidemic of lung cancer in China and because of lack of effective treatment for advanced lung cancers; these results highlight the need for ongoing prevention and control strategy to reduce the burden of lung cancer.

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Cite this article

Chen W, Zheng R, Zeng H, Zhang S (2014) The Epidemiology of Lung Cancer in China. J Cancer Biol Res 2(1): 1043.