Incidence rate of lung cancer in urban Shijiazhuang in 2012 with prevention implication

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Keywords
Air pollution; incidence rate; lung cancer; Shijiazhuang; tobacco epidemic.

Abstract
Background: Pollution has been established as an environmental factor in the development of lung cancer; however, the incidence rate in Shijiazhuang, one of China’s most heavily polluted cities, is unknown.

Methods: As Chinese citizens are entitled to complete public medical insurance coverage, we estimated the lung cancer incidence rate among registered citizens of urban Shijiazhuang in 2012 using reimbursement records of first hospitalization.

Results: In Shijiazhuang, lung cancer was the most common cancer in men and the second most common cancer in women. The age standardized world incidence rate (ASRW) was 46.42 and 19.14/100 000, respectively, compared with 51.05 and 22.24/100 000, respectively, reported for 63 Chinese tumor registration cities in 2010 (the national level). However, age-specific rates for the 55–70 range in men and the 25–55 range in women were higher in Shijiazhuang than nationally. Compared with GLOBOCAN 2012 data, the lung cancer ASRW in Shijiazhuang was comparable to that of all industrialized countries (44.7 and 19.6/100 000), but higher than all developing countries (30.0 and 11.1/100 000), Japan (38.8 and 12.9/100 000), and Korea (45.5 and 16.2/100 000).

Conclusion: The lung cancer incidence rate in Shijiazhuang matched the world’s highest level in 2012. According to the experience of western countries, the incidence rate in China is expected to continue to rise over the next 40 years. Intervention is urgently required in order to reduce smoking prevalence by a third by 2025 and to take concrete legal action to reduce air pollution.

Introduction
According to World Health Organization (WHO) GLOBOCAN 2012 data, in China, the age standardized incidence and mortality rates of lung cancer were 36.1/100 000 and 32.5/100 000, respectively; lung cancer is ranked number one in both cancer incidence and death.1 From 1988–2005, the crude incidence rate of lung cancer in tumor registration areas in China has increased annually by 1.3% in men and 2.3% in women, making lung cancer the most rapidly increasing type of cancer.2 Shijiazhuang, the capital of Hebei Province, located 270 kilometers southern of Peking, is one of the most heavily polluted cities in northern central China. The International Agency for Research on Cancer (IARC) has declared outdoor air pollution as a leading environmental cause of cancer deaths; however, the incidence rate of lung cancer in Shijiazhuang city is unknown.3 Because all registered citizens (2.37 million) of Shijiazhuang city are covered by public medical insurance systems, and, theoretically, any registered citizen diagnosed with cancer must be hospitalized to have the cost of treatment covered, we examined the reimbursement records of patients who had been hospitalized for lung cancer for the first time between 1 January to 31 December 2012 as newly diagnosed cases, and estimated the incidence rate.
Material and methods

The new cases

Since 2000, all registered citizens in Shijiazhuang city have been covered by at least one public medical insurance system. The cost of medical treatment of lung cancer among these citizens, wherever hospitalized, is reimbursed at the Shijiazhuang Municipal Medical Insurance Center. In July 2014, we compiled the reimbursement records of patients who had been hospitalized for lung cancer for the first time between 1 January and 31 December 2012 as newly diagnosed lung cancer cases of that year. We validated the date and diagnosis of lung cancer by checking hospital records. The coding of primary lung tumor site and histology was made according to International Classification of Diseases for Oncology, third edition (ICD-O-3).4

Population data

Population data concerning the gender and age distribution of registered citizens of Shijiazhuang city on 30 July 2012 was provided by the Population Division of the Shijiazhuang Public Security Bureau. The total population was 2 374 827, with 1 157 390 men and 1 217 437 women, a male: female ratio of 0.95:1.

Statistical methods

Gender and age-specific lung cancer incidence rates were calculated. The age distribution of the 2000 Chinese national population survey was used to calculate the age standardized rate for China (ASRC), and the Segi standard world population (modified by Doll) was used to calculate the age standardized rate for the world (ASRW).5 A comparison between the lung cancer incidence rate in Shijiazhuang, 63 other Chinese tumor registration cities, and GLOBOCAN 2012 was made using ASRW.1

Results

Overall lung cancer crude incidence rate

In 2012, a total of 1 132 lung cancer cases were diagnosed in Shijiazhuang, with 786 (69.43%) male and 346 (30.57%) female cases. The male to female ratio was 2.27:1. The overall lung cancer crude incidence rate, ASRC, and ASRW were: 47.67, 35.23, and 35.04/100 000 in both genders; 67.91, 44.10, and 46.42/100 000 in men; and 28.42, 20.27, and 19.14/100 000 in women, respectively. In Shijiazhuang, lung cancer is the most common cancer in men and the second most common cancer in women.

Age-specific lung cancer incidence rate

In Shijiazhuang, the incidence rate of lung cancer increases with age; however, the increase is slow up to the age of 45 years and becomes rapid thereafter. The age-specific incidence curve of lung cancer for men and women is almost the same up to the age of 45 years, with women slightly higher than men, but thereafter the increase in incidence in men becomes more rapid than in women. By 50–54 years of age, the incidence rates in men and women reach 74.67 and 27.90/100 000, respectively, equivalent to the combined incidence rate for men and women. With both genders combined, the age-specific incidence rate of lung cancer increases by 50/100 000 with each five-year increase in age. However, the rate for men is about two to three times the rate for women. The incidence rate in men is highest at 70–74 years of age, at 477.98/100 000; in women, the highest rate is in the 75–79 year age range, at 189.83 (Table 1, Fig. 1).

Figure 1

Age-specific lung cancer incidence rates in urban Shijiazhuang in 2012. —, Both sex; —, Male; —, Female.
An exact pathological diagnosis was obtained for 502 (44.25%) of the 1,132 lung cancer cases. Among the cases with exact pathological diagnoses, adenocarcinoma constituted 25.4%, squamous cell carcinoma 12.5%, small cell carcinoma 3.5%, adenosquamous carcinoma 2.5%, and mucoepidermoid carcinoma 0.4%. Among the cases with non-exact pathological diagnoses (630, 55.65%), carcinoma not otherwise specified (NOS) constituted 22.0%, and malignant tumor NOS accounted for 33.7% (Table 2).

The proportion of exact pathological diagnosis of lung cancer was significantly improved in specialized tumor hospitals. Among the 457 lung cancer cases diagnosed at the Hebei Tumor Hospital, for example, adenocarcinoma constituted 41.1%, squamous cell carcinoma 13.1%, small cell carcinoma 7.4%, other specified carcinoma 6.6%, and the percentage of non-exact pathological diagnoses was only 31.5%, with carcinoma NOS constituting 17.3% and malignant tumor NOS accounting for 14.2%.

The percentage of adenocarcinoma in lung cancer was 22.14% (174/786) in men and 32.95% (114/346) in women, suggesting that women are more likely to develop adenocarcinoma than other pathological types. However, the incidence of adenocarcinoma was still higher in men (15.03/100,000) than in women (9.36/100,000). The incidence rate of

### Table 1

| Age groups | Incidence rates in Shijiazhuang (1/10^5) | Incidence rates in 63 Chinese cities (1/10^5) |
|------------|----------------------------------------|---------------------------------------------|
|            | Both | Male | Female | Both | Male | Female |
| 0–5        | 0.00 | 0.00 | 0.00 | 0.35 | 0.00 | 0.76   |
| 1–5        | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00   |
| 5–10       | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.03   |
| 10–15      | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.14   |
| 15–20      | 0.00 | 0.00 | 0.00 | 0.15 | 0.10 | 0.20   |
| 20–25      | 0.48 | 0.00 | 0.92 | 1.09 | 1.37 | 0.81   |
| 25–30      | 1.61 | 0.00 | 3.11 | 2.52 | 2.60 | 2.43   |
| 30–35      | 5.46 | 4.09 | 6.76 | 6.08 | 6.67 | 5.45   |
| 35–40      | 12.69 | 11.76 | 13.60 | 13.69 | 16.40 | 10.93 |
| 40–45      | 20.79 | 20.28 | 21.33 | 28.57 | 36.13 | 20.97 |
| 45–50      | 51.65 | 74.67 | 34.90 | 57.89 | 80.63 | 34.09 |
| 50–55      | 98.38 | 137.69 | 60.28 | 98.50 | 136.86 | 58.78 |
| 55–60      | 149.63 | 220.23 | 80.46 | 147.86 | 206.76 | 85.59 |
| 60–65      | 207.64 | 307.50 | 112.84 | 216.11 | 306.55 | 121.20 |
| 65–70      | 302.91 | 477.98 | 144.77 | 310.50 | 434.61 | 184.63 |
| 70–75      | 322.63 | 470.67 | 189.83 | 382.63 | 552.22 | 233.61 |
| 75–80      | 215.29 | 336.05 | 117.10 | 420.21 | 629.00 | 264.41 |
| 80–85 +    | 202.37 | 327.17 | 124.82 | 396.26 | 550.08 | 237.88 |
| Crude rate (1/10^5) | 47.67 | 67.91 | 28.42 | 52.52 | 70.39 | 33.78 |
| ASR (China)1/10^5 | 32.35 | 44.10 | 20.27 | 36.62 | 51.22 | 22.52 |
| ASR (World)1/10^5 | 32.33 | 46.42 | 19.14 | 36.39 | 51.05 | 22.24 |
| Cum rate 0–74 years (%) | 4.26 | 6.27 | 2.36 | 4.42 | 6.15 | 2.63 |

### Table 2

Lung cancer histology of the registered residents of urban Shijiazhuang in 2012

| Classification | Morphology |
|----------------|------------|
|                | Squamous carcinoma (%) | Adeno carcinoma (%) | Small cell carcinoma (%) | Other specified carcinoma (%) | Carcinoma NOS (%) | Sarcoma and others (%) | Malignancy NOS (%) |
| All hospitals combined | 141 (12.5) | 288 (25.4) | 40 (3.5) | 32 (2.8) | 249 (22.0) | 1 (0.1) | 381 (33.7) |
| Men (N = 786) | 125 (15.9) | 174 (22.1) | 32 (4.1) | 26 (3.3) | 175 (22.3) | 1 (0.1) | 253 (32.2) |
| Women (N = 346) | 16 (4.6) | 114 (32.9) | 8 (2.3) | 6 (1.7) | 74 (21.4) | 0 (0.0) | 128 (37.0) |
| Diagnosed in the local tumor hospital (Hebei Tumor Hospital) | 60 (13.1) | 188 (41.1) | 34 (7.4%) | 30 (6.6%) | 79 (17.3%) | 1 (0.2%) | 65 (14.2) |
| Men (N = 320) | 53 (16.6) | 120 (37.5) | 28 (8.8) | 24 (7.5) | 55 (17.2) | 1 (0.3) | 39 (12.2) |
| Women (N = 137) | 7 (5.1) | 68 (49.6) | 6 (4.4) | 6 (4.4) | 24 (17.5) | 0 (0.0) | 26 (19.0) |

NOS, not otherwise specified.
adenocarcinoma also increased with age, reaching the highest point at the age range of 70–74 years in both men and women (95.60 and 60.96/100,000, respectively).

**Comparison of the lung cancer incidence rate between Shijiazhuang and 63 Chinese tumor registration cities**

The crude incidence rate, ASRC, and ASRW of lung cancer for men and women in Shijiazhuang city in 2012 were 67.91, 44.10, 46.42, and 28.42, 20.27, 19.14/100,000, respectively, whereas the corresponding rates for men and women in 63 Chinese cities in 2010 were 70.39, 51.22, 51.05, and 33.78, 22.52, 22.24/100,000, respectively. Although the incidence rate of lung cancer in Shijiazhuang was lower than in the 63 Chinese cities when all age intervals were combined, the age-specific incidence rate at 55, 60, 65, and 70 years in men and 25, 30, 35, 40, 45, and 55 years in women was higher in Shijiazhuang than in the 63 cities (the national level) (Table 1). A lower crude rate for Shijiazhuang was caused mainly by lower rates in the 75 or above age range in men and by lower rates in the 60 or above age range in women. This is reflected by the fact that the 0–74 cumulative rate for men in Shijiazhuang was higher than the national level (6.27% vs. 4.15%); for women the 0–74 cumulative rate was not significantly different (2.36% vs. 1.59%). As data on incidence was compiled from insurance data, the lack of death certification data resulted in lower rates in senior age intervals for Shijiazhuang city.4

**Comparison with GLOBOCAN 2012**

In the absence of death certification, the lung cancer ASRW for men and women in Shijiazhuang city was 46.42 and 19.14/100,000, lower by 6.4/100,000 in men and by 1.3/100,000 in women than the rates estimated by GLOBOCAN 2012.1 The rate of lung cancer in Shijiazhuang was comparable to the rate for all industrialized countries combined (men 44.7, women 19.6/100,000), but significantly higher than all of the developing countries combined (30.0 and 11.1/100,000), and rates in Japan (38.8 and 12.9/100,000), South Korea (45.5 and 16.2/100,000), Mongolia (27.7 and 5.8/100,000), and India (11.0 and 3.1/100,000), suggesting Shijiazhuang is a region with one of the highest rates of lung cancer in the world.

**Discussion**

**In China, the lung cancer age standardized mortality rate has increased continually since the 1970s**

According to the three Chinese national death surveys performed in 1973–1975, 1990–1992, and 2004–2005, the age standardized mortality rate of lung cancer in men increased from 10.10 to 29.70 to 39.06/100,000, respectively.6 Lung cancer in men was ranked fourth in cancer-related deaths in 1973–1975, but by 2004–2005 it ranked first.7 In women, the rate increased from 4.70 to 11.72 to 16.73/100,000, and the rank also increased from sixth in 1973–1975 to first in 2004–2005.8

**China now has a relatively high incidence rate of lung cancer in the world**

According to GLOBOCAN 2012, the lung cancer ASRW in Chinese men and women were 52.8 and 20.4/100,000, respectively, significantly higher than the world rate combined, which was only 34.2 and 13.6/100,000, respectively.1 Compared with men and women in the United States (US), Chinese men had a higher rate (52.8 vs. 44.2/100,000), while Chinese women had a lower ASR (20.4 vs. 33.7/100,000). The rate of lung cancer in China is higher than all European countries combined (European men and women 46.6 and 15.1/100,000, respectively). The ASR of lung cancer for eastern Asia (men and women 50.4 and 19.2/100,000, respectively) ranks second in men and fifth in women among 20 regions of the world. Chinese men and women had higher rates than in eastern Asia, suggesting that China can no longer be regarded among the developing world in terms of lung cancer incidence. In the absence of death certification, the ASRW of lung cancer was 46.42 and 19.14/100,000 for men and women, respectively, in Shijiazhuang city, which is almost the same as European men but higher than the rate in European women, suggesting that lung cancer in Shijiazhuang city has reached one of the highest levels in the world.

**Cigarette smoking has driven the lung cancer epidemic in developed countries**

Cigarette smoking was uncommon throughout the world in 1900, but smoking rates among men increased substantially in the US and other industrialized countries during the first half of the 20th century, with high initiation rates during the two World Wars.9 By 1950, the tobacco epidemic reached its highest level among men in the US. Women in the US and in some industrialized countries took up smoking later than men, beginning mainly during and after the Second World War.9

As an eventual effect of the smoking epidemic in the first half of the 20th century, lung cancer age standardized mortality rates in the US increased steeply from 1930–1990, particularly among men.10 In 1930, the male age standardized mortality rate of lung cancer was about 5/100,000, ranking fifth in cancer-related death after stomach, colorectal, prostate, and liver cancers, respectively, but the rate rose to nearly
Lung cancer has been ranked as the number one killer ever since.\textsuperscript{10} In September 1950, an article was published in the \textit{British Medical Journal} linking smoking to lung cancer and heart disease.\textsuperscript{11} In 1954, the British Doctors Study confirmed the discovery, after which the government issued advice that smoking and lung cancer rates were related.\textsuperscript{12} In 1964, the US Surgeon General’s Report on Smoking and Health suggested a relationship between smoking and cancer.\textsuperscript{13} By the mid-1950s, individuals and attorneys in the US began to sue cigarette producers. Tobacco became stigmatized, which led to government actions against the tobacco industry, such as raising taxes on tobacco. As a result of combined measures, more adult smokers began quitting smoking, and fewer young people took-up the habit in the US in the second half of the 20th century.\textsuperscript{9}

The male lung cancer age standardized death rates reached the highest peak in 1990 (90/100 000), after which the rate gradually began to decrease as the massive anti-smoking campaigns took effect. By 2008, the rate had steadily decreased by about 40%. Because an increase in cigarette smoking among women came much later than men, the death rates of lung cancer among women did not reach a peak until 2000, thereafter leveling off at above 40/100 000; at present, there is no sign this will decrease.\textsuperscript{10}

\textbf{According to the experience of industrialized countries, lung cancer in China will continually rise until 2050}

Although more adults gave up smoking and more young people did not start in developed countries after 1950, cigarette consumption continued to rise in many low and middle-income countries, and it has not yet reached its peak. According to 2012 data, about 1.3 billion people worldwide now smoke, most in low and middle-income countries where cessation is uncommon. It is estimated that 0.35 billion smokers live in China. Cigarette consumption in China continues to rise steeply and now accounts for more than two trillion of a worldwide total of about six trillion cigarettes smoked per year.\textsuperscript{7} In 2012, the prevalence of smoking in 15 year olds or above in the US was 21% in men and 17% in women, with corresponding rates in China of 47% and 2.0%\textsuperscript{,14} and in Shijiazhuang of 41.3% and 0.9%. In Chinese men, the smoking rate is twice that of American men, although the rate in Chinese women is much lower.

Over the next 50 years in China, smoking is expected to continue to cause more deaths, as observed in industrialized countries between the period of widespread adoption of smoking by young adults and the main effect on mortality in later life.\textsuperscript{9} For example, among all US adults, cigarette consumption averaged one, four, and 10 per day in 1910, 1930, and 1950, respectively, after which it stabilized. The long-delayed result of this increase in consumption during the first half of the century was only seen in the second half of the century: tobacco caused about 12% of all US deaths in middle age in 1950 but about 33% of such deaths in 1990.\textsuperscript{9} A similar pattern was seen about 40 years later among Chinese men, who consumed one, four, and 10 cigarettes per day in 1952, 1972, and 1992, respectively. In 1990, tobacco caused about 12% of all deaths among middle-aged Chinese men, and it is estimated to cause approximately 33% in 2030.\textsuperscript{15,16}

The lung cancer age standardized mortality rate in American men began to decrease after 1990 when it had reached 90/100 000; in American women, the rate leveled off after it had reached 40/100 000 around the year 2000.\textsuperscript{10} In comparison, the increase in the lung cancer age standardized mortality rate from 10/100 000 in 1974 to 40/100 000 in 2004 in Chinese men was almost the same as in American men during 1935–1960 and the mortality rate increase in Chinese women from 5/100 000 in 1974 to 15/100 000 in 2004 was also almost the same as in American women during 1950–1975; therefore, the mortality rate of lung cancer in China may not have reached a peak as yet.\textsuperscript{8,10} WHO estimates that the number of deaths attributable to smoking in China will rise to one million by 2025.\textsuperscript{17}

\textbf{Lung cancer is preventable}

International variations in lung cancer rates and trends largely reflect differences in the stage of the tobacco epidemic and the effect of tobacco control programs.\textsuperscript{1} In several Western countries, such as the US, the United Kingdom, and Denmark, where the tobacco epidemic began earliest and peaked around the middle of the last century, after which smoking rates decreased as the result of anti-smoking campaigns, lung cancer mortality rates have been decreasing in men and plateauing in women.\textsuperscript{1} In contrast, in countries where the epidemic has been established more recently and smoking has just peaked or continues to increase, such as in China and Indonesia, lung cancer rates are likely to continue to increase at least for the next few decades.\textsuperscript{1}

The progressive increase in the age standardized death rate of lung cancer from 1950–1990, and then a nearly 40% steady decrease from 1991–2008 among men in the US, observed 40 years since the start of the tobacco epidemic in the first half of the century, and significant anti-tobacco campaigns implemented after 1950, have been the most convincing scientific observations that lung cancer is one of the most preventable cancers.\textsuperscript{9,16} If developing countries take swift action to promote smoking cessation and prevent initiation, they can attenuate future lung cancer rates and avoid the extraordinary burden of smoking-related diseases experienced in more developed countries.

The 2013 World Health Assembly called on governments to reduce the prevalence of smoking by a third by 2025, which
would prevent more than 200 million deaths from tobacco during the remainder of the century.\textsuperscript{18,19} Price is the key determinant of smoking uptake and cessation.\textsuperscript{20} A reduction in smoking of a third could be achieved worldwide by doubling the inflation-adjusted price of cigarettes, which, in many low and middle-income countries could be achieved by tripling the specific excise tax on tobacco. Without large price increases, a reduction in smoking by a third will be difficult to achieve.

The WHO also called for countries to achieve a 25% reduction by 2025 of the probability of dying from a non-communicable disease between the ages of 30–70.\textsuperscript{21} Smoking cessation is the only practical way to achieve this goal, because a substantial reduction by 2025 in smoking uptake by adolescents will have its main effect on mortality only after 2050.\textsuperscript{9}

To help achieve a large reduction in smoking in the coming decades, governments, health professionals, journalists, and other leaders need to appreciate the significantly increased risk of lung cancer and premature death by smoking cigarettes from early adulthood, the substantial benefits of stopping at various ages, the eventual magnitude of the epidemic of tobacco-attributable deaths if current smoking patterns persist, and the effectiveness of tax increases and other interventions to reduce cigarette consumption.

**Outdoor air pollution is another challenge in the Peking-Tianjin-Shijiazhuang metropolitan area**

The smoking rate among Chinese women (less than 1%) is lower than most other countries, but lung cancer incidence rates (20.4 /100,000) are higher than in European, Japanese, and Korean women.\textsuperscript{18} Researchers have long suspected that indoor air pollution by unventilated cooking may be a complicating factor.\textsuperscript{1} Outdoor air pollution has also reached epidemic levels in the Beijing, Tianjin, and Shijiazhuang metropolitan areas in recent years.\textsuperscript{22} In December 2012, the Global Burden of Disease analyses were published in *The Lancet*.\textsuperscript{23} As part of that effort, in 2005, the average concentration of particulate matter in diameter less than 2.5 micrometers (PM2.5) in the air was estimated across the world. The Beijing-Tianjin-Shijiazhuang metropolitan area had the highest level of PM2.5 pollution in the world, with an annual average over 80 \(\mu g/m^3\).\textsuperscript{24}

PM2.5 particles consist of a mixture of chemical compounds, including sulfur oxides, nitrogen oxides, ammonia, organic chemicals, and volatile metals, some of which are established carcinogens. When suspended in the atmosphere, PM2.5 particles are the major cause of reduced visibility. Beijing experienced 124 foggy days in 2012, and the situation in Shijiazhuang is even worse.\textsuperscript{22} On such days, the concentration of PM2.5 leveled off at 250–750 \(\mu g/m^3\), which is 10 times above the internationally recommended standard (the PM2.5 standard implemented in the US in 2006 was an annual average under 15 \(\mu g/m^3\) and a 24-hour average under 35 \(\mu g/m^3\)).\textsuperscript{22}

According to a 2013 report by the International Health Effects Institute, outdoor air pollution in China was ranked as the fourth leading risk for loss of life expectancy.\textsuperscript{25} Another study supported by the American Cancer Society found that each 10 \(\mu g/m^3\) increase in the long-term average PM2.5 concentration was associated with an approximately 4% increased risk of death from all natural causes, a 6% increased risk of death from cardiopulmonary disease, and an 8% increased risk of death from lung cancer.\textsuperscript{26} In October 2013, the International Agency for Research on Cancer declared outdoor air pollution as a first class carcinogen.\textsuperscript{1} China needs to focus efforts not on verifying the health hazards of PM2.5 pollution, but on controlling pollutant levels.

As far as the control of PM2.5 pollution is concerned, priority in state policy must be placed on environmentally-friendly development. Detailed and exact air protection laws must be enacted. PM2.5 concentration monitor/alarm systems should be extensively established in order to locate primary polluting sources to provide real-time information. According to James Lents, a veteran US policymaker responsible for cleaning up pollution in Los Angeles decades ago, it took the US 40 years to control air pollution.\textsuperscript{27} In an interview with the South China Morning Post, Lents advised that comprehensive pollution data and targeted approaches were vital in removing smog in the Californian city.\textsuperscript{27} Air monitor systems must be able to tell what the emissions are, what causes them, and what are the best ways to reduce them. He also suggested a strong team of environmental staff members be chosen to strictly enforce rules.

In China, we have made some progress. Official statistics show that the average PM2.5 levels fell 16% in 189 Chinese cities in the first six months of 2015, compared with the same period in 2014. However, the concentration remains several times higher than the standard recommended by WHO (maximum annual average 10 \(\mu g/m^3\)); for example, the average PM2.5 in Beijing in early 2015 was 77.8 \(\mu g/m^3\).\textsuperscript{27}

**Potential limitations**

A population-based cancer registry is the gold standard for the assessment of incidence rates; however, as the population-based registry only commenced in Shijiazhuang in 2014, it will be several years before the results become reliable. To estimate the incidence rate of lung cancer in a short time for a city in which no cancer registration network is available, we took advantage of the insurance reimbursement data of first hospitalization for lung cancer in a public medical insurance center. As a result, the data may not have captured all lung cancer cases. However, lung cancer patients treated in private hospitals are also reimbursed in the same municipal public
insurance center as in public hospitals, and their records are kept there. For cancer patients among the registered citizens of Shijiazhuang, wherever they reside, reimbursement for hospitalization occurs only at the Shijiazhuang Public Medical Insurance Center, regardless of the location of the treating hospital. Although some private insurance programs are available in Shijiazhuang city, the public medical insurance fee is the lowest for registered citizens of Shijiazhuang city and covers a wider disease spectrum; thus, it is always the first choice. Registered citizens may choose both public and private programs, but non-registered citizens can only choose private programs.

Conclusion
In conclusion, lung cancer incidence in urban Shijiazhuang is comparable to other Chinese cities and matched the global peak in 2012. According to the experience of western countries, the incidence rate in China is expected to continue to rise over the next 40 years. As primary intervention measures, to fulfill the aims of a reduction in smoking prevalence by a third by 2025 and concrete legal action to reduce air pollution are urgently needed.

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Disclosure
No authors report any conflict of interest.

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