Global burden and trends of lung cancer incidence and mortality

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Abstract

Background: Lung cancer has been the leading cause of cancer-related deaths worldwide for many years. This study aimed to investigate the global patterns and trends of lung cancer.

Methods: Lung cancer incidence and mortality were derived from the GLOBOCAN 2020 database. Continuous data from Cancer Incidence in Five Continents Time Trends were used to analyze the temporal trends from 2000 to 2012 using Joinpoint regression, and average annual percent changes were calculated. The association between the Human Development Index and lung cancer incidence and mortality was assessed by linear regression.

Results: An estimated 2.2 million new lung cancer cases and 1.8 million lung cancer-related deaths occurred in 2020. The age-standardized incidence rate (ASIR) ranged from 36.8 per 100,000 in Demark to 5.9 per 100,000 in Mexico. The age-standardized mortality rate (ASMR) varied from 32.8 per 100,000 in Poland to 4.9 per 100,000 in Mexico. Both ASIR and ASMR were approximately twice higher in men than in women. The ASIR of lung cancer showed a downward trend in the United States of America (USA) between 2000 and 2012, and was more prominent in men. The age-specific incidence rates of lung cancer for ages of 50 to 59 years showed an upward trend in China for both men and women.

Conclusions: The burden of lung cancer is still unsatisfactory, especially in developing countries like China. Considering the effectiveness of tobacco control and screening in developed countries, such as the USA, there is a need to strengthen health education, accelerate the establishment of tobacco control policies and regulations, and improve early cancer screening awareness to reduce the future burden of lung cancer.

Keywords: Lung neoplasms; Incidence; Mortality; Early detection of cancer; China; United States

Introduction

Lung cancer is the most commonly diagnosed cancer and the leading cause of cancer-related deaths globally. According to GLOBOCAN 2020, an estimated 2.2 million new lung cancer cases (11.4%) and almost 1.8 million lung cancer deaths (18.0%) occurred in 2020.[1] The burden of lung cancer varies among different countries mainly because of divergent risk factors, such as the prevalence of smoking, environmental pollution, and even dietary habits.[2] In the United States of America (USA), the incidence of lung cancer has gradually declined since 1990,[3] due to the effective tobacco control policies and regulations. However, some developing countries, including China, exhibit a lower incidence but higher mortality from lung cancer. The reason for such patterns includes incomplete early cancer screening, poor medical conditions, and challenges with tobacco control policies and regulations.[4]

Therefore, this study aimed to describe and compare country-specific morbidity and mortality of lung cancer rates in 2020, and analyze the incidence trend in major countries.

Methods

Data sources

The incidence and mortality of lung cancer were derived from the GLOBOCAN 2020 database (https://gco.iarc.fr/).[5] It is a web-based interactive platform that provides the

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International Agency for Research on Cancer (IARC) global cancer statistics for 36 cancer types in 185 countries or territories, supplying information for cancer control and research.

To analyze the temporal trends of lung cancer incidence, we extracted cancer incidence data from the Cancer in Five Continents Time Trends (CI5*plus*) database,[6] which contains high-quality population-based cancer registries, including continuous incidence data from 108 countries or territories or subnational population-based cancer registries.

The Human Development Index (HDI) is a comprehensive index based on the three basic variables of "education level, life expectancy and quality of life" according to the following formula[7,8]: $HDI = (I_{Education} \times I_{Health} \times I_{Income})^{1/3}$. Based on the principle of the Human Development Statistic of the United Nations Development Programme,[9] countries were categorized into four levels according to HDI values (very high HDI, ≥0.800; high HDI, 0.700–0.799; medium HDI, 0.550–0.699; and low HDI, <0.550).

In this study, the International Classification of Diseases 10th revision data code C33–34 was derived from the overall cancer database to analyze the lung cancer incidence and mortality rates.

Selected countries

The 20 countries with the highest ASIRs of lung cancer defined by the United Nations Population Division were selected to assess lung cancer incidence and mortality in 2020. A representative sample of five countries (China, South Korea, the USA, the United Kingdom, and Australia) on four continents were selected and they had complete and continuous data for analyzing the incidence trends from 2000 to 2012.

Statistical analysis

The ASIR and ASMR were calculated from Segi's world standard population.[10] Lung cancer incidence and mortality in 2020 were grouped by country, sex, and age. We used Joinpoint regression (version 4.3.1.0, National Cancer Institute, USA) to analyze temporal trends in lung cancer incidence and mortality for five continents and calculated the average annual percent change (AAPC). The *Z* test was used to examine whether the average annual percent change has shown upward or downward trends and was statistically different from zero. The association of lung cancer ASIR and ASMR with HDI was detected by linear regression. *P* values <0.05 were considered statistically significant.

Results

Lung cancer incidence and mortality rates in 2020

An estimated 2.2 million new lung cancer cases and 1.8 million lung cancer-related deaths occurred in 2020, accounting for approximately 11.4% of the total cancer cases and 18.0% of the total cancer deaths worldwide. The crude incidence and mortality of lung cancer were 28.3 and 23.0 per 100,000, respectively. The ASIR and ASMR were 22.4 and 18.0 per 100,000, respectively [Tables 1 and 2].

Regarding the continents, more than half of the lung cancer cases and 61.9% of mortality occurred in Asia in 2020, with ASIR and ASMR of 22.9 and 32.7 per 100,000, respectively. Asia was followed by Europe, which had 21.6% of cases and 21.3% of deaths, and the highest ASIR (29.4 per 100,000) and ASMR (22.6 per 100,000). Africa had the lowest ASIR (6.2 per 100,000) and ASMR (5.6 per 100,000).

For countries, China had the largest number of lung cancer cases and mortality (37.0% and 39.8%, respectively) in 2020, followed by America (10.3% of cases and 7.7% of mortality) and Japan (6.3% of cases and 4.6% of mortality). Both the ASIR and ASMR among countries varied over six folds. The highest ASIR ranged from 36.8 per 100,000 in Denmark to 5.3 per 100,000 in Mexico, while the highest ASMR ranged from 32.8 per 100,000 in Poland to 4.9 per 100,000 in Mexico. The ASIR and ASMR in Demark, Poland, France, China, and the USA were much higher than the global ASIR (22.4 *vs.* 18.0 per 100,000), whereas the ASIR and ASMR in Iran, Egypt, India, and Mexico were lower than the global ASIR [Tables 1 and 2].

The highest ASIR for both men *vs.* women occurred in Poland (51.5 *vs.* 24.6 per 100,000), followed by France (49.1 *vs.* 30.4 per 100,000) and China (47.8 *vs.* 29.9 per 100,000), while the lowest ASIR was observed in Mexico (7.0 *vs.* 4.0 per 100,000) [Table 1]. The highest ASMR in men and women occurred in Poland (48.4 per 100, 000) and Demark (25.2 per 100,000), respectively. The lowest ASMR in men and women was observed in Mexico (6.6 per 100,000) and India (2.8 per 100,000), respectively [Table 2].

Association of HDI with ASIR and ASMR of lung cancer

Over 90% of lung cancer cases and 77.1% of lung cancer-related deaths occurred in countries with very high and high HDI. Less than 10% of lung cancer cases and deaths occurred in countries with medium and low HDI. ASIR and ASMR were over three times higher in countries with very high/high HDI than in countries with medium/low HDI [Tables 1 and 2]. The association of ASIR and ASMR with HDI was statistically significant [Figure 1].

Temporal trends of lung cancer incidence

The ASIR of lung cancer in men showed a consistent downward trend in South Korea (AAPC = −1.2%, $P < 0.001$), Australia (AAPC = −1.3%, $P < 0.001$), the United Kingdom (AAPC = −1.5%, $P < 0.001$), China (AAPC = −2.0%, $P < 0.001$), and the USA (AAPC = −2.5%, $P < 0.001$) [Table 3 and Figure 2]. For age-specific rates, the greatest decrease occurred in men younger than 40 years in South Korea (AAPC = −3.4%, $P = 0.008$) and China (AAPC = −3.2%, $P = 0.011$), and the greatest

Table 1: The incidence of lung cancer among the world's major countries/HDI categories in 2020.

Country/HDI category	Total			Male			Female		
	Cases	Crude rate (per 100,000)	ASIR (per 100,000)	Cases	Crude rate (per 100,000)	ASIR (per 100,000)	Cases	Crude rate (per 100,000)	ASIR (per 100,000)
Total	2,206,771	28.3	22.4	1,435,943	36.5	31.5	770,828	19.9	14.6
Asia	1,315,136	28.3	22.9	891,898	37.6	32.7	423,238	18.7	14.0
China	815,563	56.3	34.8	539,181	72.7	47.8	276,382	39.2	22.8
Japan	138,532	109.5	32.1	94,487	153.0	47.0	44,045	68.1	19.5
South Korea	28,651	55.9	25.5	19,797	77.1	39.1	8854	34.6	14.8
India	72,510	5.3	5.4	51,675	7.2	7.8	20,835	3.1	3.1
Iran	10,465	12.5	12.6	7184	16.9	16.9	3281	7.9	8.1
Europe	477,534	63.8	29.4	315,054	87.1	43.6	162,480	42.0	18.1
United Kingdom	51,983	76.6	32.3	26,943	80.3	35.2	25,040	72.9	29.9
Germany	64,804	77.3	31.9	38,436	92.8	39.2	26,368	62.2	25.7
Italy	41,953	69.4	25.3	28,369	96.4	36.0	13,584	43.8	16.4
France	48,299	74.0	34.9	31,941	101.1	49.1	16,358	48.6	22.7
Poland	29,509	78.0	36.2	18,277	99.7	51.5	11,232	57.6	24.6
Denmark	5047	87.1	36.8	2399	83.3	36.9	2648	90.9	36.8
Africa	45,988	3.4	6.2	33,282	5.0	9.8	12,706	1.9	3.2
South Africa	8950	15.1	18.3	6144	21.0	29.6	2806	9.3	10.0
Egypt	6538	6.4	8.0	4851	9.4	12.8	1687	3.3	3.8
Oceania	16,975	39.8	24.0	9277	43.4	27.4	7698	36.1	21.0
Australia	13,162	51.6	25.3	7208	56.8	28.7	5954	46.5	22.3
New Zealand	2425	50.3	24.9	1164	49.1	24.7	1261	51.4	25.0
America	351,138	34.3	21.9	186,432	37.0	25.5	164,706	31.8	19.0
USA	227,875	68.8	33.1	116,335	71.0	36.3	111,540	66.7	30.4
Mexico	7588	5.9	5.3	4503	7.1	7.0	3085	4.7	4.0
Argentina	12,110	26.8	19.2	7738	35.1	28.1	4372	18.9	12.3
Brazil	40,409	19.0	14.3	23,162	22.2	18.4	17,247	16.0	11.1
Canada	25,574	67.8	28.9	12,706	67.8	30.4	12,868	67.7	27.7
Cuba	6689	59.1	28.5	4077	72.5	36.9	2612	45.8	21.2
HDI									
High HDI	1,047,707	36.0	26.2	697,411	47.5	37.1	350,296	24.3	16.5
Very high HDI	975,665	62.4	29.9	611,867	79.1	41.1	363,798	46.0	20.6
Medium HDI	165,943	7.1	8.0	116,316	9.8	11.5	49,627	4.4	4.6
Low HDI	16,418	1.7	3.5	9713	2.0	4.5	6705	1.4	2.6

ASIR was calculated by using world Segi's standard population. ASIR: Age-standardized incidence rate; HDI: Human Development Index; USA: The United States of America.

Table 2: The mortality of lung cancer among the world's major countries/HDI categories in 2020.

Country/HDI category	Total			Male			Female		
	Deaths	Crude rate (per 100,000)	ASMR (per 100,000)	Deaths	Crude rate (per 100,000)	ASMR (per 100,000)	Deaths	Crude rate (per 100,000)	ASMR (per 100,000)
World	1,796,144	23.0	18.0	1,188,679	30.2	25.9	607,465	15.7	11.2
Asia	1,112,517	24.0	19.3	757,218	31.9	27.8	355,299	15.7	11.6
China	714,699	49.4	30.2	471,546	63.6	41.8	243,153	34.5	19.7
Japan	82,369	65.1	14.7	57,334	92.8	24.2	25,035	38.7	7.1
South Korea	20,505	40.0	16.5	15,147	59.0	28.9	5358	20.9	7.4
India	66,279	4.8	4.9	47,701	6.7	7.2	18,578	2.8	2.8
Iran	9071	10.8	10.9	6229	14.7	14.6	2842	6.8	7.0
Europe	384,176	51.3	22.6	260,019	71.9	34.9	124,157	32.1	12.9
United Kingdom	36,518	53.8	20.8	19,109	57.0	23.1	17,409	50.7	18.9
Germany	50,282	60.0	23.1	31,664	76.5	30.6	18,618	43.9	16.8
Italy	33,602	55.6	18.0	22,792	77.4	26.3	10,810	34.8	11.4
France	37,095	56.8	25.4	25,214	79.8	37.2	11,881	35.3	15.4
Poland	27,444	72.5	32.8	17,461	95.2	48.4	9983	51.2	21.2
Denmark	3927	67.8	27.0	2032	70.6	29.3	1895	65.1	25.2
Africa	41,171	3.1	5.6	29,760	4.4	8.9	11,411	1.7	2.9
South Africa	7730	13.0	15.8	5280	18.1	25.4	2450	8.1	8.7
Egypt	5817	5.7	7.2	4319	8.4	11.5	1498	3.0	3.4
Oceania	12,012	28.1	16.1	6902	32.3	19.5	5110	24.0	13.2
Australia	8867	34.8	15.8	5139	40.5	19.1	3728	29.1	12.9
New Zealand	1924	39.9	18.4	965	40.7	19.1	959	39.1	18.0
America	246,268	24.1	14.9	134,780	26.7	18.0	111,488	21.5	12.3
USA	138,225	41.8	18.9	73,009	44.6	21.9	65,216	39.0	16.4
Mexico	7100	5.5	4.9	4304	6.8	6.6	2796	4.2	3.6
Argentina	10,729	23.7	16.8	6881	31.2	24.8	3848	16.6	10.7
Brazil	35,160	16.5	12.3	19,743	18.9	15.5	15,417	14.3	9.8
Canada	21,362	56.6	22.5	10,907	58.2	24.4	10,455	55.0	21.2
Cuba	6173	54.5	25.9	3876	68.9	34.7	2297	40.3	18.3
HDI									
High HDI	918,661	31.6	22.8	610,626	41.6	32.5	308,035	21.4	14.3
Very high HDI	711,630	45.5	20.6	462,513	59.8	30.0	249,117	31.5	12.9
Medium HDI	149,887	6.4	7.2	106,011	8.9	10.6	43,876	3.9	4.1
Low HDI	15,108	1.5	3.2	8987	1.8	4.2	6121	1.2	2.4

ASMR was calculated by using world Segi's standard population. ASMR: Age-standardized mortality rate; HDI: Human Development Index; USA: The United States of America.

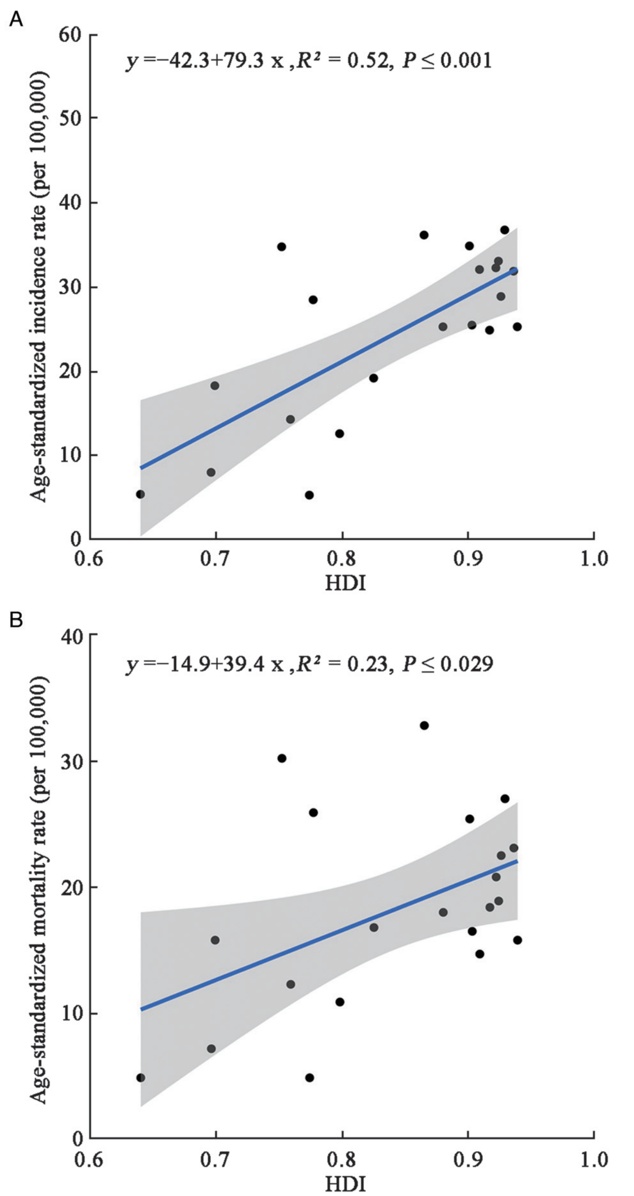

Figure 1: Association between HDI and age-standardized incidence (A) and mortality (B) rates of lung cancer. HDI: Human Development Index.

downward trends were observed in the USA (AAPC = −4.1%, $P < 0.001$) and the United Kingdom (AAPC = −2.7%, $P = 0.003$) in age group 40–49 years [Table 3 and Figure 3]. In women, the ASIR of lung cancer showed upward trends in Australia (AAPC = 1.6%, $P < 0.001$), the United Kingdom (AAPC = 1.4%, $P < 0.001$), and South Korea (AAPC = 1.1%, $P < 0.001$), and downward trends in the USA (AAPC = −0.9%, $P < 0.001$). The largest increases in women were observed in the United Kingdom at age of ≥80 years (AAPC = 4.1%, $P < 0.001$) and in South Korea at age of 40 to 49 years (AAPC = 3.2%, $P < 0.001$); the greatest decrease in trends were noted in the USA (AAPC = −3.6%, $P < 0.001$) [Table 3 and Figure 4]. Detailed information on the trend analyses is provided in [Supplementary Tables 1, http://links.lww.com/CM9/B440 and 2, http://links.lww.com/CM9/B440].

Table 3: Trends for age-standardized lung cancer incidence rates by countries, 2000–2012 (%).

Age groups (years)	China		South Korea		USA		Australia		United Kingdom	
	AAPC (95% CI)	P value	AAPC (95% CI)	P value	AAPC (95% CI)	P value	AAPC (95% CI)	P value	AAPC (95% CI)	P value
Males										
Total	−2.0* (−2.4, −1.5)	<0.001	−1.2* (−1.6, −0.9)	<0.001	−2.5* (−2.8, −2.2)	<0.001	−1.3* (−1.7, −0.9)	<0.001	−1.5* (−1.9, −1.1)	<0.001
<40	−3.2* (−5.5, −0.9)	0.011	−3.4* (−5.6, −1.1)	0.008	−3.9* (−4.9, −3.0)	<0.001	−0.3 (−2.3, 1.8)	0.780	−0.2 (−2.0, 1.5)	0.765
40–49	−1.6* (−3.1, −0.2)	0.029	−1.6* (−2.7, −0.5)	0.008	−4.1* (−4.8, −3.4)	<0.001	−0.3 (−2.1, 1.6)	0.760	−2.7* (−4.5, −0.9)	0.003
50–59	1.5* (0.2, 2.8)	0.026	−1.8* (−2.3, −1.2)	<0.001	−2.4* (−2.5, −2.2)	<0.001	−1.7* (−2.2, −1.3)	<0.001	−1.8* (−2.1, −1.5)	<0.001
60–69	−2.6* (−3.4, −1.9)	<0.001	−1.1* (−1.7, −0.6)	0.001	−3.2* (−3.4, −2.9)	<0.001	−1.7* (−2.4, −1.1)	<0.001	−1.6* (−1.9, −1.2)	<0.001
70–79	−2.9* (−3.4, −2.3)	<0.001	−1.6* (−2.2, −1.0)	<0.001	−1.9* (−2.1, −1.6)	<0.001	−1.6* (−2.2, −1.0)	<0.001	−1.5* (−2.5, −0.6)	0.002
≥80	−2.6* (−3.3, −1.9)	<0.001	0.6 (−0.3, 1.5)	0.175	−0.8* (−1.2, −0.3)	<0.001	0.5 (−0.1, 1.2)	0.117	−0.4 (−1.4, 0.6)	0.466
Females										
Total	−0.1 (−1.3, 1.1)	0.883	1.1* (0.5, 1.8)	<0.001	−0.9* (−1.2, −0.7)	<0.001	1.6* (1.1, 2.1)	<0.001	1.4* (1.0, 1.8)	<0.001
<40	−1.9 (−8.3, 4.9)	0.569	2.0 (−0.4, 4.6)	0.100	−3.6* (−4.4, −2.8)	<0.001	1.7 (−1.1, 4.6)	0.219	0.9 (−2.1, 4.0)	0.516
40–49	1.8* (0.9, 2.8)	0.002	3.2* (1.8, 4.7)	<0.001	−1.4* (−2.5, −0.3)	0.010	−0.4 (−1.8, 1.0)	0.564	−1.1* (−2.1, −0.1)	0.036
50–59	2.6* (0.6, 4.6)	0.010	2.8* (1.7, 4.1)	<0.001	−1.0* (−1.4, −0.6)	<0.001	1.0 (−0.1, 2.1)	0.080	1.0* (0.2, 1.7)	0.015
60–69	−0.2 (−2.4, 2.0)	0.844	1.3* (0.1, 2.6)	0.036	−1.9* (−2.2, −1.6)	<0.001	1.7* (1.0, 2.4)	<0.001	1.7* (0.6, 2.9)	0.004
70–79	−1.2* (−2.0, −0.5)	0.004	−0.3 (−1.0, 0.3)	0.247	0.1 (−0.6, 0.8)	0.769	1.7* (1.3, 2.1)	<0.001	0.9* (0.5, 1.3)	<0.001
≥80	−1.9* (−2.4, −1.3)	<0.001	1.2* (0.2, 2.2)	0.027	1.2* (0.7, 1.7)	<0.001	3.2* (2.2, 4.1)	<0.001	4.1* (3.5, 4.7)	<0.001

* Average annual percent change during 2000 to 2012 is significantly different from zero ($P < 0.05$). ASIR was calculated by using world Segi's standard population. AAPC: Average annual percent change; ASIR: Age-standardized incidence rate; CI: Confidence interval; USA: The United States of America.

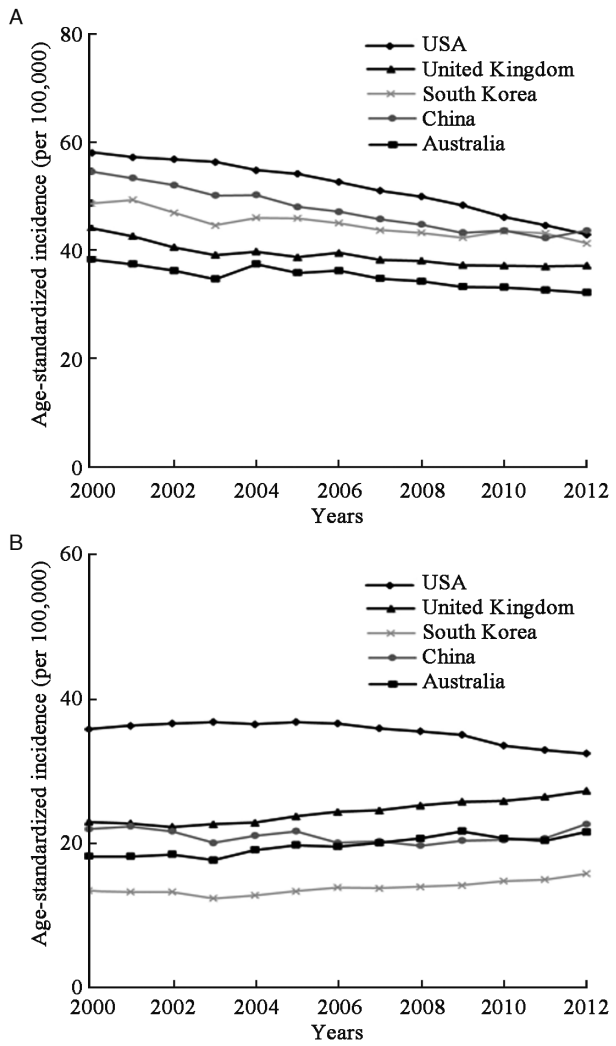

Figure 2: Trends for age-standardized incidence of lung cancer in (A) males and (B) females between 2000 and 2012.

Discussion

In this study, we aimed to analyze the trends of incidence and mortality rates of lung cancer from 2000 to 2012. Our findings revealed that the burden of lung cancer is still unsatisfactory, especially in developing countries like China. The overwhelming cause of the high incidence of lung cancer is smoking,[11] both active and passive.[12] Smoking was prevalent in western developed countries such as European countries, North America, Australia, Japan, and South Korea, earlier in their history, and reached its peak in the middle of the last century. As such, these countries had a heavier burden of lung cancer. Subsequently, the prevalence of smoking among men decreased with the introduction of tobacco control policies in these countries, and the incidence of lung cancer in men gradually declined,[13] which is consistent with the trend observed in this study.

However, the burden of lung cancer in women in these developed countries (United Kingdom, South Korea, and Australia) have reached a plateau but gradually experienced an upward trend, except for the USA. This indicates that smoking among women is still prevalent in developed countries. The heavy burden of lung cancer in China is partly due to the large population. China has the largest number of smokers in the world and consumes about 40% of the world's tobacco every year. Moreover, exposure to secondhand smoke is also notable. Approximately 70% of Chinese people are exposed to secondhand smoking every year, which leads to approximately 60,000 lung cancer deaths. China signed the WHO Framework Convention on Tobacco Control in 2003, and the Chinese government has issued a series of management regulations (regulations on the control of smoking in public places) regarding tobacco control and has vigorously highlighted the dangers of smoking in public media. This has resulted in a significant decline in the prevalence of male lung cancer in recent years. Although these regulations have resulted in positive effects, the efforts to control tobacco are not sufficient, regarding raising tobacco taxes or prices.[14,15]

Another important high-risk factor for lung cancer is ambient air pollution. A number of studies in Europe and America found that the concentration of particulate matter (PM) in the environment, especially PM $\leq$2.5 μm ($PM_{2.5}$), is closely related to the risk of lung cancer.[16-18] Therefore, outdoor air pollution was listed as a human carcinogen by the IARC in 2013.[19] Ambient air pollution is also one of the reasons for the high incidence of lung cancer in developing countries such as China, India, and Egypt. With the rapid development of Chinese industrialization and transportation, especially with the preponderant use of coal and petroleum, a large number of harmful substances have been discharged into the atmosphere.[20] The main causes of urban air pollution include the unreasonable energy consumption structure and low utilization rate. In 2012, China first proposed to monitor $PM_{2.5}$ in key areas such as the Beijing–Tianjin–Hebei region, municipalities directly under the central government, and provincial capital cities. In 2015, it was proposed that all prefecture-level cities conduct the monitoring of $PM_{2.5}$. The Chinese government has been committed to promoting energy conservation and emission reduction, and has formulated corresponding measures. In 2020, China announced the national goal of reaching a carbon peak by 2030 and becoming carbon neutral by 2060.

Another factor contributing to the high incidence of lung cancer is indoor air pollution, including soot from household burning, heating, or cooking. This might explain why the incidence of lung cancer among non-smoking East Asian women, including China and South Korea, remains high, especially between the ages of 40 and 59 years.[21,22]

Lung cancer is a malignant tumor with a notably poor prognosis. Often, it is initially asymptomatic and typically discovered at advanced stages. Thus, people are paying more attention to the early screening of lung cancer. A number of studies in Europe and America have shown that low-dose computed tomography (CT) for high-risk individuals can help in the early detection of cancer.[23,24]

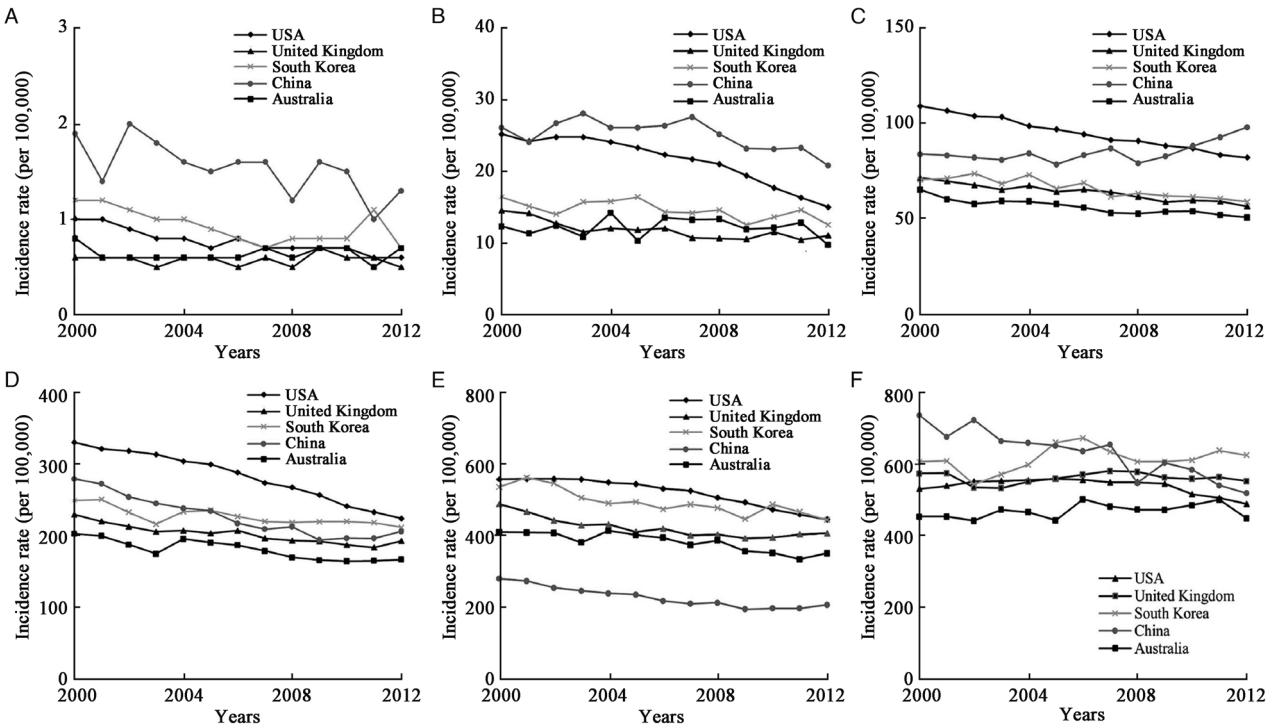

Figure 3: Trends for age-specific incidence of male lung cancer between 2000 and 2012. (A) 0–39 years; (B) 40–49 years; (C) 50–59 years; (D) 60–69 years; (E) 70–79 years; (F) ≥80 years.

The National Comprehensive Cancer Network, European Society of Radiology/European Respiratory Society, and the National Cancer Center of China have successively issued guidelines for lung cancer screening, and recommend risk assessments for people with smoking history, radon exposure, cancer history, family history of lung cancer in first-degree relatives, and disease history (chronic obstructive pulmonary disease or pulmonary fibrosis). Lung cancer screening experts recommend low-dose CT examinations for high-risk groups. Early diagnosis and treatment can reduce the death rate of lung cancer.[25-29] This explains why the incidence of lung cancer is higher in developed countries than in developing countries, but the mortality rate is lower.

Studies showed that the 5-year survival rate of lung cancer in China was 18.6% in 2000, but increased to only 19.8% in 2010.[30] In comparison, the 5-year survival rate for lung cancer in 2010 was 32.9% in Japan, 21.2% in the USA, and 25.1% in South Korea.[31] The improvement in the survival rate of lung cancer is not only related to cancer screening but also to the medical services available in a country and the pathological subtype of lung cancer. Lung cancer has traditionally been divided into two categories, non-small cell lung cancer (NSCLC) and small cell lung cancer, with the former accounting for about 85% of cases. Lung adenocarcinoma is the most common pathological subtype.[32] Studies have shown that approximately 10% to 15% of NSCLC patients in Europe and 30% to 35% in Asia have epidermal growth factor receptor (*EGFR*) gene mutation.[33,34] Approximately 60% of Asian, non-smoking female adenocarcinoma patients harbor the *EGFR* gene mutation.[35,36] A series of studies showed that patients with stage IV NSCLC had *EGFR*-sensitive mutations and recorded significantly improved progression-free survival and overall survival using epidermal growth factor receptor-tyrosine kinase inhibitor compared with patients who received standard chemotherapy.[37-39] Squamous cell lung cancer is insensitive to chemotherapy and radiotherapy, and only responds to surgery. Small cell lung cancer has the highest degree of malignancy and the worst prognosis, with frequent recurrence and distant metastasis. These two pathological subtypes offer fewer options for the previously described systemic treatments. However, recently, lung cancer had entered the era of immunotherapy, and specific populations are likely to benefit from immunotherapy regardless of the subtype of lung cancer.[40-42] In all, despite the advancements in treatment methods, medical environment, or medical insurance systems, such advancements may be beyond the reach of many developing countries or poor areas.

This study had some limitations. First, the data of this study came from public databases, which lack detailed information such as pathological subtypes, disease stages, and treatment processes. If these data can be combined with trend analysis, they should provide more value for public health and clinical practice. Second, data in the CI5plus database were only available up to 2012. Thus, we only analyzed the time trends between 2000 and 2012.

In conclusion, the burden of lung cancer is still notable globally, and it varies across different countries. The incidence of lung cancer in men showed decreasing trends among the five selected countries, while the

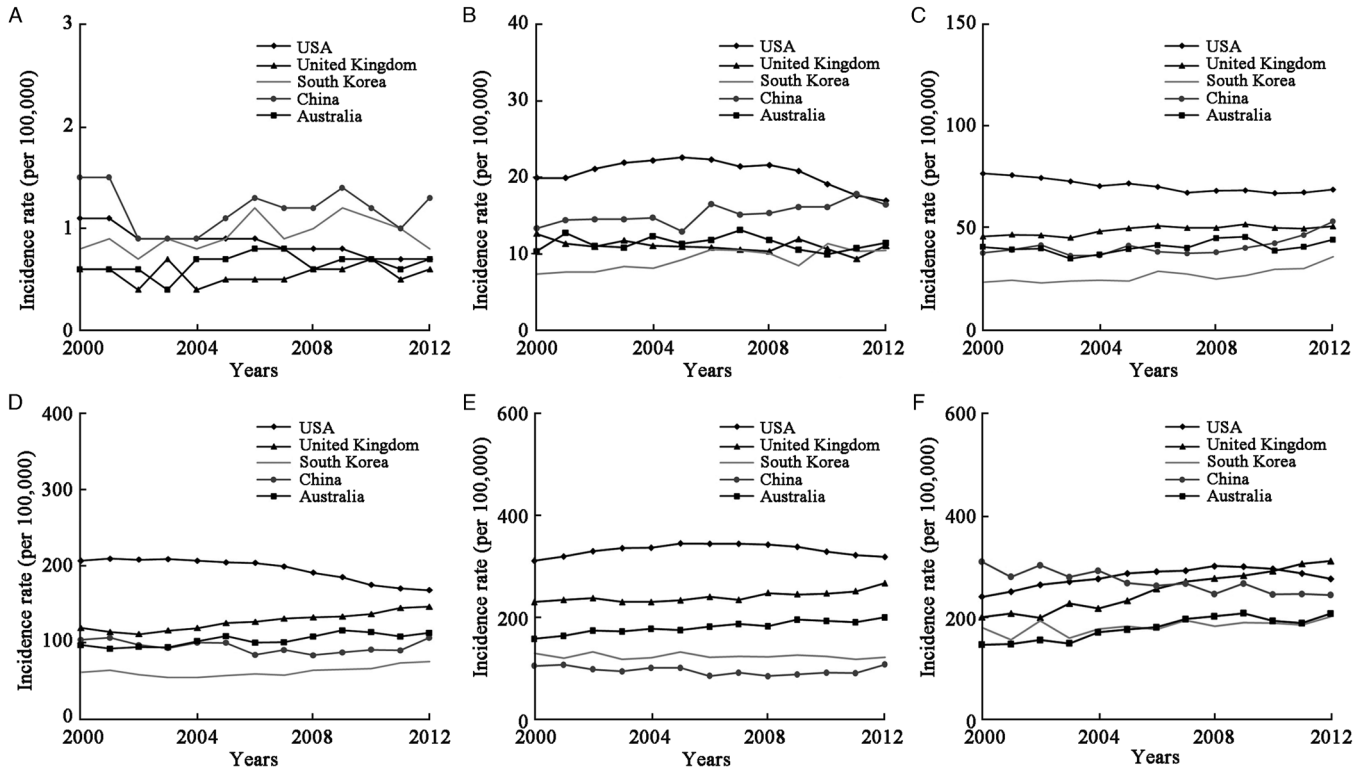

Figure 4: Trends for age-specific incidence of female lung cancer between 2000 and 2012. (A) 0–39 years; (B) 40–49 years; (C) 50–59 years; (D) 60–69 years; (E) 70–79 years; (F) ≥80 years.

incidence showed slightly upward trends in women in South Korea, Australia, and the United Kingdom. Effective tobacco control, strengthening of health education, improving awareness regarding early cancer screening, and the optimization of medical conditions, especially for women, will help to curb the notable lung cancer burden.

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Conflicts of interest

None.

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