


# Epidemiological Analysis of 1234 Cases of Laryngeal Cancer in Shanxi Province, China

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## Abstract

**Background:** Laryngeal cancer is a common malignancy of the head and neck, especially in northern China, including Shanxi province. This study intends to describe the epidemiological characteristics of laryngeal cancer in Shanxi Province, China, in order to support prevention and treatment efforts.

**Methods:** Retrospective analysis of the medical records of patients diagnosed with laryngeal cancer in hospitals in Shanxi Province from 2008 to 2012.

**Results:** The average annual incidence rate of laryngeal cancer in Shanxi province from 2008 to 2012 was 0.70/10<sup>5</sup>, the Chinese population standardized incidence rate was 0.57/10<sup>5</sup> and the world population standardized incidence rate was 0.60/10<sup>5</sup>. The city with the highest incidence of laryngeal cancer in Shanxi Province is Taiyuan, followed by Yangquan, and the lowest incidence are Yuncheng and Jincheng. The cases included 723 farmers (58.6%), 338 workers (27.4%), 95 government cadres (7.7%), 35 unemployed individuals (2.8%), 30 teachers (2.4%) and 13 individuals with other occupations (1.1%). The incidence of laryngeal cancer in rural areas was 0.78/10<sup>5</sup>, while urban areas was 0.60/10<sup>5</sup>. Of 1006 patients with smoking and drinking status reported, there were 238 both smoking and drinking (23.7%), 491 only smoking but not drinking (48.8%), 4 only drinking but not smoking (0.4%), 273 both not smoking and not drinking (27.1%) ( $P < 0.001$ ), and there were 695 males smoking (95.3%), 34 females smoking (4.7%) ( $P < 0.001$ ). Of 879 patients for whom the primary cancer location was known, 406 cases (46.2%) were supraglottic and 428 cases (48.7%) were glottic. Among 1009 patients with known pathological classification, the vast majority had squamous cell carcinoma (992 cases, 98.3%).

**Conclusions:** To sum up, the incidence of laryngeal cancer in Shanxi Province exhibited a relatively stable trend from 2008 to 2012, and the incidence is higher in men than in women in all years. The high percentage of smokers in this study underscores the importance of smoking as a risk factor for laryngeal cancer, whereas rates of drinking did not appear to be linked. Incidence of laryngeal cancer was higher in rural areas than in urban areas, a pattern that differs from other regions of China and internationally.

## Keywords

laryngeal cancer, incidence, epidemiological characteristics, head and neck cancer, China

## Introduction

Laryngeal cancer is 1 of the most common malignancies of the head and neck, accounting for 1–5% of all malignant tumors. It ranks third among malignant tumors of the head and neck and accounts for 3.3–8.1% of these tumors.<sup>1,2</sup> Laryngeal cancer is divided into 2 types, primary and secondary.<sup>1</sup> Primary laryngeal cancer refers to a tumor whose primary site is in the larynx and is most frequently squamous cell carcinoma.<sup>1</sup> Secondary laryngeal cancer refers to metastasis of malignant tumors from

other parts of the body to the larynx and is relatively rare. Clinical manifestations of laryngeal cancer include dyspnea, hoarseness, and dysphagia. Lack of timely treatment leads to poorer quality of life and reduced life expectancy. Age 70 years or greater, male gender, supraglottis, subglottis, and no treatment all independently increased the risks of death.<sup>3</sup> Therefore, early detection, diagnosis, and treatment are critical to improving prognosis.

According to the global cancer statistics 2018 report, 177,000 cases of laryngeal cancer are diagnosed annually



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and Open Access pages (<https://us.sagepub.com/en-us/nam/open-access-at-sage>).

**Table 1.** Incidence Trend of Laryngeal Cancer in Shanxi Province, 2008-2012.

Year	Male					Female					Total				
	Cases	N	Crude Incidence (1/10 <sup>5</sup> )	ASR China (1/10 <sup>5</sup> ) <sup>a</sup>	ASR World (1/10 <sup>5</sup> ) <sup>b</sup>	Cases	N	Crude Incidence (1/10 <sup>5</sup> )	ASR China (1/10 <sup>5</sup> ) <sup>a</sup>	ASR World (1/10 <sup>5</sup> ) <sup>b</sup>	Cases	N	Crude Incidence (1/10 <sup>5</sup> )	ASR China (1/10 <sup>5</sup> ) <sup>a</sup>	ASR World (1/10 <sup>5</sup> ) <sup>b</sup>
2008	202	179 44566	1.126	0.975	1.055	11	171 21052	0.064	0.061	0.062	213	350 65669	0.607	0.537	0.568
2009	231	180 33454	1.281	1.067	1.151	20	172 10571	0.116	0.106	0.108	251	352 44074	0.712	0.608	0.639
2010	235	181 39065	1.296	1.042	1.123	15	173 22263	0.087	0.077	0.080	250	354 61375	0.705	0.580	0.611
2011	236	182 50499	1.293	1.010	1.087	17	174 38695	0.097	0.083	0.085	253	356 89238	0.709	0.566	0.595
2012	245	183 71485	1.334	1.000	1.073	22	175 66529	0.125	0.101	0.104	267	359 38057	0.743	0.569	0.596
<b>Total</b>	<b>1149</b>	<b>907 39069</b>	<b>1.266</b>	<b>1.017</b>	<b>1.096</b>	<b>85</b>	<b>866 59110</b>	<b>0.098</b>	<b>0.086</b>	<b>0.082</b>	<b>1234</b>	<b>177 398413</b>	<b>0.696</b>	<b>0.571</b>	<b>0.601</b>

<sup>a</sup>Age-standardized rate (using China standard population, 2000).

<sup>b</sup>Age-standardized rate (using Segi's population).

worldwide, accounting for 1% of all cancer cases globally and yielding an age-standardized incidence rate of 2.0/100,000.<sup>4</sup> There are approximately 95,000 laryngeal cancer deaths each year, making up 1% of total cancer deaths. Both incidence and mortality from laryngeal cancer are significantly higher in men than in women (age-standardized incidence rate 3.6 vs 0.5 per 100,000, age-standardized mortality rate 1.9 vs 0.3 per 100,000).<sup>4</sup> The incidence and death of laryngeal cancer patients in China are lower than the world average, with incidences and deaths accounting for 0.67% and 0.57% of total cancer incidence and total deaths, respectively, in 2018.<sup>4</sup> The standardized incidence

and mortality rates of laryngeal cancer are 1.3/100,000 and 0.7/100,000, respectively, and male morbidity and mortality are significantly higher than female.<sup>4</sup>

Comprehensive and in-depth epidemiological investigation of laryngeal cancer has been carried out in several countries, such as North America, Europe, Spain, and Kazakhstan,<sup>1,5-8</sup> providing valuable information to guide clinical work as well as prevention and treatment efforts. However, few investigations on the incidence of laryngeal cancer have been conducted in the entire Chinese population. The registered data of laryngeal cancer patients have also been analyzed in Zhejiang Province, Zhongshan City, Guangdong Province, Luwan District of Shanghai, and Western Liaoning Province, but no such research has been carried out in Shanxi Province. To address this gap in the literature and improve the evidence base to guide prevention, treatment, and research efforts, we measured epidemiological characteristics of laryngeal cancer in Shanxi Province by analyzing medical records of 1234 patients diagnosed with laryngeal cancer between 2008 and 2012 at 12 grade 3A hospitals in the province providing treatment for laryngeal cancer.

## Methods

### Data Sources

Data were collected from medical records of patients diagnosed with laryngeal cancer (including patients undergoing surgery and radiotherapy) between 2008 and 2012 in Shanxi Province. Prevalent cases who received treatment during the study period but who had been diagnosed before 2008 were not included, covering 11 prefectures and cities in the province. After excluding duplicate records, data were retrieved for 1234 new cases. Data were collected on date of diagnosis, gender, age, smoking and drinking behavior, occupation, city of residence, clinical classification, and pathological classification.

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## Ethical Considerations and Approvals

Our study was approved by the Research Ethics Committee of Shanxi Medical University (2018LL070). All patients provided written informed consent prior to enrollment in the study.

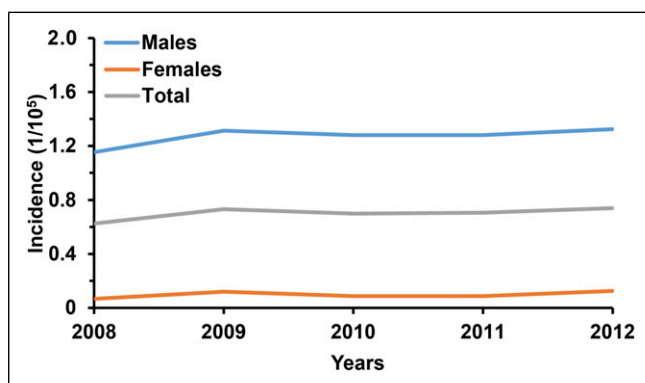
## Statistical Analysis

Descriptive analysis was presented for incidence, genders, ages, smoking and drinking habits, occupation, residence, clinical classification, and pathological classification. Chi-square tests were used to analyze differences, with a  $P$ -value  $< 0.05$  considered statistically significant. All analyses were conducted using SPSS 17.0 (IBM Corporation, Armonk, NY, USA) and Excel 2017.

## Results

### Incidence of Laryngeal Cancer

A total of 1234 new cases of laryngeal cancer were diagnosed in Shanxi Province from 2008 to 2012. The incidence by gender and year is shown in Table 1 and Figure 1. The



**Figure 1.** Incidence trend of laryngeal cancer in Shanxi Province, 2008-2012.

incidence of laryngeal cancer exhibited a relatively stable trend from 2008 to 2012, and the incidence is higher in men than in women in all years.

### Regional Incidence of Laryngeal Cancer

The city with the highest incidence of laryngeal cancer in Shanxi Province is Taiyuan, followed by Yangquan, and the cities with the lowest incidence of laryngeal cancer are Yuncheng and Jincheng (Table 2, Figure 2).

### Gender Distribution of Patients With Laryngeal Cancer by City of Residence

The gender distribution of cases by the city of residence. The ratio of men to women ranged from 26:1 in Jinzhong to 7.6:1 in Yuncheng (Figure 3).

### Age Distribution of Patients With Laryngeal Cancer

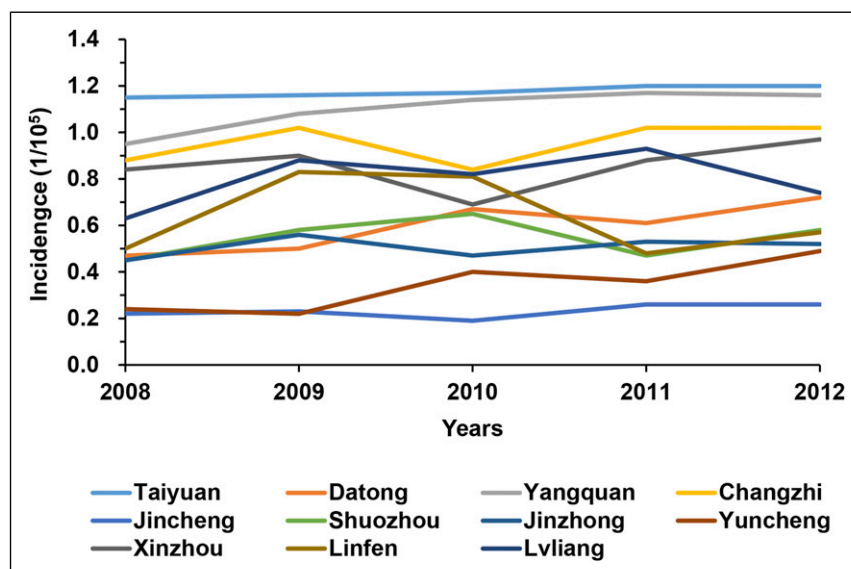
Table 3 shows the age-specific incidence of laryngeal cancer by gender. Cases ranged in age from 19 to 86 years, with a mean age of 61.57 years. The age range for male patients was 32-86 years (mean age 61.57 years), while the range for females was 19-82 years (mean 61.54 years). Age-specific incidence rates were relatively low before 40 years old and increased rapidly afterward, reaching peak at the age group of 60-69 years. Very few patients were aged over 80 or under 40. In each age group, incidence rates in males were higher than those in females (Figure 4).

### Smoking and Drinking Habits of Patients With Laryngeal Cancer

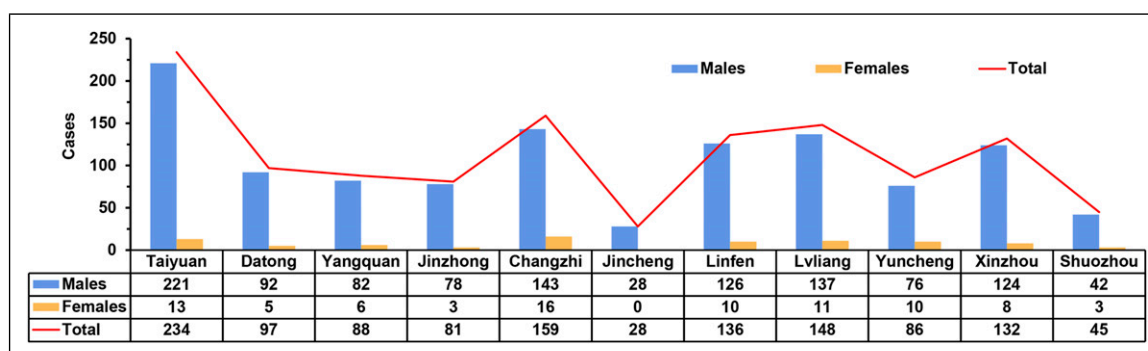
Among the 1234 patients diagnosed with laryngeal cancer in Shanxi Province from 2008 to 2012, data were available on smoking and drinking habits for 1006 patients and unavailable for 228 patients. Of these, 729 patients reported smoking (72.5%), 242 patients reported drinking (24.1%), and 238 patients reported both smoking and drinking (23.7%), 491 patients reported only smoking but not

**Table 2.** Regional Incidence of Laryngeal Cancer in Shanxi Province, 2008-2012.

City	2008			2009			2010			2011			2012		
	Case	N	Incidence (1/10 <sup>5</sup> )	Case	N	Incidence (1/10 <sup>5</sup> )	Case	N	Incidence (1/10 <sup>5</sup> )	Case	N	Incidence (1/10 <sup>5</sup> )	Case	N	Incidence (1/10 <sup>5</sup> )
Taiyuan	45	3909744	1.15	46	3963616	1.16	47	4001928	1.17	48	4002820	1.20	48	4013122	1.20
Datong	15	3189713	0.47	16	3202292	0.50	22	3300179	0.67	20	3303100	0.61	24	3342054	0.72
Yangquan	14	1479287	0.95	17	1571779	1.08	18	1577632	1.14	19	1620966	1.17	20	1721114	1.16
Changzhi	29	3299632	0.88	34	3317884	1.02	28	3320156	0.84	34	3330110	1.02	34	3331489	1.02
Jincheng	5	2231001	0.22	6	2599769	0.23	5	2599694	0.19	6	2282692	0.26	6	2282749	0.26
Shuozhou	7	1555944	0.45	9	1561821	0.58	11	1699846	0.65	8	1704635	0.47	10	1712103	0.58
Jinzhong	14	3128989	0.45	18	3200900	0.56	15	3224149	0.47	17	3209927	0.53	17	3241486	0.52
Yuncheng	12	5060897	0.24	11	4985002	0.22	20	4946245	0.40	18	5019265	0.36	25	5050699	0.49
Xinzhou	26	3083989	0.84	28	3098999	0.90	21	3064008	0.69	27	3069378	0.88	30	3078013	0.97
Linfen	21	4186639	0.50	35	4211693	0.83	34	4175417	0.81	21	4366957	0.48	25	4367115	0.57
Lvliang	25	3939834	0.63	31	3530319	0.88	29	3552121	0.82	35	3779388	0.93	28	3798113	0.74



**Figure 2.** Regional incidence of patients with newly diagnosed laryngeal cancer in Shanxi Province, 2008-2012 (N = 1234).



**Figure 3.** Regional distribution of patients with newly diagnosed laryngeal cancer by gender in Shanxi Province, 2008-2012 (N = 1234).

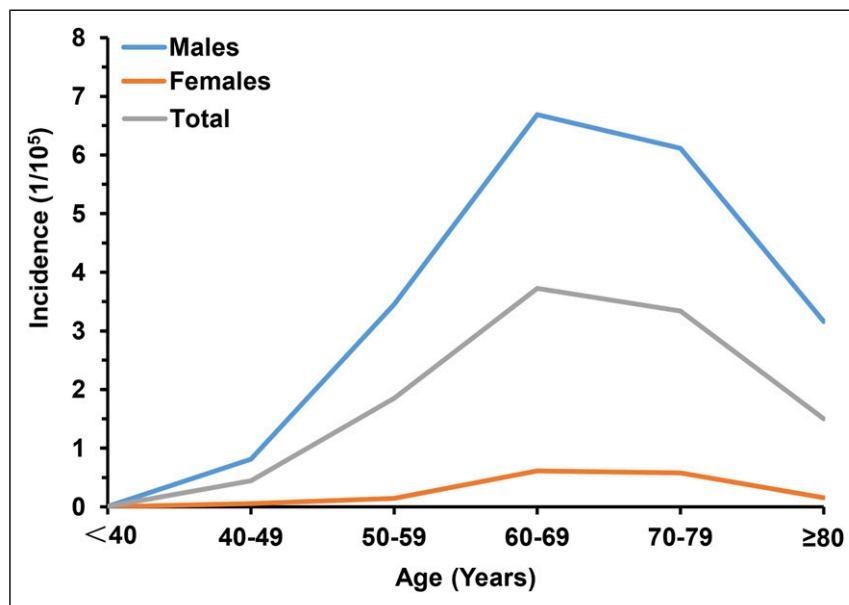
**Table 3.** Age-Specific Incidence of Laryngeal Cancer in Shanxi Province, 2008-2012.

Age Group	Male			Female			Total		
	Cases	N	Incidence (1/10 <sup>5</sup> )	Cases	N	Incidence (1/10 <sup>5</sup> )	Cases	N	Incidence (1/10 <sup>5</sup> )
<40	4	543 55881	0.007	5	515 85891	0.010	9	1059 41884	0.008
40-49	121	149 07587	0.812	8	142 98455	0.056	129	292 06081	0.442
50-59	380	110 00872	3.454	15	103 16485	0.145	395	213 17384	1.853
60-69	401	599 6135	6.688	35	571 5556	0.612	436	117 11710	3.723
70-79	210	343 4704	6.114	20	345 6663	0.579	230	68 91391	3.337
≥80	33	104 3890	3.161	2	128 6060	0.156	35	23 29963	1.502
<b>Total</b>	<b>1149</b>	<b>907 39069</b>	<b>1.266</b>	<b>85</b>	<b>866 59110</b>	<b>0.098</b>	<b>1234</b>	<b>1773 98413</b>	<b>0.696</b>

drinking (48.8%), 4 patients reported only drinking but not smoking (0.4%), 273 patients reported both not smoking and not drinking (27.1%) ( $\chi^2 = 106.980$ ,  $P < 0.001$ ) (Table 4). Smoking was more common among men, while there were 695 men smoking (95.3%) and 34 women smoking (4.7%) ( $\chi^2 = 203.085$ ,  $P < 0.001$ ) (Table 5).

#### Urban and Rural Incidence of Patients With Laryngeal Cancer

The majority of cases were farmers (723 cases, 58.6%), and slightly more than one fourth were workers (338 cases, 27.4%). All other occupations accounted for fewer than 10%



**Figure 4.** Age-specific incidence of laryngeal cancer in Shanxi Province, 2008-2012.

**Table 4.** Smoking and Drinking Habits of Patients With Newly Diagnosed Laryngeal Cancer in Shanxi Province, 2008-2012 (N = 1006).

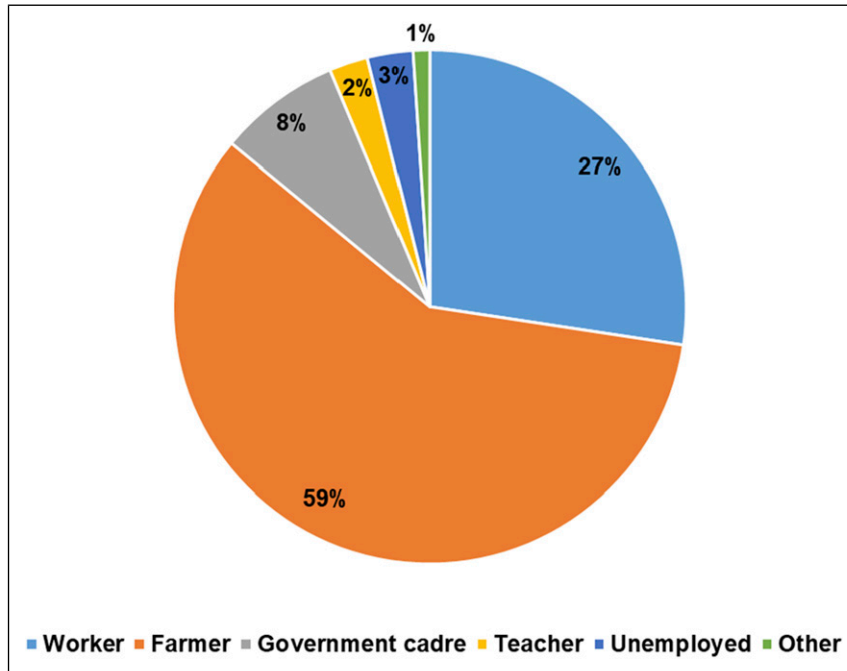
	Drinking (n, %)	No Drinking (n, %)	Total	$\chi^2$	P
<b>Smoking</b>	238 (23.7%)	491 (48.8%)	729 (72.5%)	106.980	<b>&lt;0.001</b>
<b>No smoking</b>	4 (0.4%)	273 (27.1%)	277 (27.5%)	—	—
<b>Total</b>	242 (24.1%)	764 (75.9%)	1006 (100%)	—	—

**Table 5.** Smoking Habits of Patients With Newly Diagnosed Laryngeal Cancer by Gender in Shanxi Province, 2008-2012 (N = 1006).

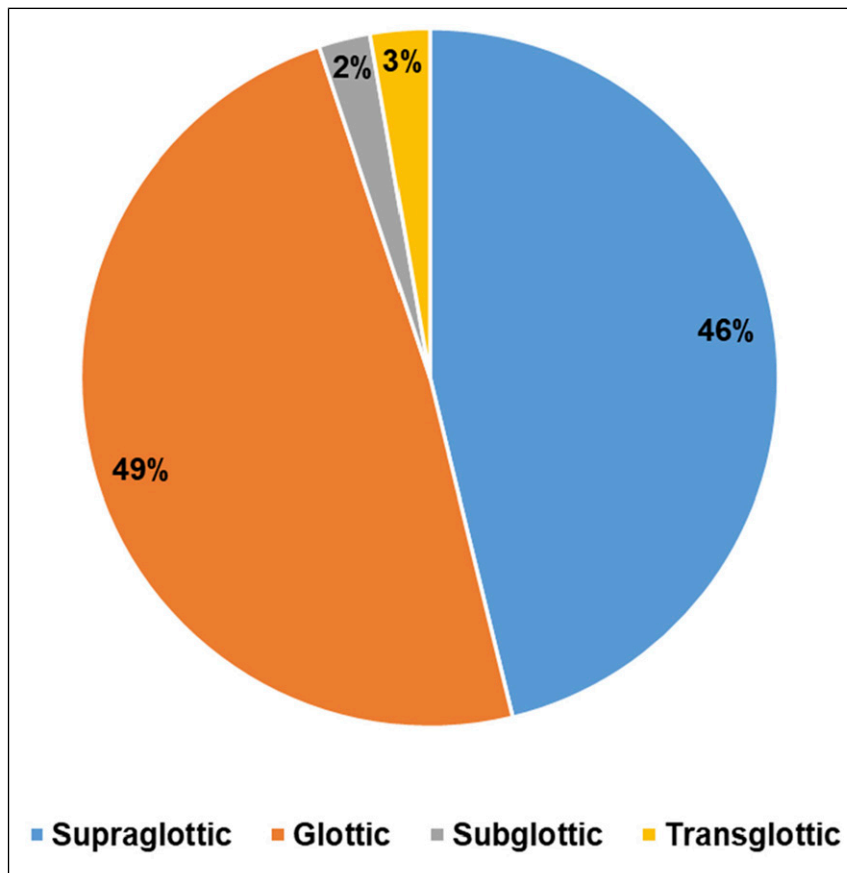
	Male (n, %)	Female (n, %)	Total	$\chi^2$	P
<b>Smoking</b>	695 (95.3%)	34 (4.7%)	729 (100%)	203.085	<b>&lt;0.001</b>
<b>No smoking</b>	241 (87.0%)	36 (13.0%)	277 (100%)	—	—
<b>Total</b>	936 (93.0%)	70 (7.0%)	1006 (100%)	—	—

**Table 6.** Urban and rural incidence of laryngeal cancer in Shanxi Province, 2008-2012.

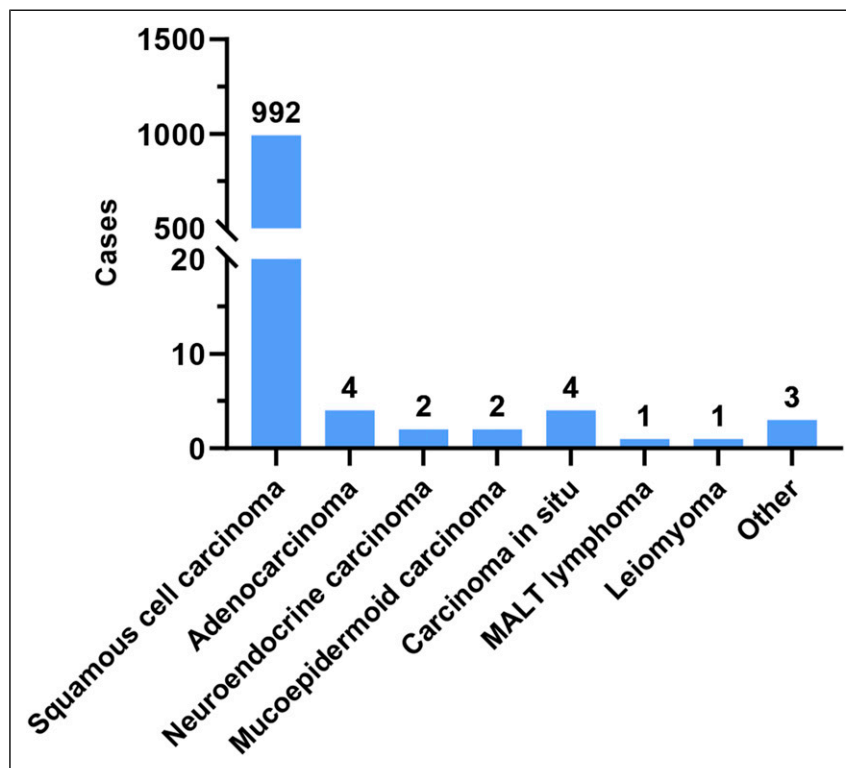
Year	Rural Areas			Urban Areas		
	Case	N	Incidence (1/10 <sup>5</sup> )	Case	N	Incidence (1/10 <sup>5</sup> )
<b>2008</b>	123	196 79827	0.625	90	153 85842	0.585
<b>2009</b>	147	194 83139	0.755	104	157 60935	0.660
<b>2010</b>	145	182 87049	0.793	105	171 74326	0.611
<b>2011</b>	130	178 36120	0.729	123	178 53118	0.689
<b>2012</b>	178	174 27233	1.021	89	185 10824	0.481
<b>Total</b>	723	927 13368	0.780	511	846 85045	0.603



**Figure 5.** Occupational distribution of patients with newly diagnosed laryngeal cancer in Shanxi Province, 2008-2012 (N = 1006).



**Figure 6.** Clinical classification of patients with newly diagnosed laryngeal cancer in Shanxi Province, 2008-2012 (N = 879).



**Figure 7.** Pathological diagnosis of patients with newly diagnosed laryngeal cancer in Shanxi Province, 2008-2012 (N = 1009).

of cases, including government cadres (95 cases, 7.7%), teachers (30 cases, 2.4%), unemployed individuals (35 cases, 2.8%), and other occupations (13 cases, 1.1%). The incidence of laryngeal cancer in rural areas was  $0.78/10^5$ , while urban area was  $0.60/10^5$  (Table 6, Figure 5).

### Clinical Classification of Patients With Laryngeal Cancer

Clinical diagnosis records were available for 879 of the 1234 patients included in the analysis. Among these, the vast majority were of supraglottic type (406 cases, accounting for 46.2% of all cases) or glottic type (428 cases, 48.7%). Approximately 5% of cases were of other clinical subtypes, including 21 cases of subglottic type (2.4%) and 24 cases of transglottic type (2.7%) (Figure 6).

### Pathological Diagnosis of Patients With Laryngeal Cancer

Pathological diagnosis records were available for 1009 of the 1234 patients included in the study. The overwhelming majority of cases were squamous cell carcinoma (992 cases, or 98.3%). The sample also included 4 cases of adenocarcinoma, 2 cases of neuroendocrine carcinoma, 2 cases of mucoepidermoid carcinoma, 4 cases of carcinoma in situ, 1 case of mucosa-associated lymphoid tissue (MALT) lymphoma, and 1 case of leiomyoma. In addition, 3 cases had 2 pathological

types of tissue (basal cell carcinoma and partial adenoid cystic carcinoma; squamous cell carcinoma and mucoepidermoid carcinoma; squamous cell carcinoma and adenocarcinoma) (Figure 7).

### Discussion

Laryngeal cancer is a common malignant tumor in otolaryngology, accounting for 1-5% of systemic cancers overall.<sup>1</sup> Smoking, alcohol drinking, sustained inhalation of harmful substances, and infection of papillomavirus may lead to laryngeal cancer.<sup>1</sup> The latest data from the 2018 global cancer statistics show a global age-standardized incidence for laryngeal cancer of 2.0/100,000.<sup>4</sup> However, incidence varies widely across different countries, with incidence rates of 7.0-16.2/100,000 in North American and Europe and 2.1/100,000 in Kazakhstan.<sup>6</sup> In China, age-standardized incidence of laryngeal cancer is 1.22/100,000 and crude incidence is 1.86/100,000,<sup>1</sup> which is lower than in many other countries. Reports show that the incidence of laryngeal cancer is rising in China.<sup>9,10</sup> However, no epidemiological data on laryngeal cancer in Shanxi Province has been published to date.

Our study showed the incidence of laryngeal cancer in Shanxi Province from 2008 to 2012 is relatively stable. The average annual incidence rate of laryngeal cancer in Shanxi Province from 2008 to 2012 was  $0.70/10^5$ , the Chinese population standardized incidence rate was  $0.57/10^5$ , which

was lower than that in the national tumor registration areas, and the world population standardized incidence rate was  $0.60/10^5$ , which was lower than that reported by GLOBOCAN 2012. According to gender statistics, the average annual incidence rate of laryngeal cancer in men and women was  $1.27/10^5$  and  $0.10/10^5$ , respectively, the Chinese population standardized incidence rate was  $1.02/10^5$  and  $0.09/10^5$ , and the world population standardized incidence rate was  $1.10/10^5$  and  $0.08/10^5$ , respectively. The incidence of laryngeal cancer in Shanxi Province is at a low level, and the reasons for this may be as follows: Shanxi Province has been promoting environmental protection and health education for a long time; its air quality, ecological environment conditions, and the health literacy level of residents have improved. At the same time, Shanxi Province also actively promotes the complete smoking ban in public places, which has achieved some results. The incidence in men is higher than that in women. It probably reflects ecological factors related to sex hormones and other risk factor exposures like smoking, alcohol drinking, and so on.

As mentioned above, significant differences exist in laryngeal cancer incidence between countries. Data from the world cancer report (GLOBOCAN 2012) shows the highest incidence found in Cuba, with elevated rates also seen in Hungary, Serbia, and Moldova in Eastern Europe, Armenia and Georgia in the Caucasus, and Iraq and Kazakhstan in Asia.<sup>4</sup> Our study showed substantial regional differences in laryngeal cancer incidence across different parts of Shanxi Province. The city with the highest incidence of laryngeal cancer is Taiyuan.

Taiyuan, the capital of Shanxi Province, is the largest anthracite production base and chemical and metallurgical industries center in the country. Beginning in 2001 with China's entry into the World Trade Organization, intense economic development in Taiyuan resulted in deteriorated air quality and increases in air pollutants. According to the ranking of the air pollution index documented under the national surveillance of environmental protection, Taiyuan was home to 1 of the most polluted cities in China.<sup>11</sup> The type of air pollution in Taiyuan is typical coal-burning pollution,<sup>12</sup> which mainly comes from the exhaust emissions of the heavy industries and coal-fired heating, including particulate matter, sulfur dioxide, and nitrogen oxide.  $SO_2$  is 1 of the major pollutants in the coal-smoking type of air pollution.<sup>13</sup> As Taiyuan mainly relies on coal for heating and cooking,  $SO_2$  pollution in Taiyuan is more serious than other cities in China.<sup>12</sup> Numerous studies have demonstrated that air pollution was the fourth highest-ranking risk factor and poor air quality adversely impacts human health.<sup>14</sup> Due to the specific geographical position and the climate type, ambient air pollution can hardly spread out immediately,<sup>15</sup> these factors may be partially responsible for the elevated incidence of laryngeal cancer in Taiyuan compared to other cities in Shanxi Province.

Laryngeal cancer is diagnosed much more frequently in men than in women. According to the International Agency for Research on Cancer (GLOBOCAN 2012) report, the

gender ratio (men: women) of laryngeal cancer is 7.8:1 worldwide and 10.5:1 in China.<sup>16</sup> The gender ratio for laryngeal cancer has been reported at 7:1 in Spain<sup>5</sup> and 10.5:1 in Kazakhstan.<sup>6</sup> Interestingly, the incidence rate of laryngeal cancer among women is comparatively high in Northeast China, with gender ratios in the range of 2.3:1-2.9:1. In contrast, our study found a gender ratio in Shanxi Province of 13.5:1, with incidence among females lower than the national level. This pattern may be related to the low rate of smoking among women in Shanxi Province: the smoking rates of both men (34.83%) and women (1.40%) in Shanxi are lower than the national level [men (66.0%) and women (3.08%)].<sup>17</sup> We also observed substantial variation in the gender ratio across different parts of the province, with gender ratios ranging from 12.5:1 to 26:1. There was no record of any women diagnosed with laryngeal cancer in Jincheng City over the study period, while women made up a disproportionate percentage of cases in Yuncheng City, in the south of Shanxi Province, where the gender ratio was 7.6:1.

As in our study, other investigations have found laryngeal cancer to be diagnosed primarily in patients over 40 years old. In a study of laryngeal cancer in Kazakhstan from 1999 to 2009, Igissinov et al found that 36.2% of cases were among patients aged 60-69 years, with a mean age of  $61.4 \pm 0.2$  years for men and  $45.5 \pm 0.6$  for women.<sup>6</sup> A study in Northeast Liaoning Province found that 43.5% of laryngeal cancer cases were 60-69 years old, with an overall mean age of 60.1 years and 73.0% of all cases falling between the ages of 50 and 69. In our study, the age-specific incidence rate of laryngeal cancer was relatively low in age groups before 40 years old and increased rapidly afterward, reaching peak at the age group of 60-69 years, with an incidence of  $3.72/10^5$ . In each age group, incidence rates in men were higher than those in women. Consistent with other studies in China and internationally, few patients were over age 80 or under age 40.

Tobacco can significantly increase the risk of squamous cell carcinoma in the glottic area, whereas alcohol consumption can significantly increase the risk of supraglottic cancer,<sup>7,18-20</sup> with a multiplicative effect produced when smoking and drinking are combined.<sup>5,20,21</sup> Consistent with these patterns, the prevalence and incidence of supraglottic carcinoma in Northeast China, which has elevated rates of both smoking and drinking, is significantly higher than in other parts of China. Of 1006 patients with smoking and drinking status reported in our study, the proportion of smoking but not drinking was the highest, while the proportion of drinking but not smoking was the lowest ( $P < 0.001$ ). The high percentage of smokers underscores the importance of smoking as a risk factor for laryngeal cancer, whereas rates of drinking did not appear to be linked to incidence of laryngeal cancer in Shanxi Province. Smoking rates are relatively low among women in Shanxi Province, which may partly explain why the observed incidence of laryngeal cancer in Shanxi Province was lower than in other parts of China.



Most previous studies from China and other countries show a significantly higher incidence of laryngeal cancer in cities compared to rural areas,<sup>8,9</sup> with especially high incidence seen in industrial cities. This is likely the result of air pollution, as suggested by elevated incidence observed among workers. In our study, workers accounted for 27.4% of laryngeal cancer cases, whereas farmers accounted for 58.6% of cases. In contrast to previous studies, incidence was significantly higher in rural areas than in urban areas. This pattern may partly stem from recent development and expansion of cities in Shanxi Province, where some pollution-generating industries have moved to rural areas, and coal mines, steel smelting plants, and other enterprises have been built directly in rural areas, leading to deteriorations in air quality. Research shows that there was a significant association between exposure to coal dust and laryngeal cancer since coal dust typically contains substantial amounts of mineral matter.<sup>22</sup> Meanwhile, the education and awareness around occupational use of protective equipment among employees in these industries are often lacking.<sup>23</sup> These patterns may be important contributors to the elevated incidence of laryngeal cancer seen in rural parts of Shanxi Province. This may also related to the higher health awareness and health-care level of urban people, and the specific reasons need to be further explored.

Laryngeal cancer is more frequently presented as squamous cell carcinoma, which accounts for about 98% of cases. In contrast, adenocarcinoma, undifferentiated carcinoma, lymphosarcoma, and fibrosarcoma are rare in laryngeal cancer. The most common clinical subtype is glottic, accounting for about 60% of cases, followed by supraglottic, which accounts for about 30% of cases, with subglottic cancer being relatively rare. However, supraglottic cancer is somewhat more common among laryngeal cancer cases in Northeast China. Findings from our analyses with respect to clinical subtype are consistent with previous reports on the epidemiological characteristics of laryngeal cancer in most parts of China. Squamous cell carcinoma accounted for 98.3% of all cases in our analyses, and the main clinical types were supraglottic and glottic, accounting for 48.7% and 46.2% of cases, respectively.

## Conclusion

Our study showed the incidence of laryngeal cancer in Shanxi Province exhibited a relatively stable trend from 2008 to 2012. We also observed marked regional differences in incidence within the province, with the highest incidence of laryngeal cancer found in Taiyuan City. The majority of patients were between 60 and 69 years old, with an average age of 61.57 years. The incidence among women was significantly lower than the national average, yielding a gender ratio of 13.5:1.

The smoking rate of patients with laryngeal cancer (72.5%) is higher than that of residents of Shanxi Province (36.22%). The high smoking rate in this patient population underscores the importance of smoking as a risk factor for laryngeal cancer.

There appeared to be little effect of drinking on laryngeal cancer, but drinking and smoking had a synergistic effect on the occurrence of laryngeal cancer. The majority of patients were farmers, and most came from rural areas. This pattern stands in contrast to findings from other studies in China and internationally and may be the result of high levels of air and water pollution in rural areas from sources such as coal coke and other industrial sources. However, eliciting the specific reasons underlying geographic and occupational patterns of laryngeal cancer incidence in Shanxi requires further research. The most frequent type of laryngeal cancer in Shanxi Province was glottic cancer, but supraglottic cancer was nearly as common. As has been found in previous research, squamous cell carcinoma was the most common type of cancer, accounting for 98.3% of cases in our study.

To sum up, although the incidence of laryngeal cancer in Shanxi Province was lower than the national average, the prevention and treatment of laryngeal cancer cannot be relaxed. We should focus on male intervention, carry out effective publicity and education on the basis of community, and advocate early diagnosis and early treatment of laryngeal cancer through strategies and measures such as banning smoking in public places, advocating quitting smoking and limiting alcohol, improving the environment, reducing occupational exposure, and eating scientifically to prevent the increase in morbidity of laryngeal cancer.

## Appendix A

### Abbreviation

MALT Mucosa-associated lymphoid tissue

### Declaration of Conflicting Interests

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### Ethical approval

Our study was approved by Research Ethics Committee of Shanxi Medical University (2018LL070).

## Informed consent

All patients provided written informed consent prior to enrollment in the study.

## Data Availability Statement

All materials, data, code, and associated protocols will be promptly available to readers without qualifications or restrictions. The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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