

## Preplanned Studies

## Economic Burden of Malignant Tumors — Yichang City, Hubei Province, China, 2019

Xiaojuan Long<sup>1,✉</sup>; Fangfang Lu<sup>2,✉</sup>; Xianglong Xiang<sup>1</sup>; Jiajuan Yang<sup>2</sup>; Chengzhong Xu<sup>2</sup>; Pei Zhang<sup>2</sup>; Shicheng Yu<sup>1</sup>; Qiqi Wang<sup>1,✱</sup>; Chi Hu<sup>2,✱</sup>

### Summary

#### What is already known about this topic?

Malignant tumors are common chronic non-communicable disease and have caused serious health hazards to residents and heavy economic burden of disease to the society.

#### What is added by this report?

This is the first report on the economic burden of multiple types of malignant tumors in Yichang City. In 2019, the direct medical burden of lung cancer in Yichang was the highest, reaching 561.67 million CNY, and the indirect economic burden of lung cancer in Yichang was higher than that of other malignant tumors, costing 326.49 million CNY.

#### What are the implications for public health practice?

The results can provide evidence for the formulation of local cancer prevention and control strategies and public health decision-making.

Economic burden of disease is the economic loss of patients, families, and society caused by morbidity, disability, and premature death, as well as the consumption of health resources from disease prevention and treatment (1–2). Domestic and foreign studies show that the morbidity and mortality of malignant tumors have increased year by year (3), which brings heavy economic burden to the world. For example, economic burden of malignant tumors in Spain was 39.61 million CNY in 2015 (4), and economic burden of malignant tumors of a region in Southwest China was 18.86 billion CNY in 2016 (5). In this study, data from the cause of death surveillance, tumor registration, and big data platform of health management in Yichang City were used to calculate the direct medical burden of 14 types of malignant tumors and to estimate indirect economic burden by human capital method. The results showed that direct medical burdens of lung cancer, liver cancer, and colorectal carcinoma in 2019 were higher than those of

other malignant tumors, being 561.67 million CNY, 386.08 million CNY, and 177.49 million CNY, respectively; indirect economic burdens of lung cancer, liver cancer, and esophageal cancer were also higher, being 326.49 million CNY, 188.17 million CNY, and 66.03 million CNY, respectively. Therefore, the economic burden of lung cancer, liver cancer, colorectal carcinoma, and esophageal cancer was significant, and these cancers should be the focus of disease prevention and control in Yichang City.

In this study, cancer mortality was derived from the cause of death surveillance that covers all 9 counties and 5 districts in Yichang. Cancer incidence was obtained from the tumor registration that includes 5 districts and 2 counties. Outpatient and inpatient diagnostic data and expense data of malignant tumors were gained from the big data platform of health management that contains medical information from all hospitals in 5 districts and 2 counties in Yichang. Yichang's population data and per-capita GDP (per-capita Gross Domestic Product) from the statistical yearbook were employed to estimate direct medical burden and indirect economic burden of 14 types of malignant tumors for the year of 2019 in Yichang.

The 2019 outpatient and inpatient diagnostic databases from the big data platform of health management were linked with the expense database by unique personal identification number to get annual average medical cost of a patient for the year 2019. Items of medical cost include western medicine fee, Chinese herbal medicine fee, Chinese patent medicine fee, radiation fee, laboratory fee, examination fee, radiography fee, operation fee, blood transfusion fee, oxygen delivery fee, diagnosis fee, treatment fee, bed companion fee, nursing fee, hospitalization fee, bed fee, registration fee, material fee, and others. The following formula was applied to calculate direct medical burden for a cancer.

$$\text{Direct medical burden} = \text{Annual average medical cost per patient} \times \text{prevalence rate} \times \text{population size} \quad (1)$$

This study analyzed the median, smaller fourth quartile, and higher fourth quartile of the direct medical burden of 14 malignant tumors. The 2019 values of prevalence rate and number of populations in Yichang were taken for the above calculation. The calculation of prevalence rate of a cancer was illustrated in the calculation of years lived with disability (YLDs).

A human capital method was employed to estimate indirect economic burden of a malignant tumor for the year of 2019 in Yichang. The disability-adjusted life years (DALYs) and productivity weight were combined to estimate indirect economic burden. The formula is shown below.

$$\text{Indirect economic burden} = \text{per-capita GDP} \times \text{DALYs} \times \text{productivity weight} \quad (2)$$

Through consulting relevant literature on economic burden research, several assumptions were made. The contribution of different age groups to production was different, so the productivity weight was different by age group and their values were set at 0.15, 0.75, 0.80, and 0.1 for 0–14, 15–44, 45–59, and 60 years old and above, respectively, and the productivity weight of the overall population was 0.5 (6–8). The per-capita GDP of Yichang was 11,410.52 CNY for all age groups. The four age groups were applied for the above calculation and were then summed to obtain indirect economic burden of a cancer. The DALYs for the four age groups were estimated as follows.

After adjusting for missing report rate and garbage codes, the mortality rate of malignant tumors by age group for the year 2019 in Yichang was estimated. The years of life lost (YLLs) caused by early death of a malignant tumor were further calculated.

$$\text{YLLs} = D \times L \quad (3)$$

D was the number of deaths by age group, L was the life loss value by age group from the standard life expectancy table of the GBD 2013.

The YLDs caused by cancer disability were estimated by the following formula.

$$\text{YLDs} = P \times DW \quad (4)$$

P was the prevalence by age group; DW was the disability weight that reflected the severity of disability caused by disease, and its value was between 0 and 1, in which 0 represents complete health and 1 represents death (9). Hereby, the value of disability weight for all 14 types of cancers was 0.451 as estimated from the GBD 2013. A five-year period was utilized for calculating the cancer prevalence of 2019, therefore the above number of prevalence was accumulated from 2015 to 2019.

The incidence data of malignant tumor surveillance in Yichang from 2015 to 2018 were obtained, but the incidence data of malignant tumors in 2019 were lacking. Therefore, this study needed to estimate the incidence of malignant tumors in 2019 first, and then the incidence data and prevalence rate of malignant tumors in 2019, and further estimate the YLDs of malignant tumors.

The specific estimation process was as follows. First, a linear model was established based on the incidence of cancer in counties and cancer types in tumor registration regions from 2015 to 2018 to estimate the incidence of malignant tumors in 2019. Second, the number of deaths of patients with new malignant tumors in 2019 was estimated based on the proportion of deaths and incidence of cancer types and counties in tumor registration regions from 2015 to 2018, combined with the incidence of malignant tumors in 2019. Then, according to the number of cancer incidence and death from 2015 to 2019, the number and prevalence of malignant tumors in 2019 were calculated. Finally, the YLDs of malignant tumors in Yichang in 2019 were estimated according to the above formula.

The DALYs of malignant tumors were estimated using the following formula.

$$\text{DALYs} = \text{YLLs} + \text{YLDs} \quad (5)$$

In short, the above estimation was applied to each type of cancer. YLDs were estimated as the product of an estimate of prevalence and a disability weight for the cancer; YLLs were expressed as the product of mortality estimates and years of life lost due to premature death; and DALYs were calculated as the sum of YLLs and YLDs. All statistical analyses were performed using SAS (version 9.4, SAS Institute Inc., Cary, USA).

The results showed that the top five malignant tumors of medical cost per patient for the year 2019 in Yichang were pancreatic cancer, cerebral cancer, liver cancer, esophageal cancer, and lung cancer, which were 15,670 CNY, 12,136 CNY, 11,744 CNY, 11,474 CNY, and 10,144 CNY, respectively. The results were shown in [Table 1](#).

From [Table 2](#), the direct medical burdens of lung cancer, liver cancer, colorectal carcinoma, esophageal cancer, and breast cancer were ranked top five for direct medical burden, which were 561.67 million CNY, 386.08 million CNY, 177.49 million CNY, 151.80 million CNY, and 1,113.45 million CNY, respectively.

TABLE 1. Medical cost per patient by types of malignant tumors in Yichang City, Hubei Province, 2019.

Type of malignant tumors	Number of patients	Medical cost per patient (1 CNY)		
		Median	Q <sub>1</sub>	Q <sub>3</sub>
Pancreatic cancer	242	15,670	3,043	41,299
Cerebral cancer	229	12,136	1,470	50,196
Liver cancer	1,700	11,744	3,139	27,286
Esophageal cancer	940	11,474	2,380	38,946
Lung cancer	4,863	10,144	2,094	30,468
Lymphoma	1,388	8,667	1,379	32,043
Prostate cancer	827	8,073	1,987	21,566
Colorectal carcinoma	2,201	7,855	1,525	38,651
Gastric cancer	555	6,857	664	7,820
Leukemia	1,023	6,512	846	31,078
Cervical cancer	1,466	4,895	1,035	27,000
Bladder cancer	708	3,694	725	16,202
Breast cancer	3,379	3,344	956	17,950
Corpus cancer	675	2,348	810	17,337

Note: Q<sub>1</sub>, known as the “Smaller fourth Quartile”, is equal to the 25% of all values in the sample, from smallest to largest. Q<sub>3</sub>, known as the “higher fourth quartile”, is equal to the 75% of all values in the sample, from smallest to largest.

TABLE 2. The direct medical burden of malignant tumors in Yichang City, Hubei Province, 2019.

Type of malignant tumors	Direct medical burden (10,000 CNY)
Lung cancer	56,166.73
Liver cancer	38,608.42
Colorectal carcinoma	17,749.18
Esophageal cancer	15,179.58
Breast cancer	11,344.66
Cervical cancer	10,142.83
Lymphoma	8,287.72
Prostate cancer	6,772.66
Gastric cancer	6,607.42
Leukemia	6,181.25
Bladder cancer	4,742.55
Pancreatic cancer	4,634.35
Cerebral cancer	3,437.72
Corpus cancer	1,762.43

Table 3 showed that the indirect economic burdens of lung cancer, liver cancer, esophageal cancer, colorectal carcinoma, and gastric cancer in Yichang were higher than those of other malignant tumors, which were 326.49 million CNY, 188.17 million CNY, 66.03 million CNY, 57.30 million CNY, and 39.86 million CNY, respectively. The indirect economic burden of malignant tumors varied greatly

by age group, of those, the indirect economic burden of 45–59 years old group was among the highest, 15–44 years old group was the second.

## DISCUSSION

The direct medical burden of lung cancer, liver cancer, colorectal carcinoma, esophageal cancer, and breast cancer in Yichang was higher among all malignant tumors in 2019, and the indirect economic burdens of lung cancer, liver cancer, esophageal cancer, colorectal carcinoma, and gastric cancer were among the top five. It can be seen that lung cancer, liver cancer, colorectal carcinoma, esophageal cancer, breast cancer, and gastric cancer had a great impact on residents' health and the economy in Yichang. The results of burden of malignant tumors in Yichang from 2005 to 2015 from a study and those of other cities also suggest that lung cancer, liver cancer, colorectal carcinoma, and other malignant tumors have caused a serious disease burden on Yichang (10). Therefore, the prevention and control of these cancers is not only the difficulty of the prevention and control of malignant tumors in Yichang, but also the focus of upcoming prevention and control work.

The indirect economic burden of malignant tumors for the year 2019 in Yichang varied greatly by age groups. The indirect economic burden of 45–59 years

TABLE 3. The indirect economic burden of malignant tumors by age group in Yichang City, Hubei Province, 2019.

Type of malignant tumors	Indirect economic burden (10,000 CNY)				
	Total	Age group (years)			
		0–14	15–44	45–59	60 and above
Lung cancer	32,648.90	9,794.67	48,973.34	52,238.23	6,529.78
Liver cancer	18,816.81	5,645.04	28,225.22	30,106.90	3,763.36
Esophageal cancer	6,602.55	1,980.76	9,903.82	10,564.07	1,320.51
Colorectal carcinoma	5,730.22	1,719.07	8,595.33	9,168.36	1,146.04
Gastric cancer	3,986.32	1,195.90	5,979.48	6,378.11	797.26
Cervical cancer	3,372.08	1,011.62	5,058.12	5,395.32	674.42
Pancreatic cancer	3,368.99	1,010.70	5,053.48	5,390.38	673.80
Breast cancer	2,966.14	889.84	4,449.21	4,745.82	593.23
Cerebral cancer	2,925.18	877.56	4,387.78	4,680.30	585.04
Leukemia	2,534.64	760.39	3,801.96	4,055.43	506.93
Bladder cancer	1,777.94	533.38	2,666.91	2,844.71	355.59
Lymphoma	1,655.38	496.61	2,483.06	2,648.60	331.08
Prostate cancer	1,202.95	360.89	1,804.43	1,924.73	240.59
Corpus cancer	728.69	218.61	1,093.03	1,165.90	145.74

old group was higher than that of 0–14 years old, 15–44 years old, 60 years old and above, and the indirect economic burden of 15–44 years old group was the next highest. The indirect economic burden caused by malignant tumor patients in 45 to 59 years old and 15 to 44 years old in Yichang was relatively heavy, and the prevention and treatment of malignant tumors should pay more attention to these two groups.

This study was subject to some limitations. First, the economic burden includes direct economic burden, indirect economic burden, and intangible economic burden; the direct economic burden contains direct medical cost burden and direct non-medical burden. Neither the direct non-medical burden nor the intangible economic burden was included in this study, so the economic burden may be underestimated. Second, the number of years of malignant tumor incidence data available for collection in Yichang was short, so the estimated prevalence of malignant tumors may be low, which may further lead to a low estimated economic burden.

In conclusion, malignant tumors such as lung cancer, liver cancer, colorectal cancer, esophageal cancer, breast cancer, and gastric cancer not only cause great harm to the health of local residents, but also cause a huge economic burden and a great impact on societal and economic development in Yichang. Local health authority should place priority to these cancers when formulating cancer prevention and control

strategies and allocate resources for chronic disease prevention and control. In addition, the indirect economic burden caused by the 45–59 age group was relatively high. Relevant departments in Yichang should pay more attention to economic burden caused by a certain malignant tumor in this age group. The focus of cancer prevention and control should be targeting this age group of people. Therefore, Yichang can reduce the economic burden of malignant tumors by early detection, early diagnosis, early treatment, screening of key cancer species, and health education.

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# Corresponding authors: Qiqi Wang, wangqq@chinacdc.cn; Chi Hu, 271112631@qq.com.

<sup>1</sup> Office of Epidemiology, Chinese Center for Disease Control and Prevention, Beijing, China; <sup>2</sup> Yichang Center for Disease Control and Prevention, Yichang City, Hubei Province, China.

<sup>‡</sup> Joint first authors.

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